

Nov. 23, 1937.

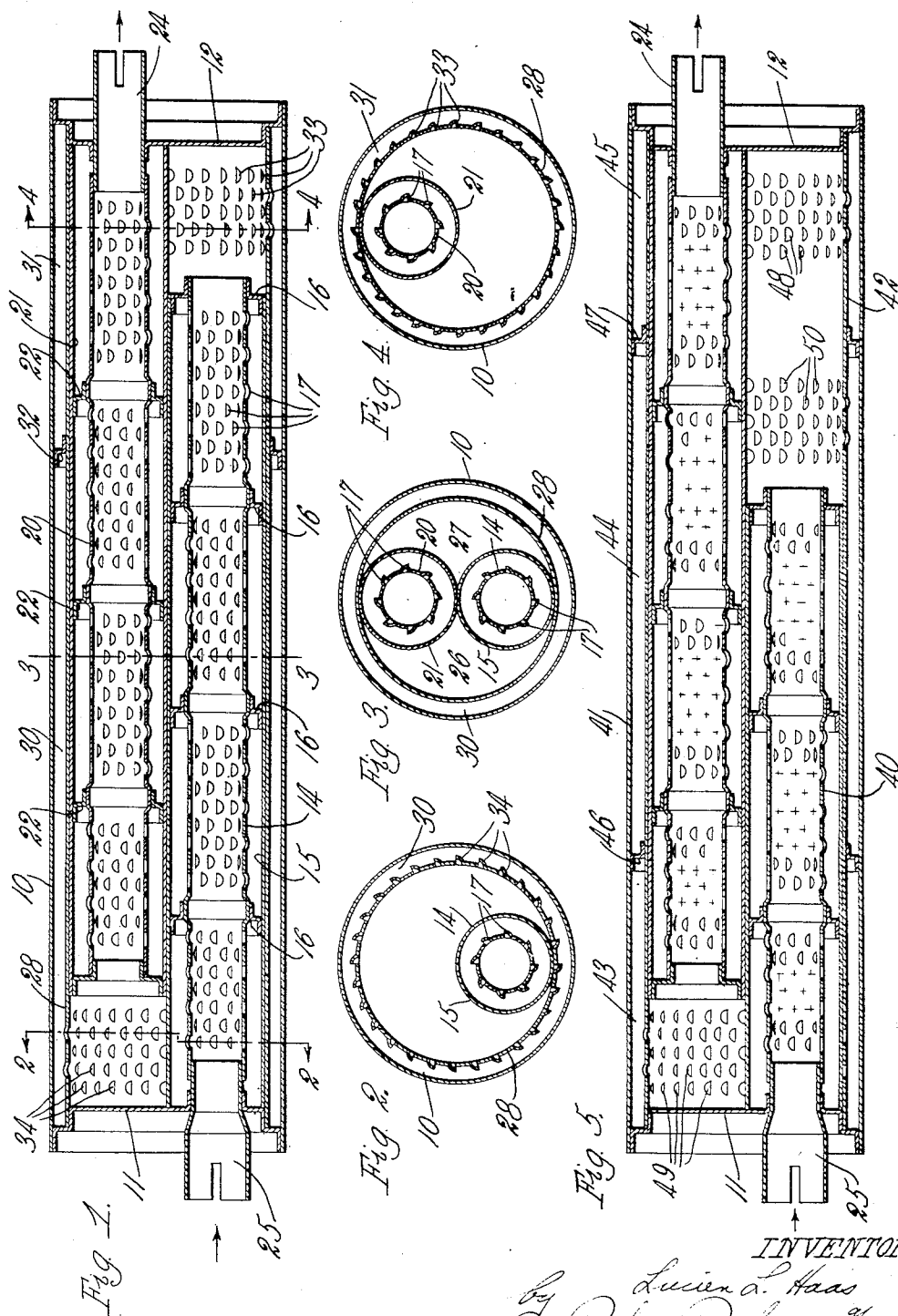
L. L. HAAS

2,100,030

SILENCER

Filed June 7, 1934

2 Sheets-Sheet 1



INVENTOR

Lucien A. Haas
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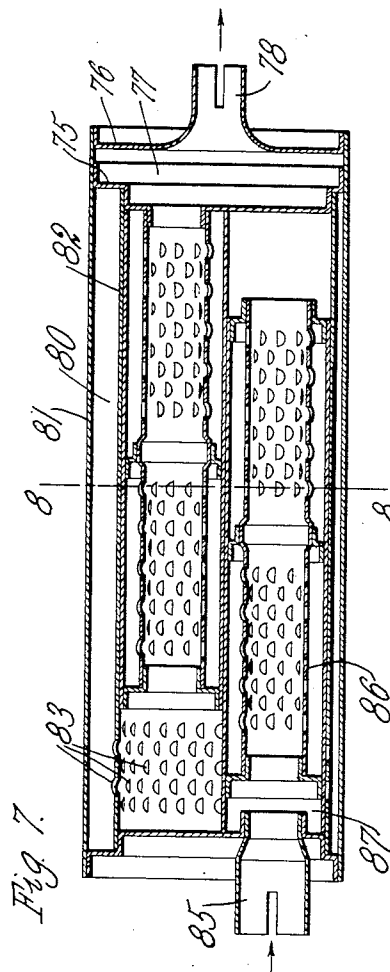
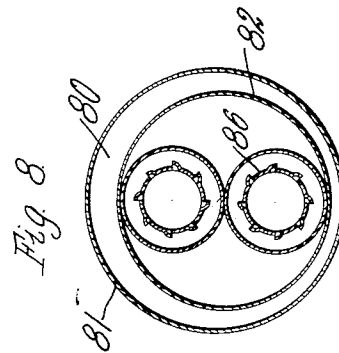
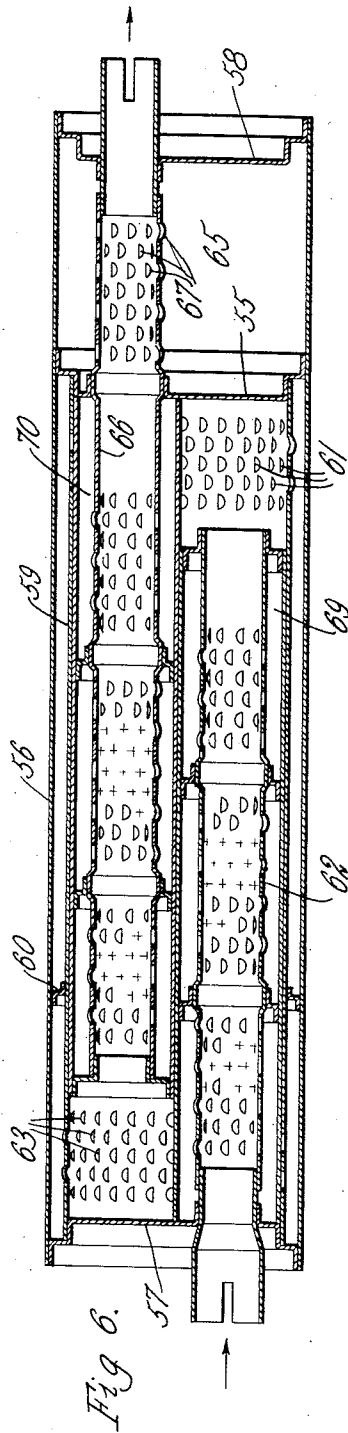
L. L. HAAS

2,100,030

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2 Sheets-Sheet 2



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2,100,030

SILENCER

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Application June 7, 1934, Serial No. 729,451

19 Claims. (Cl. 181-54)

This invention relates to improvements in silencers or mufflers, particularly of the type employed for the silencing of the exhaust from internal combustion engines.

5 The objects of this invention are to provide an improved muffler of the type in which the gases, instead of flowing straight through the muffler from one end thereof to the other, have their direction of flow changed within the muffler; also
10 to provide a muffler of this type within which a pair of gas conducting and sound attenuating units are arranged in overlapped relation to each other within the muffler, and in which a shell surrounding the units is used to conduct the gases
15 from one of the sound attenuating units to the other.

