Nov. 22, 1960 O. E. BLAIR 2,961,059

MUFFLER

Filed Oct. 28, 1958 2 Sheets-Sheet 1

Fig. 1

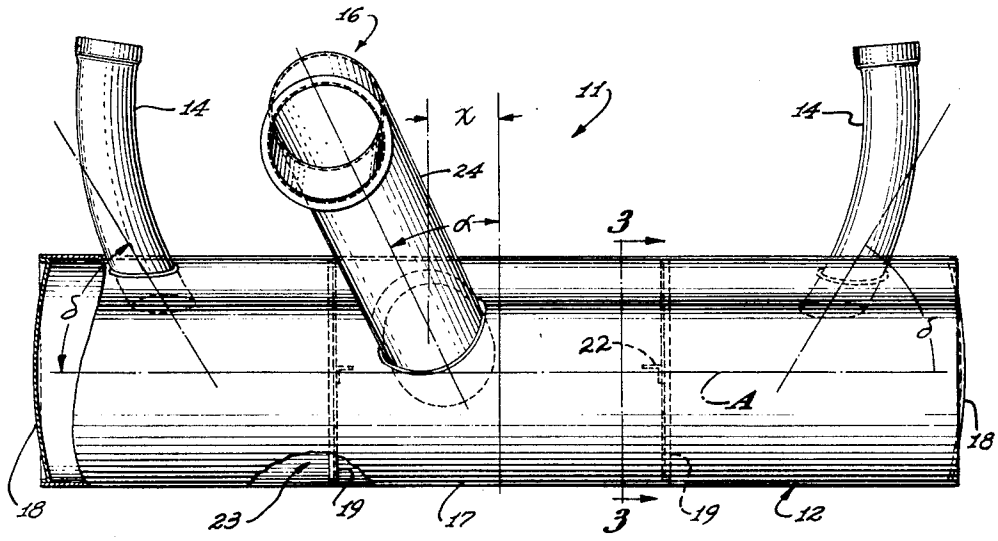
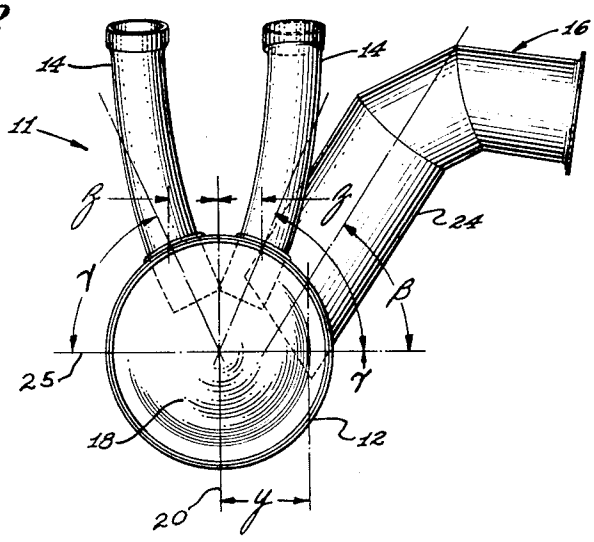


Fig. 2



INVENTOR:
Orby E. Blair

By Willard M. Graham
Agent

Nov. 22, 1960 O. E. BLAIR 2,961,059

MUFFLER

Filed Oct. 28, 1958 2 Sheets-Sheet 2

Fig. 3

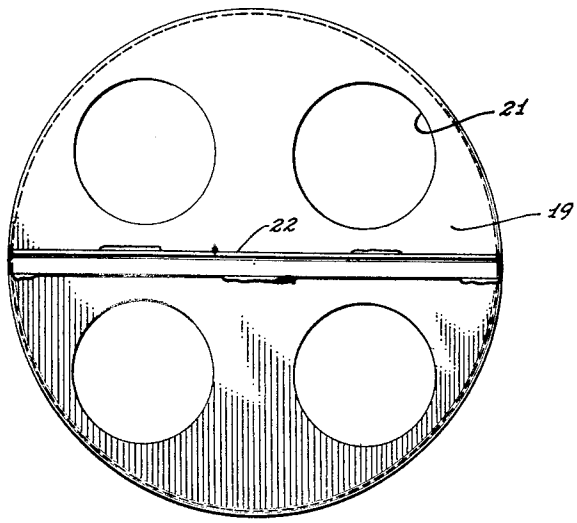
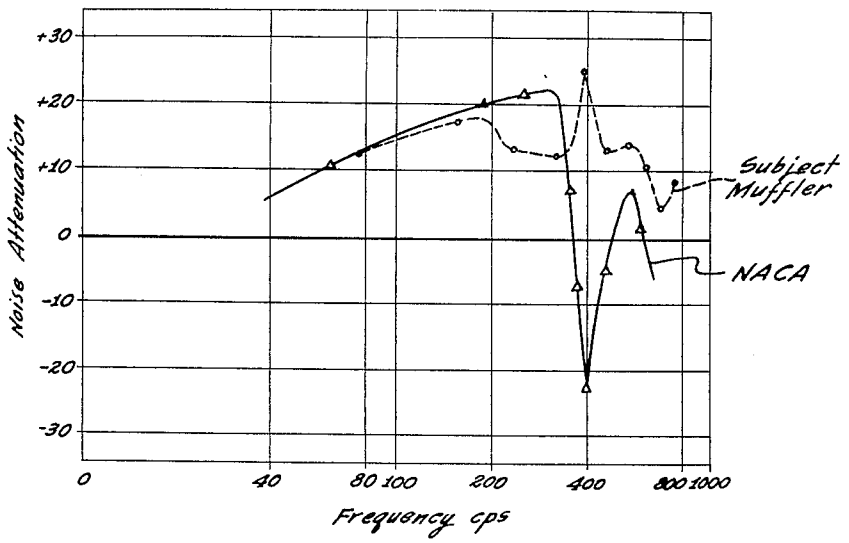


