R. J. MacKENZIE AND L. L. HAAS.

EXHAUST MUFFLER.

APPLICATION FILED MAR. 16, 1917.

1,376,957.

Patented May 3, 1921.

3 SHEETS—SHEET 1.

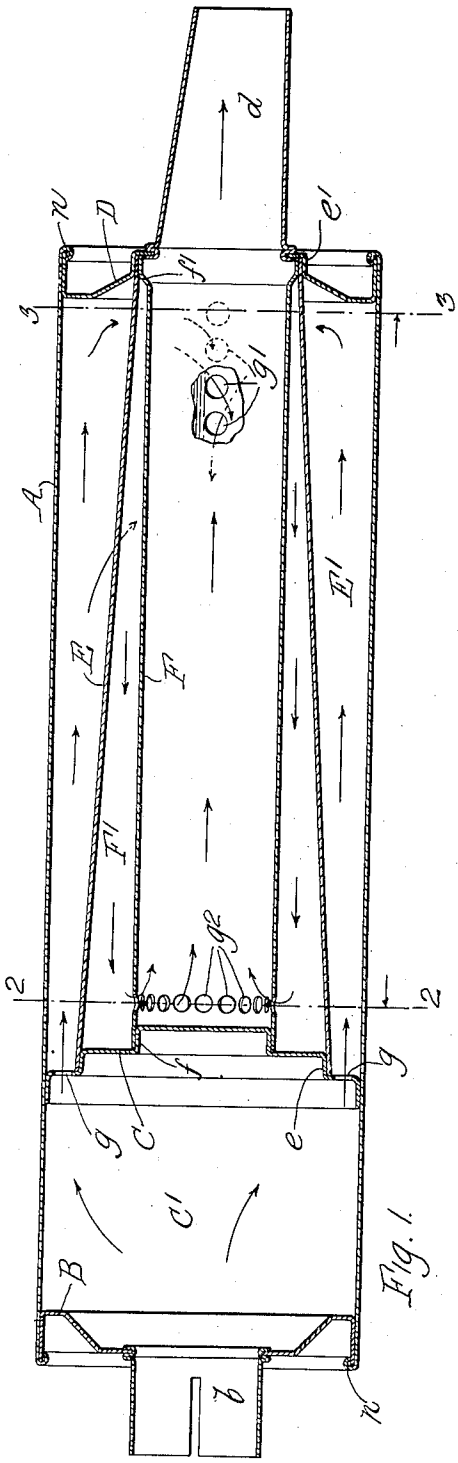

Fig. 1.

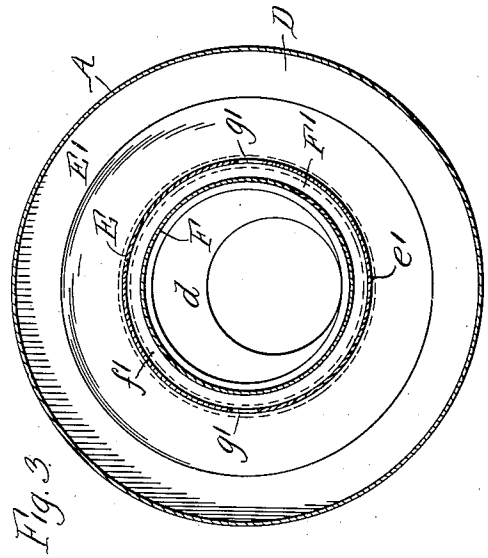

Fig. 3

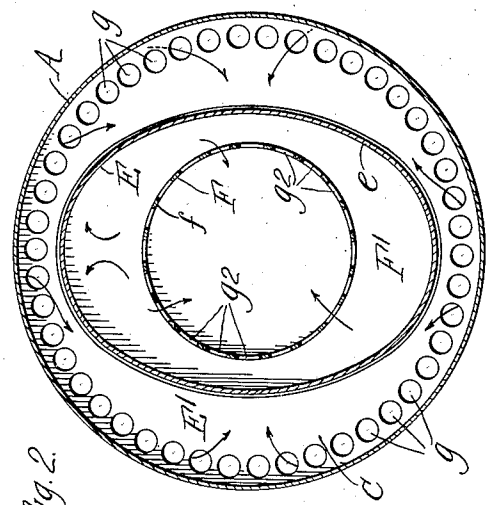

Fig. 2.