Other objects of the invention are to provide a muffler of this type with an outer annular sound attenuating chamber surrounding the sound
20 attenuating units; also to construct a muffler of this type in such a manner that the inner sound attenuating units are acoustically insulated from the outer shell of the muffler for the purpose of eliminating certain noises caused by direct contact
25 of the sound attenuating units with the outer shell of the muffler; also to provide a muffler of this kind with a space that may be divided by a baffle or baffles into a number of sound attenuating chambers, so that by mere change in position
30 of a baffle, or by increasing or decreasing the number of baffles, the dimensions of the sound attenuating chambers and their actions on certain sound waves or frequencies can be varied; also
35 to improve the construction of mufflers of this type in other respects hereinafter specified and claimed.

In the accompanying drawings:

Fig. 1 is a longitudinal central sectional view of one type of muffler embodying this invention;

40 Figs. 2, 3 and 4 are transverse sectional elevations thereof, on lines 2-2, 3-3, 4-4, respectively, of Fig. 1;

Figs. 5, 6 and 7 are longitudinal central sectional elevations of mufflers of somewhat modified constructions;

45 Fig. 8 is a transverse sectional elevation on line 8-8, Fig. 7.

Referring to Fig. 1, 10 represents the outer shell or casing of the muffler which has heads 11 and 12 secured to the ends thereof, the head 11 being provided with an inlet opening and the head 12 with an outlet opening. Within the muffler are arranged a number of sound attenuating and gas conducting units preferably extending
50 parallel to each other and in tangential and
55 overlapping relation to each other, although it is not essential that the units be in tangential or over-lapping relation to each other. The mufflers shown in the drawings represent relatively simple embodiments of my invention and in these mufflers only two sound attenuating units are used, although more of such units may be employed, if desired, or only one sound attenuating unit may be employed, and the other sound attenuating unit may be replaced by a
10 conduit for the exhaust gas. One of these units communicates with the aperture in the head 11, and the other unit connects with the aperture in the head 12 at the discharge end of the muffler.

These sound attenuating units may be of any
15 suitable or desired construction, and in the particular muffler illustrated in Fig. 1, the sound attenuating unit connecting with the inlet head 11 includes an inner conduit or tube 14 provided with perforations throughout the greater portion of the length thereof and a substantially imperforate tube 15 surrounding the conduit 14
20 and spaced therefrom by means of one or more annular baffles 16. The openings in the conduit 14 are of relatively small size, and preferably the inner conduit 14 has portions thereof pressed outwardly at the perforations in this shell to form louvers 17. When such louvers are used,
25 the gases and sound waves discharged through the apertures in the inner conduit 14 are deflected tangentially to produce a spinning or whirling movement of the gases and sound waves in the sound attenuating spaces or chambers between the inner conduit 14 and the shell 15.
30 Preferably, the louvers in different chambers extend alternately in opposite directions as shown in the drawings.

The other sound attenuating member may be similar to the one which has already been described, and as shown also includes an inner perforated conduit 20 and a substantially imperforate tube 21 surrounding the same and spaced therefrom by means of one or more baffles 22 to form sound attenuating chambers about the conduit. This conduit, as shown, connects with a
45 short tube 24 extending through the head 12 and the usual tail pipe (not shown) leading from the muffler may be connected to this tube. The first sound attenuating unit connects with an inlet tube or passage 25 extending through the head
50 11 and to which the exhaust pipe from the engine may be connected.

The first sound attenuating unit connecting with the inlet head 11 terminates at a distance from the other head 12, and the other sound at-
55

tenuating unit communicating with the aperture in the head 12, terminates at a distance from the inlet head 11. Consequently, exhaust gases discharged from the first unit have their direction of flow reversed and pass backwardly on the exterior of the two sound attenuating units into the receiving end of the second unit and after passing through this second unit, are discharged into the tail pipe. The two units, as clearly shown in Fig. 3, are preferably arranged in contact with each other and may, if desired, be welded together, so that the two units produce a relatively strong and rigid construction, and so that rattling is prevented, but these units may be arranged within the muffler in spaced relation to each other, and may be secured against rattling in other ways. As shown in Fig. 3, spaces 26 and 27 are provided outside of the units through which the gases flow from the rear to the front end of the muffler, which spaces together are of much greater cross-sectional area than the cross-sectional area of the conduits 14 or 20. Consequently, the gases are expanded after discharge from the conduit 14, which assists in silencing noise and reducing back pressure of the muffler.

