

April 26, 1949.

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2,468,384

MANIFOLD SILENCER WITH CIRCULAR FLOW

Filed March 30, 1945

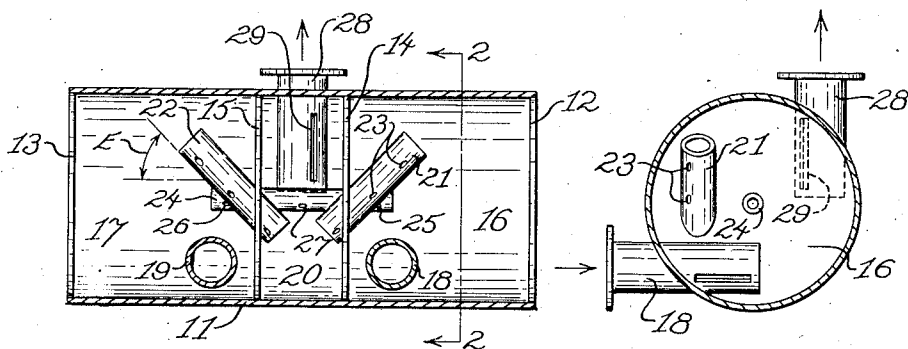


Fig. 1

Fig. 2

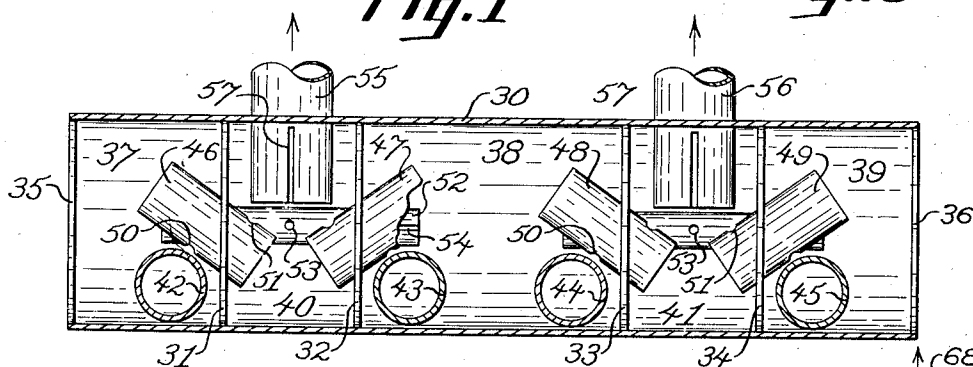


Fig. 3

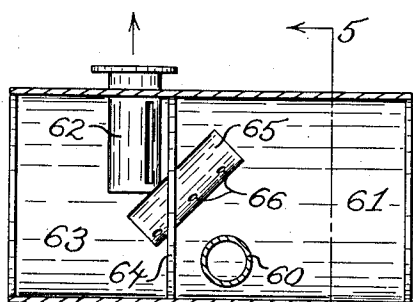


Fig. 4

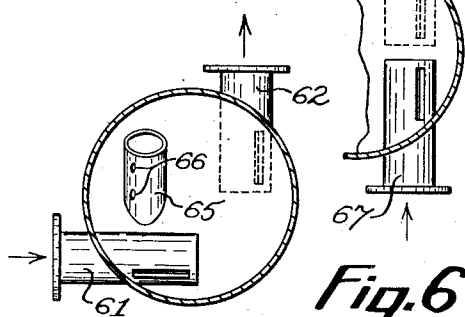


Fig. 6

Fig. 5

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2,468,384

MANIFOLD SILENCER WITH CIRCULAR FLOW

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Application March 30, 1945, Serial No. 585,590

6 Claims. (Cl. 181-40)

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The present invention relates to silencing devices adapted to be installed directly on the exhaust ports of internal combustion engines so as to combine the functions of a gas collecting manifold such as is usually found on multi-cylinder engines with that of an effective silencer. Such devices are of particular application to railway locomotives where the space available for silencing equipment is a minimum.