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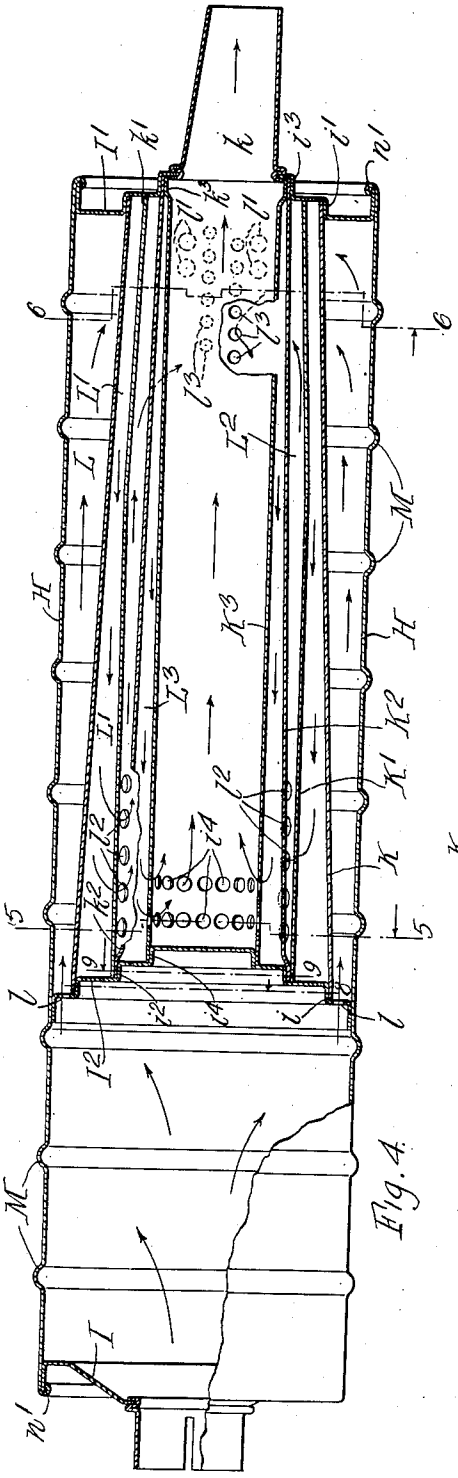

Fig. 4.

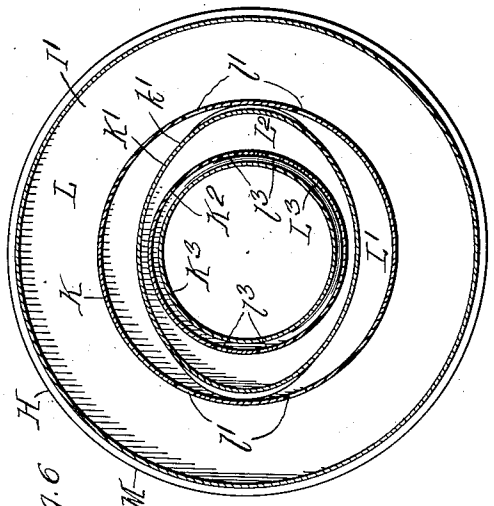

Fig. 6

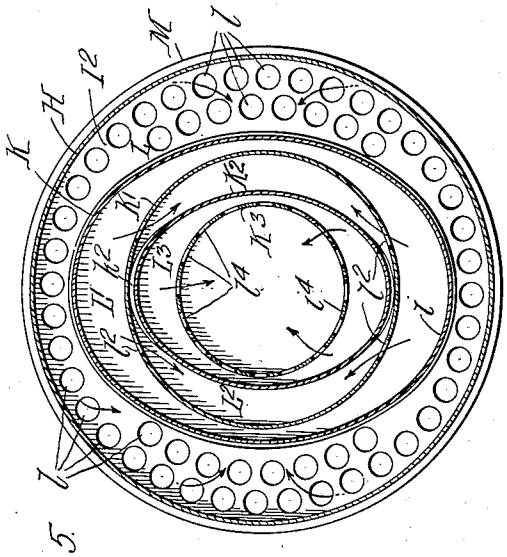

Fig. 5.

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3 SHEETS—SHEET 3.

Fig. 7.