It has been found that in mufflers in which sound attenuating units of this type are employed and arranged in contact with the outer shell of the muffler, a certain pinging sound is produced when pulsations or impulse waves from the engine pass into the muffler, which sounds can be heard within the body of the vehicle. I have found that this objection can be overcome by providing within the outer shell 10, a shell 28 spaced at a distance from the outer shell, and I also utilize the space between these two shells as resonator chambers, by means of which certain low frequency sound waves can be attenuated, which are not eliminated in the sound attenuating units which have already been described.

The space between the shells 28 and 10 may be employed in any suitable or desired manner to attenuate sound waves, and in the particular construction shown in Fig. 1, I divide this space into two sound attenuating or resonating chambers 30 and 31 by means of a baffle 32. I also provide perforations in the opposite end portions of the shell 28, such perforations 33 near the discharge end of the muffler communicating with one end of the resonating chamber 31, and corresponding apertures 34 near the inlet head 11 communicating with one end of the chamber 30. These apertures may be in the nature of spinner slots as used on the inner conduits 14 and 20 by forming louvers on the shell 28 at the apertures therein. This arrangement of the apertures in the shell 28 will cause gases and sound waves to be deflected tangentially into the end portions of the resonating chambers and by admitting these sound waves at one end of each chamber, the imperforate portion of each chamber will act as a resonating chamber. By varying the lengths of these resonating chambers by changing the position of the baffle 32, this portion of the muffler can be tuned to eliminate different sound waves. It is well known that different engines produce different noises in the exhaust and a muffler which is entirely satisfactory on engines of one design will be noisy when used on an engine of other design. By means of the construction described, the baffle 32 can be shifted to eliminate certain low frequency sound waves, and the higher frequency sound waves can be eliminated by varying the dimensions of the two sound

attenuating units which have been described, or by other means.

The construction shown in Fig. 5 is similar to that described in connection with Fig. 1, except that the first sound attenuating unit 40 is shorter than that shown in Fig. 1, and the space between the outer shell 41 of the muffler and the adjacent shell 42 is divided into three silencing or resonator chambers 43, 44 and 45 by means of baffles 46 and 47. As in the construction shown in Fig. 1, the chamber 45 receives gases and sound waves through a series of apertures 48 in the shell 42 near the end thereof, and the chamber 43 receives gases and sound waves through a series of apertures 49. A third set of apertures 50 is provided in the shell 42 through which gases and sound waves may enter one end of the resonator chamber 44.

Fig. 6 illustrates another muffler of modified form embodying my invention. In the case of this muffler, in addition to the two end heads, an intermediate head 55 is employed. The outer shell 56 of this muffler extends from the inlet head 57 to the outlet head 58, and the second shell 59 spaced adjacent thereto extends from the inlet head 57 to the intermediate head 55. The shell 59 is provided with apertures 61 through which gases and sound waves may pass after passing through the first sound attenuating unit 62, and another series of apertures 63 are provided at the other end of the shell 59, both of these apertures communicating with resonance chambers formed between the shells 56 and 59 and separated by a baffle 60.

A sound attenuating chamber 65 of different form is employed in this muffler between the heads 55 and 58 and the gas and sound conducting conduit 66 of the second sound attenuating unit extends through the chamber 65, and is provided with openings 67 in the portion thereof extending into this chamber. This arrangement produces a whirling action of the gases when the conduit 66 is provided with louvers 67 as shown in the drawings and by arranging the conduit 66 eccentrically within the chamber 65, a sound attenuating effect is produced which has been found very effective for certain types of noises, since sound waves, whirling about the conduit 66 in the eccentric chamber surrounding this conduit are more effectively attenuated than when whirling in a concentric annular chamber.

