Aug. 1, 1950 R. B. BOURNE 2,516,949

MUFFLER WITH INNER SOUND ABSORBING TUBE

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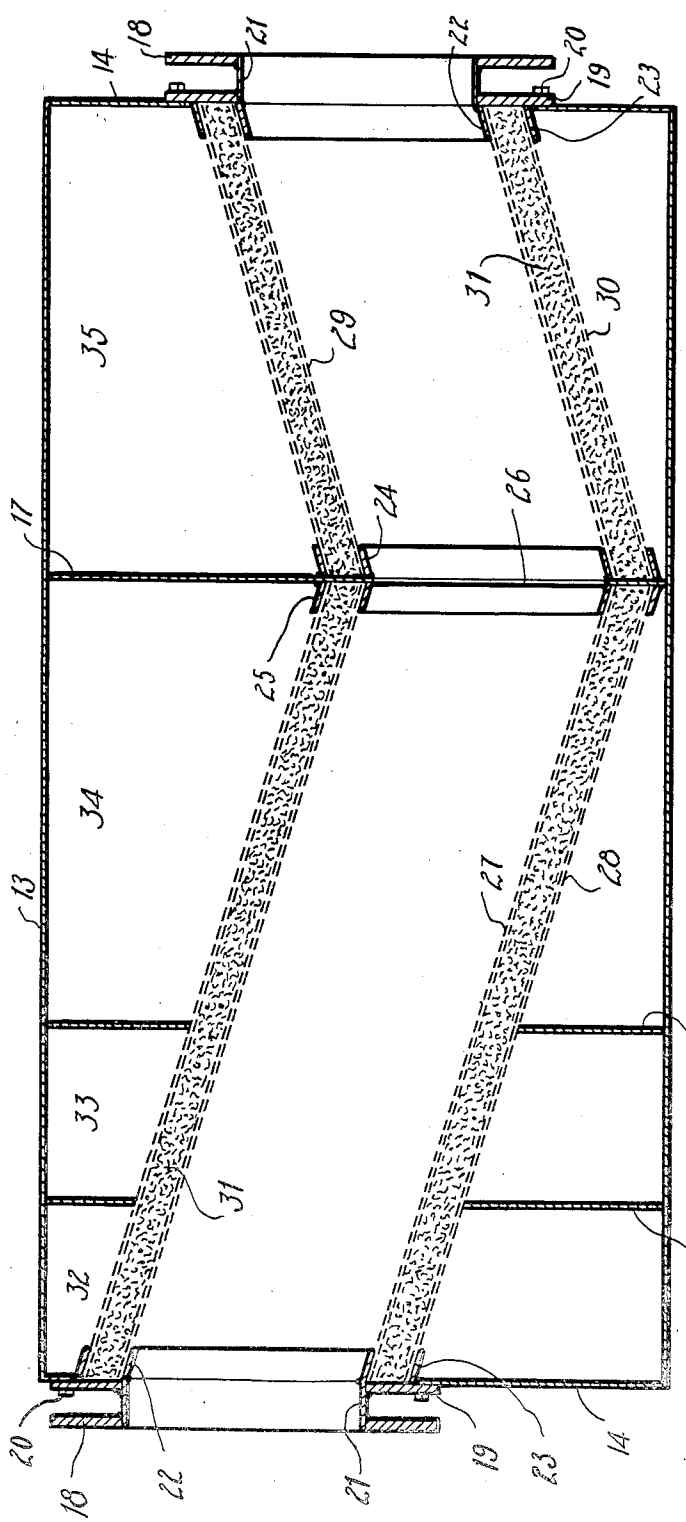


Fig. 1

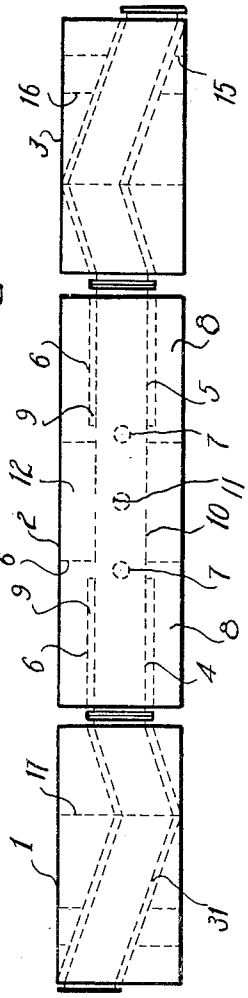


Fig. 2

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## MUFFLER WITH INNER SOUND-ABSORBING TUBE

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1 Claim. (Cl. 181—42)

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This invention relates to silencers, and in particular to silencers of large size which are required to possess high attenuation for high as well as low frequencies. It is well known that as the pipe size for which the silencer is designed becomes larger the difficulty of silencing the higher frequencies likewise increases; whereas with silencers of small dimensions the real problem is to obtain adequate silencing of the lower frequencies. While for normal pipe sizes the constructions disclosed in my prior Patents Re. 22,283, 2,271,892 and 2,326,612 give very uniform attenuation over a wide band of frequencies, in the larger sizes (which may reach two feet and over in diameter) the attenuation in the higher frequencies suffers. The present invention utilizes the principles of the patents referred to, but with certain modifications which greatly increase the attenuation of higher frequencies.

The invention will now be described with relation to the accompanying drawing, in which

Fig. 1 is a view of the complete assembly; and

Fig. 2 is an enlarged view, in median section, of one of the end sections shown in Fig. 1.