As is well known in the art, it is extremely difficult to obtain a satisfactory degree of silencing with a device limited to a single chamber. Attempts to incorporate a two chamber device in space generally allotted for silencing on a locomotive has resulted in the creation of too high a back pressure. This effect is augmented by the fact that there is little chance for cooling of the exhaust gases between the cylinder and the closely adjacent silencing manifold and consequently the temperature remains high with proportionately high gas velocities.

It is a feature of the present invention that the back pressure of the multichambered device shown is of the same order as that usually obtained with single chambered manifold silencers while the sound attenuation is considerably greater. The invention accomplishes this purpose by providing a path for the gases which, while the noise producing surges are broken up, permit the gases to flow without any abrupt changes in direction, the gases entering the casing tangentially and persisting in the same sense of rotation until they are discharge from the silencer.

For a complete description of the invention reference is made to the drawings in which

Fig. 1 is a side elevation, with the casing broken away to the median plane, of one embodiment of the invention;

Fig. 2 is a transverse section on line 2-2 of Fig. 1;

Fig. 3 is a side elevation, with the casing broken away to the median plane, of another embodiment of the invention;

Fig. 4 is a side elevation, with the casing broken away to the median plane, showing the application of certain principles of the invention to a silencer of other than the manifold type;

Fig. 5 is a section on line 5-5 of Fig. 4; and

Fig. 6 is a detail of a further modification.

Referring to Fig. 1, it will be seen that this embodiment is adapted to serve two cylinders. It comprises a cylindrical shell 11 closed by end headers 12, 13, and having a pair of intermediate transverse headers 14, 15 dividing the interior of the silencer into two separate inlet chambers 16, 17, into which the exhaust gases flow through tan-

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gentially disposed, slotted inlet pipes 18, 19, respectively. The gases are thus given a whirling motion within chambers 16 and 17. An outlet chamber 20 is positioned between the inlet chambers. Since the spacing of these inlet pipes is determined by the engine ports, which are generally close together, it is desirable to position the intermediate headers 14, 15 close to these inlet pipes in order to increase the size of the outlet chamber and thus to secure as good a balance as possible between the volumes of the two inlet chambers and the outlet chamber 20 defined by the casing 11 and headers 14, 15.

The whirling gases in the inlet chambers 16, 17 are conducted into the outlet chamber 20 through intermediate, angularly disposed tubes 21, 22 preferably provided with anti-resonance perforations 23. For a disclosure of such anti-resonating constructions reference is made to the patent to Bourne, 2,297,046, September 29, 1942, in which the proper sizes and spacing of the anti-resonance holes are fully described. These intermediate tubes are located near one side of the casing and project into their respective inlet chambers at an angle E with the axis of the silencer of preferably from 30 to 50 degrees. I have found that this arrangement yields the lowest backpressure because the exhaust gases in the inlet chamber partake of a spiral motion and by disposing the intermediate tubes as described the gases enter them with a minimum change in direction. Since the outlet chamber 20 is ordinarily relatively short in longitudinal extent, due to limitations of engine design, it is expedient to terminate the intermediate conduits 21, 22 within it close to the intermediate headers in order to avoid undue interference with smooth gas flow in the outlet chamber.

In order to provide somewhat more effective volume for the inlet chambers as seen from their respective engine cylinders; that is to say, in order to make available the volume of both inlet chambers to either inlet, I provide an equalizing conduit 24, extending from the interior of one inlet chamber to the interior of the other. This conduit is axially disposed and projects an appreciable distance into the chambers from the intermediate headers. It is preferably fitted with anti-resonance perforations 25, 26 in the inlet chamber portion and with a relatively small aperture 27 opening into the outlet chamber 20. This equalizing conduit does not function as a primary gas passage but serves to introduce into each of the inlet chambers an acoustic reactance whereby

any natural resonances which may exist are damped. In addition, heavy surges introduced into either inlet chamber are partly bled off through the conduit 24 into the other inlet chamber, since the pressure conditions in the two chambers are out of phase with each other due to the fact that both engine cylinders involved do not fire at the same instant. A tangential outlet conduit 23, preferably provided with a narrow longitudinal slot 29, is positioned to conduct the whirling exhaust gases from the periphery of the outlet chamber 20 to atmosphere. The inner end of this conduit is seen to point in a direction to pick up the whirling gases in this chamber, this whirling motion being perpetuated in the outlet chamber by the angularly disposed intermediate conduits 21, 22.