It will be noted too that in the first sound attenuating unit 62, one of the chambers 69 is of greater length than the length of the perforated portion of the inner conduit extending through the same, and a similar arrangement is provided in connection with the second sound attenuating unit in which a similar chamber 70 is provided. The portions of these chambers about the imperforate parts of the inner conduit form resonators which act to destroy certain sounds.

Figs. 7 and 8 show still another modification of my invention. In the muffler shown in these figures, an intermediate head 75 is provided which with the discharge head 76 forms an expansion chamber 77 for the gases after passing through the sound attenuating units of the muffler. By means of this construction, the discharge outlet forming a part of the rear head 76 may be formed in any convenient location, and need not be in alignment with the second sound attenuating unit of the muffler. In the construction shown, this outlet 78 to which the tail pipe may be connected is formed centrally on the discharge head 76.

In this muffler only a single resonating chamber 80 is formed between the outer shell 81 and the adjacent shell 82. It will be noted also that the shell 82 is arranged eccentrically with reference to the outer shell 81, see particularly Fig. 8, and the shell 82 is provided with apertures 83 communicating with the resonating chamber 80. In this construction, such apertures are only used at one end of the shell 82, but if desired, a baffle may be arranged in the chamber 80, in which case, apertures could also be provided near the other end of the shell 82.

By discharging gases and sound waves substantially tangentially into an annular chamber, the walls of which are eccentric with reference to the conduit from which the gases are discharged, as in the case of the chamber 80 in Figs. 7 and 8, and in the chamber 65 in Fig. 6, the sound waves are subjected in their passage around the eccentric chamber to travel between alternately converging and diverging walls of the chamber. This has a distorting or modifying effect on the sound waves which is even more effective in reducing sounds than when such waves pass around an annular chamber.

At the inlet end of this muffler, a short inlet tube 85 is employed which terminates at a distance from the adjacent end of the inner conduit 86 of the first sound attenuating unit, thus forming an expansion chamber 87 into which the gases pass upon first entering the muffler. An expansion chamber of this type may, of course, be used in connection with any of the other constructions which have been illustrated, and such chambers are effective in decreasing certain sounds and in decreasing the degree of impulse waves entering the muffler.

In all of the mufflers described, certain pinging sounds or shell noises, which are produced in mufflers in which the outer shells are secured to or contact directly with some of the sound attenuating units, are entirely eliminated by the provision of chambers between the sound attenuating units and the outer shells of the mufflers, and these chambers by means of the constructions illustrated also serve as resonator chambers, and thus serve the dual purpose of eliminating shell noise as well as different fundamental sounds and their harmonics. The mufflers in the form shown in the drawings are of strong and rigid construction, in that the outer shells or tubes of the two sound attenuating units of each muffler may be secured together, for example, by welding, and these tubes in turn may be welded to the inner shell of the outer resonance spaces of the mufflers, so that the several tubular parts reinforce each other.

In the operation of mufflers of the kind shown in the drawings, the exhaust gases and sound waves from the engine first pass into the first sound attenuating unit which includes a number of chambers communicating with the inner conduit through the perforations therein. Each of these chambers eliminates certain sounds, mostly of high frequency type, and also the tops or crests of the impulse waves entering the muffler are eliminated in these chambers. The exhaust gases then pass out of the first sound attenuating unit into the space near the discharge end of the muffler where their path of movement is reversed, and if at this point apertures are provided at the inner shell of the outer resonance chamber, other sound waves of lower frequency are destroyed or modified. The gases then pass toward the inlet end of the muffler in the relatively large spaces

surrounding the sound attenuating units and within the inner shell of the outer resonance chambers, and at the front or inlet end of the muffler, additional apertures may be provided in this shell, communicating with an outer resonance chamber tuned to attenuate still other sound waves. The action upon the sound waves and gases in passing through the second sound attenuating unit is much the same as in the first one and by the time the gases and sound waves reach the tail pipe, assuming that the muffler is proportioned and properly tuned for a particular type of engine, with which it is used, will be substantially free from noises. Because of the relatively large area of the return passages connecting the two sound attenuating units, there will be comparatively little back pressure produced in mufflers of this type, and the expansion of the gases in this part of the muffler also has the effect of reducing noise and impulse waves.