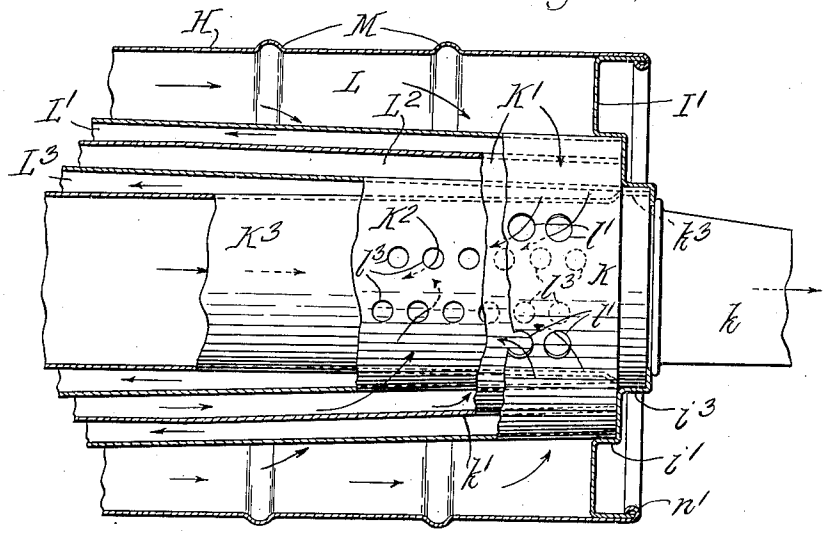


Fig. 8.

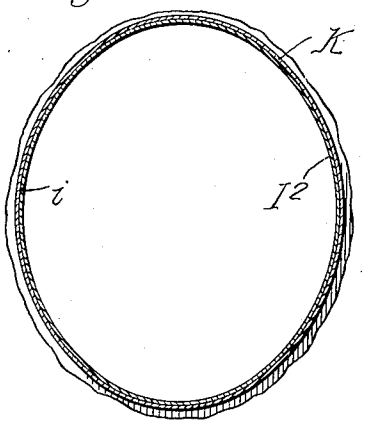
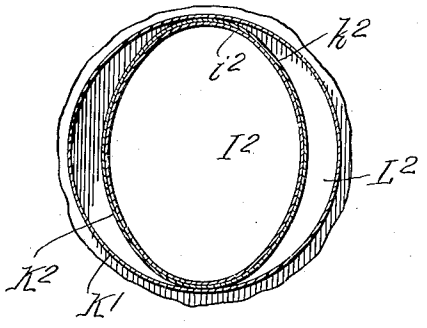


Fig. 9.



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UNITED STATES PATENT OFFICE.

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EXHAUST-MUFFLER.

1,376,957. Specification of Letters Patent. Patented May 3, 1921.

Application filed March 16, 1917. Serial No. 155,331.

To all whom it may concern:

Be it known that we, ROY J. MacKENZIE, and LUCIEN L. HAAS, citizens of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented a new and useful Improvement in Exhaust-Mufflers, of which the following is a specification.

This invention relates to mufflers or silencers of the kind commonly used in connection with internal combustion engines to reduce or eliminate the noise caused by the engine exhaust.

The objects of the invention are to produce a muffler of this kind having a series of nested shells forming chambers in which the exhaust gases flow both lengthwise and circumferentially and in which the chambers increase in sectional area in the direction of the flow of the gases; also to provide a muffler of this kind in which tapering elliptical shells and cylindrical shells are arranged alternately; also to improve the construction of mufflers of this kind in other respects hereinafter specified.

In the accompanying drawings:—

Figure 1 is a longitudinal central sectional elevation of a muffler embodying the invention.

Figs. 2 and 3 are transverse sectional elevations thereof on lines 2—2 and 3—3, Fig. 1, respectively.

Fig. 4 is a longitudinal central section partly in elevation of a muffler of modified construction.

Figs. 5 and 6 are transverse sectional elevations thereof on lines 5—5 and 6—6 respectively, Fig. 4, on an enlarged scale.

Fig. 7 is a fragmentary central sectional elevation thereof, partly in elevation.

Figs. 8 and 9 are transverse sectional elevations thereof on lines 8—8 and 9—9, Fig. 4.

In the construction shown in Figs. 1—3, A represents the outer shell or housing of the muffler and B represents one of the heads of the muffler, which is secured at one end of the shell A and is provided with an inlet tube *b* through which the exhaust gases enter the muffler. A supporting cone or intermediate head C is secured to the inner face of the shell A forming an expansion chamber C′ into which the exhaust gases pass on entering the muffler. At the other end of the muffler, a head D is secured to the outer shell A and is preferably provided with a discharge pipe or nozzle *d*. The heads may be secured to the outer shell A in any suitable manner.