Fig. 4



INVENTOR:
Orby E. Blair

By Willard N. Graham
Agent

United States Patent Office 2,961,059
Patented Nov. 22, 1960

2,961,059

MUFFLER

Orby E. Blair, Hawthorne, Calif., assignor to Northrop Corporation, a corporation of California

Filed Oct. 28, 1958, Ser. No. 770,102

1 Claim. (Cl. 181—56)

This invention relates to sound suppressors and more particularly to mufflers for internal combustion engines and the like.

The instant muffler was developed during a program initiated to provide a suitable sound suppressor for the internal combustion engines of helicopters. To the best of applicant's knowledge mufflers or other types of sound suppressors have not been utilized to suppress the noise originating with internal combustion engines mounted in helicopters. The non-use of mufflers on helicopter engines is unquestionably due to space limitations within the engine compartment.

During the aforementioned development program it was discovered that the muffler as disclosed herein displayed superior attenuating characteristics not found in mufflers now available. Numerous theories have been advanced as to why the instant muffler is more effective as a sound suppressor than conventional mufflers of a similar type especially throughout certain frequency ranges. Inasmuch as these theories are not in complete agreement a discussion thereof will not be given in this specification. However, as the specification progresses it will be shown that the instant muffler structure does provide superior attenuating characteristics which conventional types of mufflers do not provide.

It is an object of this invention to provide a muffler for internal combustion engines having superior attenuating characteristics as compared with conventional type mufflers.

Another object is to provide a muffler that is extremely simple and compact in design and construction and is economical to manufacture.

Although the characteristic features of the present invention are particularly pointed out in the appended claim, the invention itself, also the manner in which it may be carried out, will be better understood by referring to the following description taken in connection with the accompanying drawings forming a part of this application and in which:

Figures 1 and 2 are side and end views, respectively, of the muffler disclosed herein. In Figure 1 portions of the muffler are broken away to show the internal construction thereof.

Figure 3 is a sectional view, the view being shown on an enlarged scale of the muffler as it appears when viewed along the line 3—3 of Figure 1.

Figure 4 is a graphical showing of the attenuation characteristics of the instant muffler as compared with an available muffler designed by National Advisory Committee for Aeronautics (NACA).

Referring now to the drawings, a muffler structure of the type disclosed herein is shown in Figures 1 and 2 and is identified in its entirety by the numeral **11**. The muffler **11** includes a body portion **12**, a pair of inlet ducts **14—14** and an exhaust duct **16**.

The body portion **12** comprises an elongated tubular section **17**, which is circular in cross-section, a pair of disc-like end plates **18—18** and a pair of disc-like baffle

plates **19—19**. The baffle plates **19—19** have four apertures **21** formed therein which are equally spaced and positioned in the plates **19** substantially as shown in Figure 3. A strengthening rib **22** is welded to one of the side surfaces of each of the plates **19** and extends diametrical across the plates at locations between the ports or apertures **21**. The end plates **18—18** are circular in plan and have a concavo-convex configuration.

The end plates **18—18** are secured in the respective ends of the tubular section **17** in fluid tight relation with their convex portions extending outboard a slight distance beyond the ends of the section **17** substantially as shown in Figure 1. As assembled the section **17** and end plates **18—18** cooperate to define an exhaust chamber **23**. The baffle plates are secured in the section **17** and extend in a direction normal to the longitudinal axis A of the section **17** to divide the chamber **23** into a center and a pair of outboard sub-chambers, all of the sub-chambers being of substantially equal length and volume.

The exhaust duct **16** is circular in cross-section and includes a straight section **24** which extends through the wall of the section **17**. The section **24** extends a short distance, approximately one-half the radius of the section **17**, into the chamber **23**. The location of the section **24** is further characterized in that it is offset laterally with respect to the axis A and longitudinally with respect to the mid-point of section **17** and is canted in two directions with respect to first and second reference planes **20** and **25**, respectively. In Figures 1 and 2 the reference planes **20** and **25** are vertical and horizontal, respectively, and their intersection coincides with the axis A.