Fig. 3 shows an arrangement adapted for use with a four cylinder engine. In this case the casing 30 is divided by partitions 31, 32, 33 and 34 and provided with end headers 35 and 36 to form three inlet chambers 37, 38 and 39 and two outlet chambers 40 and 41. The inlet pipes 42, 43, 44 and 45 enter tangentially and are constructed to fit the manifolds of the particular engine to which the silencer is to be applied. Their detail is therefore unimportant and the pipes have been shown diagrammatically. The remaining construction is generally similar to that shown in Fig. 1 and only the differences will be emphasized. The two central inlet pipes 43 and 44 enter a single chamber 33 approximately twice the size of each end inlet chamber. The slanting transfer conduits 46, 47, 48 and 49 are here shown as arranged at an angle of 35° to a horizontal plane including the axis of the silencer, and each has an anti-resonance hole 50 at its center lying within the inlet chamber and an anti-resonance hole 51 at its quarter point lying within the outlet chamber. The equalizing conduit 52 has a single hole 53, preferably positioned at the side of the pipe remote from the transfer conduits, and is provided at each end with a slot 54 lying wholly within the respective inlet chamber. The two exhaust pipes 55 and 56 are tangentially arranged in the same manner as shown in Fig. 2 and are provided with slots 57 within the exhaust chamber.

Figs. 4 and 5 show an adaptation of certain principles of the invention to a silencer having one inlet connection 60 leading into the inlet chamber 61, and one outlet connection 62 for conducting the whirling gas out of the outlet chamber 63. The intermediate transverse partition 64 is pierced by a transfer conduit 65 having anti-resonating holes 66 and serving to conduct the gases from chamber 61 to chamber 63. This embodiment is particularly useful where extremely low backpressure is desired and where installation conditions permit its use. An alternative arrangement for the inlet pipe to the silencer is depicted in Fig. 6 wherein the inlet conduit 67 is shown arranged in the same vertical plane as the outlet conduit 68.

In order to further improve the silencing action in devices of this type, I preferably proportion the lengths of the inlet and outlet chambers so that they do not bear an integral relation one with the other. For instance I may make the lengths of these chambers in the ratio of 7:3 or 7:2 in the case of the embodiments shown in Figs. 1 to 3. For the device of Figs. 4 and 5 I prefer to make them in the ratio of 7:5. Thus, any important longitudinal resonances which might exist in one chamber are not reinforced in the other.

I claim:

1. A silencer comprising walls defining a generally cylindrical inlet chamber and a generally cylindrical outlet chamber axially aligned therewith and adjacent thereto, an inlet conduit having an open end projecting into the inlet chamber transversely to the axis of the chamber and substantially tangentially thereof and at the side of the inlet chamber adjacent to the outlet chamber, whereby gases entering the inlet chamber through the inlet conduit will be given a whirling motion about the axis of the casing, an outlet conduit having an open end projecting into the outlet chamber transversely to the axis of the chamber and substantially tangentially thereof and at the side of the outlet chamber adjacent to the inlet chamber and facing oppositely to the inlet conduit in relation to the circumference of the chamber, whereby gases whirling in the sense imparted by the inlet conduit will be picked up by the open end of the outlet conduit without reversal of gas flow, and an open ended intermediate conduit passing through that portion of the walls separating the inlet and outlet chambers at one side of the axis of the casing and extending lengthwise of the casing with its ends displaced circumferentially in such directions that its openings into the inlet and outlet chambers are directed oppositely to the open ends of the inlet and outlet conduits respectively in relation to the circumferences of said chambers, whereby gas will be transferred by the intermediate conduit from one chamber to the other without reversal of its direction of whirl.