The gases after leaving the chamber C′ pass into a plurality of longitudinal chambers formed by an intermediate shell E and an inner shell F, which are secured at opposite ends to the intermediate head or cone C and the outer head D. The intermediate shell E is tapering or conical and the largest end is bent into elliptical shape and secured to an elliptical shoulder *e* formed on the intermediate head C. The smaller end of the shell E is substantially circular in cross section and engages a circular shoulder *e′* on the head D. The intermediate shell E therefore forms with the outer shell A a chamber E′, increasing in cross sectional area from the head C to the head D. The inner shell F is substantially cylindrical throughout its length and of circular cross section and is held at one end by an annular shoulder *f* of the head C and its other end is held in place by the end of the intermediate shell and is preferably shouldered or enlarged at *f′*. This end of the inner shell communicates with the discharge nozzle or pipe *d*. The inner shell forms with the intermediate shell E a chamber F′ which increases in cross-section from the part thereof adjacent to the head D to the part adjacent to the head C and which is also of greater width at the parts thereof adjacent to the greatest diameter of the elliptic portion of the shell. Other means for connecting the heads and shells may be employed.

The exhaust gases enter the chamber E′ from the chamber C′ through a plurality of holes *g* arranged about the outer portion of the intermediate head C. The intermediate shell E is provided with two series of holes *g′* adjacent to the head D through which the gases enter from the chamber E′ into the chamber F′. These holes *g′* are arranged at diametrically opposite sides of the shell and at substantially right angles from the points of greatest diameter of the elliptic portion of the shell E. The inner shell has an annular series of holes *h²* arranged in the shell adjacent to the intermediate head C.

By means of the described arrangement of the shells and of the discharge holes or openings therein, the gases are caused to

flow lengthwise of the chambers E′ and F′ and in the shell F, substantially from one end of a chamber to the other and also receive a circumferential motion owing to the arrangement of the discharge openings g' with regard to the intermediate shell E. The gases entering the outer chamber tend to flow circumferentially toward the parts of the chamber having the greatest cross sectional area, and pass out through the openings g' at these parts of the chamber. These openings are arranged approximately at right angles to the parts of the chamber F′ which are of greatest cross sectional area so that the gases again flow circumferentially from the openings to these parts of the chamber. In both of the chambers E′ and F′ the gases are divided and the divided portions thereof flow in opposite directions toward each other and impinge, thus also helping to diminish the noise caused by the exhaust.

In the muffler described, the gases enter first into the relatively large chamber C′ where they expand, and are then conducted to the outer chamber E′ where some of the heat of the gases is readily dissipated through the outer shell A. By means of the structure shown, the exhaust gases are first conducted to the largest chambers of the muffler and since the pressure of the gases varies to a much greater extent at the points where the gases enter the muffler than at the discharge end of the muffler, a better muffling effect is produced by passing the gases first into the larger chambers in which the variations in pressure can be equalized to a greater extent than in the smaller chambers.

In the alternative construction shown in Figs. 4 to 9, a muffler is disclosed operating on the same principle as the muffler shown in Figs. 1–3, but having a larger number of shells. In this construction, H represents the outer shell, I I′ represent the two outer heads of the muffler and I^2 the intermediate head or cone, all of the heads being secured in any suitable manner to the outer shell H. The space between the intermediate head I^2 and the outer head I′ is divided into a plurality of chambers by means of a plurality of nested tubular members or shells K, K′, K^2 and K^3, the inner shell communicating with a discharge nozzle or pipe k secured on the outer head I′. The shell K is elliptical at one end and is secured at this end to an elliptical shoulder i formed on the intermediate head I^2. This shell tapers toward the head I′ and is substantially circular in cross section at this end and engages a circular shoulder i' formed on the head I′. The next shell K′ is substantially cylindrical at the portions thereof adjacent to the intermediate head I^2 and is elliptical in cross section at the portion k' thereof adjacent to the outer head I′ and is secured adjacent to the parts of greatest diameter of the ellipse to the shell K, Fig. 6. The other end of the cylindrical tube K′ is held in place by an elliptical shoulder i^2 of the intermediate head. The shell K^2 is also tapering or conical and is substantially elliptical in cross section at the largest end thereof and is held in place by the elliptical shoulder i^2 of the intermediate head, being provided with an enlarged or shouldered part k^2 adjacent to the shoulder i^2 of the intermediate head. The other end of this shell is circular in cross section and telescopes into a shouldered portion i^3 of the outer head I′. The cylindrical end of the shell K′ engages the shouldered part k^2 of the shell K^2 at the portions of greatest diameter of the shell K^2 and is held in place thereby. The inner shell K^3 is cylindrical in shape and has a shouldered portion k^3 which also telescopes into the shoulder i^3 of the outer head I′. The other end of the shell is held in place by a circular shoulder i^4 on the intermediate head. The alternate arrangement of cylindrical and conical or tapering shells produces a plurality of chambers L L′ L^2 L^3, each of which is of greater cross sectional area at one end than at the other end. Other means for securing the shells in the muffler may be employed if desired.