By means of the construction described, the manufacture of mufflers of the reverse flow type is greatly simplified for the reason that only two gas conducting conduits are arranged within the muffler, and a shell surrounding these conduits constitutes a return passage for the gases, thus eliminating the usual additional transverse baffles which are needed when a third or return conduit is used.

I claim as my invention:

1. A muffler including an imperforate outer shell, heads to which the opposite ends of said shell are connected and provided with openings for inlet and discharge of exhaust gases, a second shell arranged within said outer shell and spaced therefrom to form with said outer shell a resonator chamber, a pair of conduits arranged side by side within said second shell, one of said conduits receiving gases at one end thereof from the inlet opening and the other conduit discharging gases from the other end thereof through the discharge opening in the other head, each of said conduits terminating at their other ends at distances from said heads, at least one of said conduits being perforated throughout the greater portion of the length thereof, means arranged about the perforated portion of said conduit to form therewith a sound attenuating chamber, said second shell forming a return duct in which gases flow in a direction opposite to that in said conduits, said second shell having apertures to permit gases and sound waves to enter said resonator chamber.

2. A muffler including a shell and heads connected therewith and spaced apart, one of said heads being provided with an inlet opening for exhaust gases and the other head being provided with an outlet therefor, a pair of sound attenuating and gas conducting units arranged side by side in said shell, one of said units receiving exhaust gases from said inlet opening in one head and terminating within said muffler at a distance from the other head, and the other unit communicating with the discharge opening in the other head and terminating within said muffler at a distance from said first head, each of said units being of approximately half of the inside diameter of said shell and secured thereto, the portions of the shell surrounding said units providing for a return flow of gases from one of said units to the other, and an outer shell surrounding and spaced from said first mentioned shell to form therewith a resonance chamber in communication with the interior of said muffler, said first mentioned shell having an opening located adjacent to an end of the muffler

for admitting sound waves to said resonance chamber.

3. A muffler including a pair of sound attenuating units, each including an inner perforate open-
ended conduit and a tubular member arranged
about said inner conduit, said units being ar-
ranged in overlapping relation to each other, the
overlapping portions of said units contacting with
each other, a tubular member arranged about
both units and contacting with the same, one of
said units receiving gases at one end thereof and
discharging the same into the interior of said
tubular member, and the other unit receiving gases
from the interior of said tubular member and
discharging the same from the muffler, said sound
attenuating units dividing the interior of said
tubular member into two passages in which gases
may flow from one unit to the other in a direction
opposite to that in which gases flow in said units.

4. A muffler including three sound attenuating
members, each comprising an inner perforate
conduit and a shell surrounding said conduit to
form a sound attenuating chamber between the
conduit and shell, two of said sound attenuating
members being of not more than half of the diam-
eter of the interior of the other sound attenuating
member and being arranged in overlapping
relation to each other within said other sound
attenuating member, one of the inner sound atten-
uating members receiving gas at one end and dis-
charging the same into the interior of said third
sound attenuating member, and the other inner
sound attenuating member receiving gases from
the interior of said third sound attenuating mem-
ber and conducting the same to the discharge of
said muffler.

5. A muffler including three tubular sound at-
tenuating and gas conducting units, each com-
prising an inner perforate conduit and a shell ar-
ranged about said conduit, and forming a sound
attenuating chamber between said shell and con-
duit, the conduit of one of said units having its
inner diameter at least equal to the combined
outer diameters of the shells of the other two
units, and having its shell form the outer shell
of the muffler, said other two units being ar-
ranged in overlapping relation to each other with-
in the larger unit, heads closing the ends of said
larger unit, the conduits and shells of said inner
units terminating near the opposite ends of said
larger unit and at distances from said heads,
whereby said larger unit conducts gases about
said inner units from one inner unit to the other
in a direction opposite to the direction of flow of
gases in said inner units.