The point of entry of the section **24** into the chamber **23** is offset a distance X with respect to the mid-point of section **17**. The distance X is approximately equal to one-quarter of the longitudinal extent of one of the sub-chambers comprising the exhaust chamber **23**. Laterally the point of entry of the section **24** is offset a distance Y with respect to the axis A. The distance Y is approximately equal to four-fifths of the radius of the section **17**. The relation of the section **24**, with respect to the section **17**, is also characterized in that it is canted with respect to the aforementioned vertical and horizontal reference planes by angles α and β, respectively, substantially as shown in Figures 1 and 2. These angles α and β are of a magnitude of approximately 30 and 60°, respectively.

The inlet ducts **14—14** are of arcuate configuration when considered in a lengthwise sense and are circular in cross-section. They extend through the wall of the section **17** at locations adjacent the end plates **18—18**. The relation of the ducts **14—14**, with respect to the section **17**, is further characterized in that they are located equal distances Z on opposite sides of the vertical reference plane. The respective distances Z are equal to approximately one-third of the radius of the section **17**. The inlet ducts are also canted inboard laterally and longitudinally of the section **17**, that is in the direction of the mid-point of the section **17**, as indicated by the angles γ and δ, respectively, which angles (γ and δ) are approximately 60°. The ducts **14—14** also extend a short distance, approximately equal to one-half the radius of the section **17**, into the chamber **23** and terminate in respective outboard sub-chambers.

The construction of the muffler **11** having been described a discussion of the acoustical properties of the instant muffler, with respect to the aforementioned NACA designed muffler, follows.

Referring to Figure 4 the attenuation characteristics of NACA muffler (Configuration No. 59) is graphically compared to the attention characteristics of muffler **11**. The construction of the NACA muffler (Configuration No. 59—described and illustrated in NACA Tn No. 1838, dated March 1949) is similar to the muffler **11**, however,

the NACA muffler does not incorporate the novel features disclosed therein. In Figure 4 noise attenuation is plotted against noise frequency (c.p.s.); the solid curve depicts the actual noise attenuation of the NACA muffler while the broken line represents the actual noise attenuation of the muffler **11**. From the comparative graph of Figure 4 it will be seen that in the frequency range below 200 c.p.s. both mufflers follow very nearly the same curve. In the frequency range between 200–300 c.p.s. the NACA muffler has an 8 to 10 decibel advantage over the muffler **11**. At frequencies higher than 300 c.p.s. the NACA muffler offers practically no attenuation, in fact it provides severe ampliation around 400 c.p.s., while the muffler **11** achieves its greatest noise attenuation in this area. The latter area (above 300 c.p.s.) represents the range in which an internal combustion engine normally operates and certainly is the range of an engine mounted in a helicopter during its cruise period.

It should be understood that negative attenuation, shown as occurring in connection with the NACA muffler at frequencies between 300–500 c.p.s. in Figure 4, does not imply the generation of sound within the muffler, but simply that the muffler provides a less favorable terminal impedance to the exhaust pipe than an open pipe, that is an exhaust pipe without a muffler, offers.

While in order to comply with the statute, the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise a preferred form of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claim.

What is claimed is:

A muffler for internal combustion engines and the like comprising: a body structure including side and end walls

secured together to provide a cylindrical exhaust chamber; the longitudinal axis of said exhaust chamber coinciding with the intersection of first and second reference planes having a normal relation with respect to each other; a pair of apertured baffle plates mounted in said body structure dividing said exhaust chamber into a cylindrical center sub-chamber and a pair of cylindrical outboard sub-chambers located respectively at each end of said center sub-chamber; a pair of inlet ducts extending through the side walls of said body structure in fluid tight relation; the location of said inlet ducts being characterized in that they are canted inboard to exhaust gases flowing therethrough toward the geometric center of said exhaust chamber, they are located on opposite sides of said first reference plane and their inner ends terminate respectively in said outboard sub-chambers; an outlet duct extending through the side wall of said body structure in fluid tight relation with the inner end thereof terminating in said center sub-chamber: said outlet duct being offset laterally and longitudinally with respect to the longitudinal axis and geometric center, respectively, of said exhaust, chamber; and said outlet duct being canted with respect to said first and second reference planes.

References Cited in the file of this patent

UNITED STATES PATENTS

2,468,384	Tyskewicz	Apr. 26, 1949
2,692,025	Maxim	Oct. 19, 1954

OTHER REFERENCES

National Advisory Committee for Aeronautics, Technical Note No. 1838, "Dynamometer-Stand Investigation of a Group of Mufflers" (Washington), March 1949 (page 27 of particular significance).

German Application 1,021,641, printed Dec. 27, 1957 (Kl. 46c^6 6/01).