The intermediate head and the several shells are provided with holes or openings which are so arranged that the gases enter the chambers at the portions thereof of small cross sectional area and flow out of the chambers at the parts of larger cross section. In the construction shown, the intermediate head I^2 has a plurality of holes or openings l through which gases are discharged into the outer chamber L. The shell K is provided in the portion thereof adjacent to the head I′ with holes or openings l', arranged in the construction shown in the sides of the shell and substantially in alinement with the parts of the chamber L of greatest cross sectional area so that some of the gases in the chamber L will travel in substantially parallel paths to the holes l' in the shell K. The gases enter the chamber L′ at the tapering or small end thereof and at portions adjacent to the greatest diameter of the elliptic portion k' of the shell K′ and flow in several directions from the small to the large end of the chamber L′ and to the largest portions of the chamber, the gases therefore moving in substantially spiral directions and being subdivided and impinging in the portions of greatest cross sectional area of the chamber L′. The shell K′ has holes or openings l^2 arranged at substantially right angles to the holes l' and adjacent to the intermediate head so that the gases flow in spiral directions in the chamber L^2, substantially opposite to the spiral direction of flow in the chamber L′. The

shell K^2 has holes l^3 arranged at substantially right angles to the holes l^2 of the shell K′ and adjacent to the outer head I′. The flow of gases in the chamber L^3 will therefore be substantially the same as in the chamber L′. The inner shell K^3 has a plurality of holes or openings l^4 adjacent to the intermediate head I^2 and arranged around the shell.

The elliptical portions k' of the shell K′ produce an increased area in the chamber L′ in which the gases can flow and expand and thus reduce the back pressure of the muffler.

The outer shell H in the construction shown in Figs. 4–9 is preferably provided with a plurality of circumferential beads or ribs M which prevent this shell from receiving vibrations from the exhaust gases which might cause a ringing sound. The beads therefore not only stiffen and strengthen the outer shell, but also help to silence the noise of the exhaust.

In both of the constructions shown, the shells are secured to one of the shell supporting heads and are slidably arranged on the other head to permit the tubes to expand independently of each other during the heating or cooling of the muffler. In the muffler shown, the shells are welded or otherwise secured to the intermediate heads and slidingly engage the shoulders of the outer heads.

In assembling the mufflers, the intermediate head with the shells secured thereto is rigidly secured to the outer shell or housing and the outer head is then secured in place to hold the outer ends of the shells in their proper positions by turning over or upsetting the edge of the outer shell, forming a joint indicated by n in Fig. 1 and by n' in Figs. 4 and 7. By upsetting or spinning in the end of the outer shell, the outer head of the muffler as well as the inner and intermediate shells are all held in place and the inner shells of the muffler need not be secured to the shoulders of the outer head, but are free to expand and contract independently of each other. Mufflers embodying the invention described have the advantages of first conducting the gases to the largest chambers, giving the gases the greatest chance to expand, and conducting the gases to the smaller chambers after the flow of the gases has become somewhat more uniform. The gases on first entering the muffler are in contact with the outer walls thereof so that a large amount of heat can be radiated through these walls. By causing the gases to flow from the small portion of a chamber to a large portion thereof, considerable cooling of the gases results and the impinging of the gases in the enlarged portions of the chambers also causes a reduction in the velocity of the gases and deadens the noise.

We claim as our invention:—

1. A muffler having a plurality of substantially concentrically arranged shells of substantially cylindrical and conical shape, a cylindrical shell being arranged adjacent to a conical shell to form a chamber having a greater cross-sectional area at one end than at the other end, one of said shells being provided with a portion of elliptical cross-section to form, with an adjacent shell of circular cross-section, an expansion chamber having diametrically opposed portions of enlarged cross-sectional area and diametrically opposed portions of reduced cross-sectional area, and means for admitting gases to said chamber substantially at said portions thereof of reduced cross-sectional area.