The silencer is shown in Fig. 1 on a greatly reduced scale, the particular silencer represented having a pipe diameter of twenty eight inches and an over-all length of more than forty four feet. The silencer is built in three sections 1, 2 and 3, sections 1 and 3 being of identical construction and section 2 being of substantially the construction shown in Patent 2,326,612 with the addition of a central resonance chamber. This section has inlet and outlet conduits 4 and 5 of perforated metal, each being surrounded by a perforated metal sleeve 6 for a portion of its length. This sleeve terminates short of a partition 6' leaving room for an acoustic coupling 7 into a surrounding chamber 8. The acoustic coupling is preferably made as shown by providing holes in the conduit, as this has the advantage over a slot of providing support for the conduit. The space between the conduit and the sleeve is filled with a sound absorbing material 9 such as copper wool. This type of construction is fully described in the patents referred to. Between these two end sections is a central conduit 10 which is imperforate except for coupling holes 11 entering an annular chamber 12. This section is a volumetric resonator, and acts to attenuate sounds of a frequency for which the resonator is tuned. The dimensions of the chamber will of course be varied to cause the resonant frequency to correspond to one existing in the system to which the silencer is attached.

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The two end silencers 1 and 3 are identical except for position, and each comprises a casing 13 provided with end walls 14 and partitions 15, 16, and 17, which are provided with holes as will be described to receive removably the main sound conducting conduit. At each end each silencer is provided with a coupling flange 18 for attachment to the next unit in the acoustical line, and with a header 19 secured by bolts 20 to the end wall 14. The flanges and headers are secured together by sleeves 21 having welded or otherwise secured to their inner ends short skew collars 22. A second concentric skew collar 23 is fixed as by welding to the inner surface of flange 19 concentric with the first. Similar pairs of skew collars 24 and 25 are secured to each side of the partition 17 around the hole 26 through which the main channel passes. Parallel cylinders 27 and 28 of perforated metal pass freely through holes in the partitions 15 and 16, and have their ends received respectively outside the flanges 22 and 24 and inside flanges 23 and 25. Similar cylinders 29 and 30 are located between partition 17 and the end wall 14.

The space between the concentric cylinders of perforated metal is filled with a pervious layer of sound absorbing material such as copper or bronze wool, although other sound absorbents can be used if regard be had to the condition of the exhaust gases. As is fully discussed in the patents referred to, the resonating action of the outer chambers 32, 33, 34 and 35 causes not only the direct attenuation of sound waves corresponding to the resonating frequencies, but causes high attenuation of all frequencies by reason of the disposition of the sound absorbing material at a point of high acoustic velocity thereby causing maximum dissipation of the acoustic energy in the form of heat.

In the present invention the dissipation of high frequencies is further increased by the arrangement of the main channel in reversely slanting sections. I have discovered that where the pipe size is large there is a strong tendency for the higher frequencies to travel through it in a beam and to resist being drawn outwardly through the pervious layer of sound absorbent. This tendency is present in all pipe sizes, but becomes more consequential in the larger sizes both because the ratio of cross sectional area to circumference increases with the pipe diameter, thereby decreasing the amount of sound absorbent available per unit of cross sectional area; and because the

beam formation is effective on lower frequencies as their wave lengths become comparable with the pipe size.

By inclining the main channel, and particularly by reversing its inclination at partition 17, any tendency for sound waves to form a beam traveling straight down the channel is utilized to increase the attenuation, for instead of changing their direction at the conduit surface the waves pass into and through the sound absorbent. The steeper the inclination the greater the effect, but also the greater the increase in back pressure due to the abrupt change in direction of exhaust gas flow. In instances where the back pressure is of great importance, it is desirable to keep the angle of inclination as low as is compatible with the attenuation needed. In general an angle of 16½° with the axis has been found practically suitable. It will be observed that, assuming initial flow parallel to the axis, change in direction causing dissipation of beamed energy occurs at the entrance to silencer 1, at the intermediate bend in the conduit, within conduit 4 in silencer 2, at the entrance to silencer 3, and at the intermediate bend in its conduit. This particular absorption of sound is in addition to that occurring through the operation of silencers as described in the cited patents.

When a silencer of this type is operated on the exhaust of an internal combustion engine, and even when it is used on intakes without a separate air filter, the sound absorbent becomes plugged with dirt and needs relatively frequent cleaning. Indeed, if the exhaust is very dirty no silencer employing sound absorbing material can be used in practice. In the present invention the method of supporting the perforated metal cylinders on the skew flanges permits ready disassembly so that the sound absorbent can be removed for cleaning or replacement. By removing bolts 20 the flanges 18 and 19, together with the skew cylinders or collars attached to them, can be withdrawn in a direction along the axis of the cylinders 27, 28; leaving the latter free for unobstructed removal.



What I claim is:

A sound attenuating device comprising a cylindrical casing, an acoustically pervious wall of sound absorbing material defining within itself a sound conducting channel passing through said casing in a bent line having its legs at an angle to the axis of the casing, said wall comprising two pairs of concentric perforated metal shells and sound absorbing material between the shells, a partition within the casing located at the bend in said channel and provided with a hole aligned with the channel, two pairs of skew collars secured to the partition to support one end of each of the pairs of shells, a removable header at each end of the casing, and a pair of skew collars secured to the inner surface of each removable header to support the second ends of said shells, whereby the shells and sound absorbing material can be removed for cleaning or replacement.

ROLAND B. BOURNE.


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