July 24, 1951 R. L. HOYLE 2,562,101

APPARATUS FOR SILENCING NOISE PRODUCING GASES

Filed March 8, 1946

Fig. 1

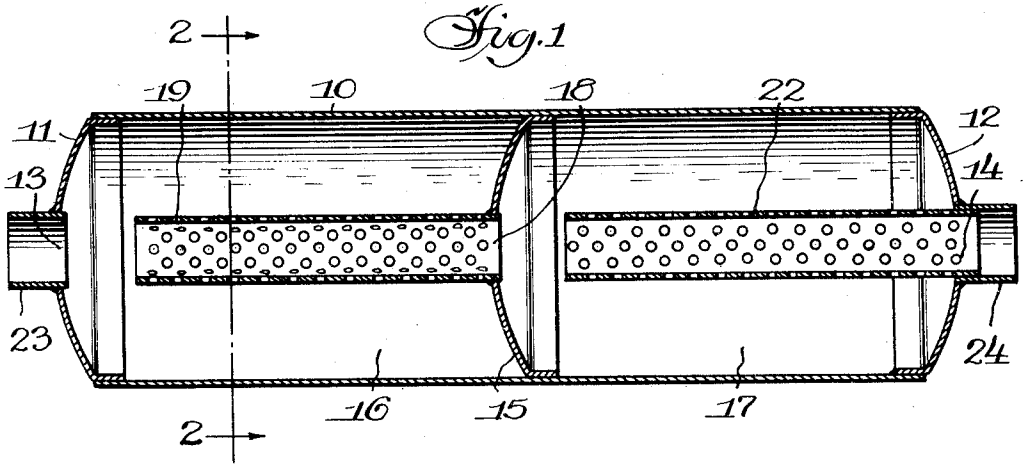


Fig. 2

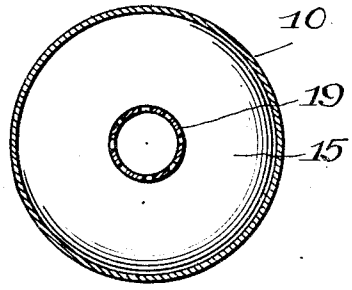
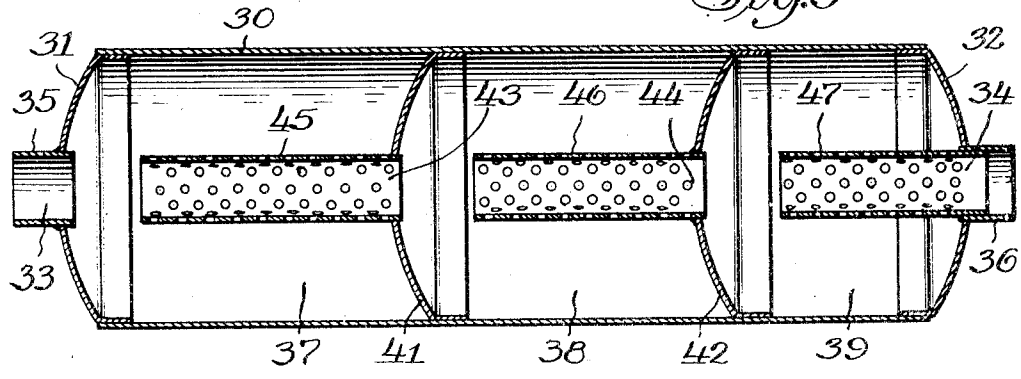


Fig. 3



INVENTOR.
Robert L. Hoyle,
BY
Jesch and Darbo Attys.

Patented July 24, 1951 2,562,101

UNITED STATES PATENT OFFICE

2,562,101

APPARATUS FOR SILENCING NOISE PRODUCING GASES

Robert L. Hoyle, Chicago, Ill., assignor to Burgess-Manning Company, Chicago, Ill., a corporation of Illinois

Application March 8, 1946, Serial No. 652,903

2 Claims. (Cl. 181—48)

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This invention relates to improvements in apparatus for silencing pulsating flowing gases, and particularly to improvements in silencers for the intakes and exhausts of internal combustion engines, blowers, air compressors, or the like.

It is the object of the invention to provide an improved construction for silencing apparatus which is highly effective in the performance of the silencing function, presents but little restriction to gas flow, and is simple in structure and low in cost.

Briefly, the silencing apparatus of the invention is of the plural snubbing or surge chamber type in which the chambers have an inlet opening in one end wall and an outlet opening in the opposite end wall and an open-ended, apertured-walled conduit extending inwardly from the outlet opening toward the inlet end wall and stopping short of the latter wall, the openings and conduit being in alignment with one another. Two or more of such snubbing or surge chambers are arranged in series in the path of the gases and they accomplish an effective quieting action with a minimum restriction to gas flow.

Silencing apparatus employing the snubbing or surge principle have been used heretofore, but in them the apertured walled escape conduits have been arranged in non-alignment with the inlet openings of the chambers. In accordance with the present invention, it has been discovered that the escape conduits may be arranged in alignment with the inlet openings and that such construction is substantially as effective as the previous construction in producing a quiet exhaust or intake. This is a surprising result, as will be apparent in the light of the detailed description set forth hereinafter.