6. A muffler including a shell, heads connected
therewith and spaced apart and being provided
with openings for the inlet and discharge of ex-
haust gases to and from said muffler, a pair of gas
conducting conduits arranged in overlapping rela-
tion to each other within said shell, at least one of
said conduits having a perforate portion, sound
attenuating means arranged about said perforate
portion of said conduit, one conduit receiving
gases from the inlet opening and the other con-
duit discharging gas through the outlet opening
of the muffler, said shell forming a return pas-
sage connecting the other ends of said conduits,
and means associated with said shell to form
chambers communicating with the interior of
said muffler for attenuating sounds discharged
into said muffler by said first mentioned unit.

7. A muffler including a shell, heads connected
therewith and spaced apart and provided with
openings for the inlet and discharge of gases, a

conduit arranged within said shell and receiving
gases through an opening in one of said heads
and terminating at a distance from the other
head, a second conduit arranged to discharge
gases through the opening in the other head
and terminating at a distance from said first head,
said conduits being arranged in overlapping rela-
tion to each other within said shell, whereby said
shell constitutes a return duct for conducting
gases from one conduit to the other, sound at-
tenuating chambers associated with at least one
of said conduits, and an outer shell surrounding
said first mentioned shell to form a chamber com-
municating with the interior of said muffler for
attenuating sounds discharged into said muffler by
said first mentioned unit, said chamber receiving
sound waves from said return duct.

8. A muffler including a pair of outer shells
spaced apart one within the other to form be-
tween them an annular sound attenuating cham-
ber, a pair of conduits for exhaust gases arranged
within said shells and in overlapping relation to
each other and through which gases flow in one
direction, one of said conduits discharging gases
into the space confined by the inner of said outer
shells and the other conduit receiving gases from
said space to produce a reverse flow of gases in
said space about said conduits, the inner of said
outer shells having apertures for admitting sound
waves to the chamber formed between said outer
shells to attenuate sound waves.

9. A muffler including a pair of outer shells
arranged one within the other in spaced relation
to each other to form between them a resonator
chamber, means for producing a reverse flow of
gases within said muffler, including a plurality
of gas conducting and sound attenuating units
having conduits for exhaust gases, one of said
conduits discharging gases near one end of the
inner of said shells and the other of said conduits
receiving said gases near the other end of said
inner shell, the inner of said shells constituting a
conduit for the reversely flowing gases, and being
apertured for admitting sound waves from the
gases confined by the inner of said shells into said
resonator chamber.

10. A muffler provided with means for produc-
ing a reverse flow of gases therein and including
a pair of outer shells spaced apart one within the
other and forming between them a resonating
chamber, the inner of said shells having an open-
ing through which sound waves from said ex-
haust gases may be admitted to said resonating
chamber, the inner of said shells also constitut-
ing a conduit for the gases when flowing in the
reverse direction.

11. A muffler including an imperforate outer
shell, heads to which the opposite ends of said
shell are connected and provided with openings
for inlet and discharge of exhaust gases, a second
shell arranged within said outer shell and spaced
therefrom to form with said outer shell a
resonator chamber, a pair of gas conducting and
sound attenuating units arranged in overlapping
relation to each other within said second shell
and each including an inner perforate conduit
and a shell surrounding said conduit to form
therewith a sound attenuating chamber, the shell
of one unit being arranged in contact with the
shell of the other unit, and both of the shells of
said units contacting with the second shell, the
conduit of one of said units receiving gases at one
end thereof from said inlet opening and dis-
charging gases in said muffler adjacent to the head
thereof having the outlet opening, the conduit
of the other sound attenuating unit being con-

ected at one end with said discharge opening and terminating within said muffler adjacent to the head having the inlet opening, said second shell forming a return duct for gases discharged into said muffler by said first unit and conducting said gases to the inner end of said second unit, said second shell having apertures to permit gases and sound waves to enter into said resonator chamber.

12. A muffler including a pair of conduits extending into the same, one conduit extending into the muffler from one end thereof, and the other conduit extending into the muffler from the other end thereof, said conduits being arranged in overlapping relation to each other, a shell surrounding both of said conduits and having portions thereof spaced from said conduits to form a return passage from one conduit to the other, means associated with at least one of said conduits to form a sound attenuating chamber, and means associated with said shell for forming a sound attenuating chamber about said return passage.