2. A silencer comprising a generally cylindrical casing, a transverse header dividing the casing into an inlet chamber and an outlet chamber, an inlet conduit projecting into the inlet chamber transversely to the axis of the chamber and substantially tangentially thereof, whereby gases entering the inlet chamber through the inlet conduit will be given a whirling motion about the axis of the casing, an outlet conduit projecting into the outlet chamber transversely to the axis of the chamber and substantially tangentially thereof and facing oppositely to the inlet conduit in relation to the circumference of the casing, whereby gases whirling in the sense imparted by the inlet conduit will be picked up by the outlet conduit without reversal of gas flow, and an open ended intermediate conduit passing through the transverse header at one side of the axis of the casing and extending lengthwise of the casing with its ends displaced circumferentially in such directions that its openings into the inlet and outlet chambers are directed oppositely to the open ends of the inlet and outlet conduits respectively in relation to the circumference of the casing, whereby gases will be transferred by the intermediate conduit from one chamber to the other without reversal of its direction of whirl.

3. A silencer comprising walls defining a pair of generally cylindrical and axially aligned inlet chambers and a generally cylindrical outlet chamber located between and in axial alignment with them, a pair of inlet conduits having open ends projecting in the same direction into the inlet chambers transversely to the axis of the chamber and substantially tangentially thereof, whereby gases entering the inlet chambers through the inlet conduits will be given a whirling motion in the same sense in both said inlet chambers, an outlet conduit having an open end projecting into the outlet chamber transversely to the axis of the chamber and substantially tangentially thereof and facing oppositely to the inlet conduits in re-

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lation to the circumference of the chamber, whereby gases whirling in the sense imparted by the inlet conduits will be picked up by the open end of the outlet conduit without reversal of gas flow, and open ended intermediate conduits passing through that portion of the walls separating the inlet and outlet chambers at one side of the axis of the casing and extending lengthwise of the casing with its ends displaced circumferentially in such directions that their openings into the inlet and outlet chambers are directed oppositely to the open ends of the inlet and outlet conduits respectively in relation to the circumferences of said chambers, whereby gas will be transferred by the intermediate conduits from the inlet chambers to the outlet chamber without reversal of its direction of whirl.

4. A silencer comprising walls defining a pair of generally cylindrical and axially aligned inlet chambers and a generally cylindrical outlet chamber located between and in axial alignment with them, a pair of inlet conduits having open ends projecting in the same direction into the inlet chambers transversely to the axis of the chamber and substantially tangentially thereof, whereby gases entering the inlet chambers through the inlet conduits will be given a whirling motion in the same sense in both said inlet chambers, an outlet conduit having an open end projecting into the outlet chamber transversely to the axis of the chamber and substantially tangentially thereof and facing oppositely to the inlet conduits in relation to the circumference of the chamber, whereby gases whirling in the sense imparted by the inlet conduits will be picked up by the open end of the outlet conduit without reversal of gas flow, open ended intermediate conduits passing through that portion of the walls separating the inlet and outlet chambers at one side of the axis of the casing and extending lengthwise of the casing with its ends displaced circumferentially in such directions that their openings into the inlet and outlet chambers are directed oppositely to the open ends of the inlet and outlet conduits respectively in relation to the circumferences of said chambers, whereby gas will be transferred by the intermediate conduits from the inlet chambers to the outlet chamber without reversal of its direction of whirl, and a conduit passing

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through the outlet chamber and having an open end within each inlet chamber.

5. A silencer comprising a generally cylindrical casing, a transverse header dividing the casing into an inlet chamber and an outlet chamber, an inlet conduit projecting into the inlet chamber transversely to the axis of the chamber and substantially tangentially thereof at a point adjacent the header, an intermediate conduit projecting into said inlet chamber and passing through the header into the outlet chamber at a point removed from the center of the header and making an angle of from 30 to 50 degrees with a plane passing through the axis of the casing, the open ends of said conduit being in adjacency to the cylindrical walls of the chambers, and an outlet conduit projecting into the interior of said outlet chamber transversely to the axis of the chamber and substantially tangentially thereof and positioned in adjacency to the header with its open end disposed oppositely to the inlet conduit with relation to the circumference of the casing, whereby gases passing through the silencer acquire and maintain a whirling motion in the same sense in both the inlet and the outlet chambers and suffer no reversal of flow in their passage through the silencer.

6. A silencer as claimed in claim 5, wherein the inlet and outlet conduits are so positioned that planes passing through the longitudinal axis of each of said conduits parallel to the axis of the casing are at substantially right angles to each other.

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