In the drawing:

Fig. 1 is a longitudinal sectional view of the silencing apparatus of the invention;

Fig. 2 is a transverse sectional view along line 2—2 of Fig. 1; and

Fig. 3 is a longitudinal sectional view of a different modification of the invention.

The apparatus will be described in connection with its application for use in silencing the exhaust of an internal combustion engine, although it is adapted as well for the quieting of intake noises, as stated heretofore.

The construction of Figs. 1 and 2 consists of a cylindrical shell 10, having walls 11 and 12 at the ends thereof, said walls having inlet opening 13 and outlet opening 14 therein, respectively. A partition 15 extends transversely of the shell 10 at an intermediate portion thereof and divides the

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said shell into two snubbing or surge chambers 16 and 17. Chamber 16 is shown as being slightly larger than chamber 17, but this is not critical, and they may be of any relative size as desired. The partition 15 and the end walls 11 and 12 are shown as being dished to increase their strength, but they may be planar, if desired. All of the parts may be joined together in a suitable manner, as by welding.

Partition 15 has an outlet or escape opening 18 therein arranged in alignment with inlet and outlet openings 13 and 14. An apertured walled escape conduit 19 is connected at its rearward end to the opening 18 and extends forwardly into snubbing chamber 16 and stops short of the forward end wall 11, whereby its forward end is arranged in spaced relationship to inlet opening 13. The dimensions of conduit 19 are not critical, but it should have a diameter not substantially less than the diameter of the inlet opening 13 and it should extend into the chamber 16 a distance at least twice its diameter. The annular opening or gap between conduit 19 and the forward end wall 11 should preferably have an area as great as twice the cross sectional area of conduit 19 whereby the inlet opening is in immediate communication with the entire volume of chamber 16. These factors will be discussed hereinafter in connection with the explanation of the action which takes place within the device.

In a similar manner, an apertured walled escape conduit 22 extends forwardly into the second snubbing chamber 17 from the escape opening 14 in the rearward end wall 12 of the device. The construction and arrangement of escape conduit 22 in snubbing chamber 17 is similar to that of escape conduit 19 in snubbing chamber 16. An inlet snout 23 is connected to inlet opening 13 in end wall 11 of the device and is adapted to be connected to the exhaust conduit of the internal combustion engine. An imperforate outlet snout 24 is connected to outlet opening 14 in end wall 12 and is adapted to provide communication between escape conduit 22 and the atmosphere.

In operation, the inlet snout 23 is connected to the exhaust pipe of the internal combustion engine. The exhaust gases enter the first snubbing chamber 16 through said snout 23 in the form of a succession of high pressure surges or slugs separated by intervening spaces at low pressure, which may be lower than atmospheric pressure. The slugs consist of masses of gas under pressure and traveling at high velocity. The slugs emerge into the snubbing chamber 16

and immediately upon their emergence expand throughout the volume of said chamber. It might be expected that each slug would continue to travel as a slug until it reached the escape conduit 19 and then proceed through said conduit and into the second chamber 17 without undergoing much reduction in pressure or kinetic energy. This is not the fact, however, but rather the slug expands immediately upon its emergence into chamber 16 and spreads throughout the entire volume of the chamber in an action in which its velocity, pressure and kinetic energy are greatly reduced and dissipated. The residual gases previously in the chamber are ejected by the expanding slug and filter into the escape conduit 19 through the open entrance end and the apertures of the walls thereof. The interior of chamber 16 is under increased pressure due to the expanding gases of the slug. The latter then filter into the escape conduit 19 through the apertures and the open entrance end thereof and pass into the second snubbing chamber 17. The apertured wall of conduit 19 exerts a moderate restraining action upon the gases and this retards them slightly with the result that the pressure thereof is equalized to a large extent throughout the volume of the chamber and an effective checking or snubbing of the high velocity, high pressure slug takes place.

There are two factors of the design of the apparatus of the invention which are important. First, the expansion of the gases immediately upon their emergence from the inlet opening should be free and unrestricted into the entire volume of the snubbing chamber. To realize this factor, the annular opening or gap between the forward end of escape conduit 19 and the inlet opening 13 should be relatively large, and should preferably have an area as great as twice the cross sectional area of said escape conduit 19. Such annular opening is the path by way of which the gas can spread laterally and expand into the entire volume of the snubbing chamber 16.

Secondly, the passage of the gases out of the first chamber and into the second should be a moderately restrained filtration distributed over a relatively large area. To realize this factor, the escape conduit 19 should extend into the snubbing chamber 16 a substantial distance, equal to at least twice the diameter of said conduit 19. Also, the apertures in the wall of escape conduit 19 should be distributed, preferably uniformly, over the area of said wall and should preferably have an aggregate area from 1 to 5 times the cross sectional area of the escape conduit. The limits are not critical because of the wide variation in type, size, speed, etc. of the engine with which the device may be used. The two factors may be combined in such manner as to produce the best silencing results for the particular engine to which the device is to be attached.