2. A muffler having a plurality of nested shells of substantially cylindrical and conical shape, a cylindrical shell being arranged adjacent to a conical shell to form a chamber having a greater cross sectional area at one end than at the other end, said conical shells having parts of elliptical cross section forming with an adjacent shell of circular cross-section a chamber having diametrically opposed portions of reduced cross sectional area, and means for admitting gases to said chamber substantially at said portions thereof of reduced cross sectional area.

3. A muffler having a plurality of nested shells of substantially cylindrical and conical shape, a cylindrical shell being arranged adjacent to a conical shell to form a chamber having greater cross sectional area at one end than at the other end, the larger part of said conical shells being of elliptical cross section and forming with an adjacent shell of circular cross-section a chamber having diametrically opposed portions of reduced cross sectional area, and means for admitting the gases to said chamber substantially at the reduced end thereof and in a longitudinal diametric plane passing through said opposed portions of reduced cross sectional area.

4. A muffler comprising an outer shell, outer and intermediate heads secured to said shell, one of said outer heads and said intermediate head forming at the inlet end of said muffler an expansion chamber, and alternately arranged conical and cylindrical shells held in place by said intermediate head and said outer head and forming chambers of varying cross section through which the gases pass from said expansion chamber.

5. A muffler comprising an outer shell, outer and intermediate heads secured to said shell, one of said outer heads and said intermediate head forming at the inlet end of said muffler an expansion chamber, and alternately arranged conical and cylindrical shells held in place by said intermediate

head and said other head and forming chambers of greater cross section at one end than at the other end, and means for admitting the exhaust gas to the portions of smaller cross section and discharging the gas from the chambers at the portions thereof of larger cross section.

6. A muffler having nested shells of cylindrical and conical shape, the cylindrical and conical shells being arranged alternately and forming a chamber having one end of greater cross sectional area than the other end, the larger part of said conical shell being substantially elliptical in cross section, whereby the said chamber has enlarged portions at diametrically opposite sides, and inlet openings for the gases arranged to admit the gases to the small portions of said chamber and at substantially right angles to the enlarged portions of the chamber.

7. A muffler having nested cylindrical shells and a conical shell arranged between said cylindrical shells and forming therewith two chambers, each chamber having one end of greater cross sectional area than the other end, the large end of one chamber being arranged adjacent to the small end of the other chamber, said conical shell having a portion of elliptical cross section, and means for admitting gas to the small end of one of said chambers at substantially right angles to the plane of the largest diameter of the elliptic portion thereof, and discharging gas from the large end of said chamber.

8. A muffler having an outer shell and a plurality of nested shells, heads rigidly secured to said outer shell and having shouldered portions for supporting said nested shells, said nested shells being secured to one of said heads and having a sliding connection with the shouldered portions of said other head.

9. A muffler having an outer shell and a plurality of nested shells, an intermediate head and an outer head rigidly secured to said outer shell and having shouldered portions for supporting said nested shells, said nested shells being secured at one end to said intermediate head and having a sliding connection with the shouldered portions of said outer head.

10. A muffler having an outer shell and a plurality of nested shells, an intermediate head secured in said outer shell and having parts for supporting said nested shells, and an outer head having parts with which said nested shells are adapted to engage for holding said shells in place, said outer head being held in position to support said nested shells by turning in the edge of said outer shell.

11. A muffler having an outer shell and a plurality of nested shells, a head secured to said outer shell and having parts for supporting the adjacent ends of said nested shells, and a head at the other end of said shells having parts adapted to hold the other ends of said shells in place, said last mentioned head being held in position to support said nested shells by turning over the edge of said outer shell.

12. A muffler having an outer shell and a plurality of longitudinally extending nested shells, a head secured on said outer shell and having shouldered portions adapted to engage the ends of said nested shells to hold said ends in place relatively to each other, and a head at the other ends of said shells and having shouldered portions for engaging said other ends of the shells, whereby the two heads hold said shells against displacement relatively to each other, said last mentioned head being held in position to support said nested shells by turning over the edge of said outer shell.

Witness our hands this 12th day of February, 1917.

ROY J. MacKENZIE.
LUCIEN L. HAAS.

Witnesses:
T. C. Willis,
E. E. Spangle.