13. A muffler of the reverse flow type in which the exhaust gases flow first toward the discharge end thereof, then toward the inlet end thereof and then again toward the discharge end, said muffler including conduits for the gases and a shell surrounding said conduits and to which said conduits are secured at their sides, said conduits having open ends terminating within said shell and said shell serving to conduct gases from the open end of one conduit to the open end of the other conduit, and an outer shell surrounding said first mentioned shell and spaced therefrom to form a chamber between said shells to deaden shell noises, and an opening in said first mentioned shell through which gases and sound waves may pass into and out of said chamber, said opening being adjacent to an open end of one of said conduits.

14. A muffler including three tubular sound attenuating and gas conducting units, the internal diameter of one of which is at least equal to the combined external diameter of the other two units, each of said units including a perforate conduit and means forming a sound attenuating chamber about the conduit, said other two units being arranged in overlapping relation to each other within the larger unit, heads closing the ends of the larger unit, one of said heads having an inlet for gas connecting with one of the inner units and the other head having a discharge opening for gas communicating with the other inner unit, said inner units terminating within said larger unit at distances from said heads and said larger unit conducting gases from one inner unit to the other in a direction opposite to that in which gases flow in said inner units.

15. A muffler including an outer shell and end heads, one of which has an inlet opening through which gases may enter the muffler and the other of which has a discharge opening for gases, an inlet conduit connected with said inlet opening and discharging gases into the interior of said muffler, a second conduit connecting with said discharge opening and having perforate portions, a second shell about said perforate portions forming therewith an acoustical expansion chamber, the portion of said muffler between said outer shell and said inlet conduit and said second shell being substantially unobstructed to form a return flow passage from one conduit to the other and

forming an expansion chamber for gases between pressure impulses transmitted to the muffler.

16. A muffler including an outer shell and end heads, one of which has an inlet opening through which gases may enter the muffler and the other of which has a discharge opening for gases, an inlet conduit connected with said inlet opening and discharging gases into the interior of said muffler, a second conduit connecting with said discharge opening and having perforate portions, a second shell about said perforate portions forming therewith an acoustical expansion chamber, the portion of said muffler between said outer shell and said inlet conduit and said second shell being substantially unobstructed to form a return flow passage from one conduit to the other and forming an expansion chamber for gases between pressure impulses transmitted to the muffler, said first mentioned conduit having perforations and means within said muffler for preventing gases discharged through said perforations of the first mentioned conduit from impinging directly on said outer shell.

17. A muffler of the return flow type including an outer shell and end heads, one of which is provided with an inlet opening and the other of which has a discharge opening, an inlet conduit connected with said inlet opening and a discharge conduit connected with said discharge opening, said conduits extending into the interior of said muffler into overlapping relation to each other, said discharge conduit being perforate, an intermediate shell arranged about the perforations of said discharge conduit to form therewith an acoustical expansion chamber, the space within said outer shell and about said inlet conduit and intermediate shell being substantially unobstructed and forming a return flow passage of materially greater cross sectional area than that of said conduits and forming an expansion chamber for reducing pressure pulsations discharged into said muffler through said inlet conduit.

18. A muffler of the return flow type including an outer shell and end heads, one of which is provided with an inlet opening and the other of which has a discharge opening, an inlet conduit connected with said inlet opening and a discharge conduit connected with said discharge opening, said conduits extending into the interior of said muffler into overlapping relation to each other, said discharge conduit being perforate, an intermediate shell arranged about the perforations of said discharge conduit to form therewith an acoustical expansion chamber, said muffler being provided with a return flow passage leading from said inlet to said discharge conduit which is of materially greater cross sectional area than that of said conduits and which forms an expansion chamber for reducing pressure pulsations discharged into said muffler through said inlet conduit.

19. A muffler of the return flow type including an outer housing having inlet and outlet conduits arranged in overlapping relation therein, said outlet conduit being perforate, a shell about said outlet conduit and forming therewith an acoustical expansion chamber, said housing forming a return duct for gases from said inlet conduit to said outlet conduit and being of materially greater cross sectional area than that of either of said conduits.

LUCIEN L. HAAS.