The action in the second chamber 17 is substantially the same as has been described. The pressure and kinetic energy of the surges entering this chamber have been greatly reduced, but the gases are still in the form of pulsations, and these undergo a further reduction and dissipation of their pressure and kinetic energy by a snubbing action as has been described heretofore. The gases leaving the device by way of outlet snout 24 are in the form of a relatively steady stream and there is no objectionable noise.

As has been explained, the device may also be used as an intake silencer for internal combustion engines and blowers, and the snout 24 of the device of Figs. 1 and 2 may be connected to the engine or blower intake.

The construction illustrated in Fig. 3 is similar to that of Figs. 1 and 2 with the exception that it has three snubbing chambers instead of two, arranged in succession in the path of the gases. It comprises a cylindrical shell 30 having end walls 31 and 32, said walls containing inlet opening 33 and outlet opening 34, respectively, said openings having snouts 35 and 36 connected thereto. The shell 30 is divided into three snubbing chambers 37, 38 and 39 by two transverse partitions 41 and 42. Partitions 41 and 42 have openings 43 and 44 therein in alignment with inlet and outlet openings 33 and 34, and apertured walled escape conduits 45, 46 and 47 are connected at their rearward ends to openings 43, 44 and 34 and extend forwardly into chambers 37, 38 and 39, respectively, the construction within each snubbing chamber being similar to that which has been described heretofore in connection with the snubbing chambers of the device of Figs. 1 and 2. Inlet snout 35 is adapted to be connected to the exhaust conduit of an internal combustion engine, and the action within the apparatus is similar to that which has been described heretofore in connection with the device of Figs. 1 and 2. The three chambered device is employed where conditions are relatively severe, and any number of chambers may be employed as desired, depending upon the severity of the conditions which must be met.

As has been explained heretofore, the apparatus of the invention produces unexpectedly good silencing results, and, in addition, produces somewhat less restriction to the flow of gases than do the prior devices in which the apertured-walled escape conduits are arranged in non-alignment with the inlet openings of the snubbing chambers.

While but a few modifications have been described and illustrated, they are by way of example and modifications thereof may be made within the scope of the invention. For example, while the openings and escape conduits are all arranged centrally within the shells, they may be arranged off center, as long as the aligned relationship of escape conduit to inlet opening of the snubbing chamber is maintained. The conduits may be of other than the cylindrical shape shown, for example, angular, oval, irregular, such as star-shaped, in transverse section. The outer shell may also be of other than cylindrical shape, such as angular, oval, etc. In the same way, the openings in the end walls may be of other than circular shape. The apertures in the walls of the escape conduits are shown as being circular, and they, also, may be of other shape, and may be in the form of elongated slots. A snout, such as the snout 23 of Fig. 1, may project a substantial distance into the snubbing chamber from the inlet opening thereof, as long as an annular opening of sufficient size is maintained between the snout and the escape conduit to permit the ready and free expansion of the surges or slugs into the snubbing chamber, as has been explained heretofore. In such case, the end of the snout is the inlet opening for the chamber. The chambers may be of different relative size than has been described and illustrated in the foregoing.

What is claimed is:

1. Apparatus for silencing noise-producing

gases, comprising a plurality of chambers, said chambers each having forward and rearward walls arranged oppositely with respect to each other, said forward and rearward walls having inlet and outlet openings therein respectively, the structure within each said chamber consisting of an open-ended, apertured-walled conduit connected to the outlet opening of said chamber and extending forwardly toward and stopping short of the forward wall thereof, said outlet conduit being throughout its length of substantially less cross sectional area than said chamber, the apertures of said conduits being distributed over the area of the walls thereof, said conduits and said inlet and outlet openings being substantially in alignment with one another, the gap in each chamber between the forward wall thereof and the forward end of the conduit therein having an area at least as great as twice the cross-sectional area of said conduit, the aggregate area occupied by the apertures in the walls of each of said conduits being approximately 1.0 to 5.0 times the cross-sectional area of said conduit, the conduit of one chamber being connected to the inlet opening of the next chamber whereby said chambers are connected in series in the path of the gases.

2. Apparatus for silencing noise-producing gases, comprising a plurality of chambers, said chambers each having forward and rearward walls arranged oppositely with respect to each other, said forward and rearward walls having inlet and outlet openings therein respectively, the structure within each said chamber consisting of an open-ended, apertured-walled conduit connected to the outlet opening of said chamber and extending forwardly toward and stopping short of the forward wall thereof, said outlet conduit being throughout its length of substantially less cross sectional area than said chamber, the apertures of said conduits being distributed over the area of the walls thereof, within each chamber the conduit and the inlet and outlet openings being substantially in alignment with one another, the gap in each chamber between the forward wall thereof and the forward end of the conduit therein having an area at least as great as twice the cross-sectional area of said conduit, the conduit of one chamber being connected to the inlet opening of the next chamber whereby said chambers are connected in series in the path of the gases.

ROBERT L. HOYLE.

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