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SILENCER FOR GAS ENGINES, &c.
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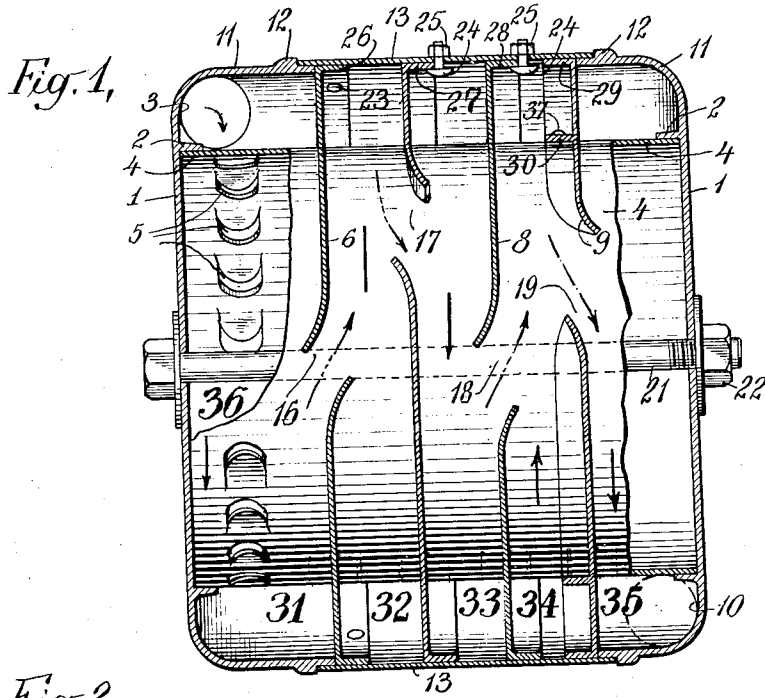
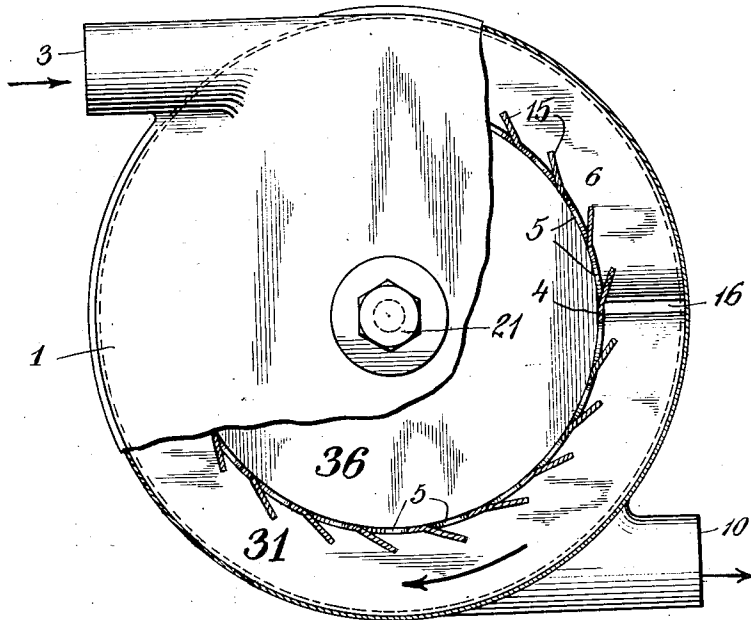


Fig. 2.



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SILENCER FOR GAS-ENGINES, &c.

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To all whom it may concern:

Be it known that I, HIRAM PERCY MAXIM, a citizen of the United States, and resident of Hartford, in the county of Hartford and State of Connecticut, have made a certain new and useful Invention Relating to Silencers for Gas-Engines, &c., of which the following is a specification, taken in connection with the accompanying drawing, which forms part of the same.

This invention relates especially to silencers for the exhaust of gas engines or the like which may be provided with a casing comprising end members having substantially tangential inlet and outlet openings and formed with suitable end partitions and connected flanges to cooperate with a relatively adjustable casing body which may be mounted on these flanges. By mounting an internal shell in said end members an inner substantially cylindrical equalizing chamber may be formed within the casing around which may extend a series of annular whirl chambers separated by suitable annular intermediate partitions mounted on the shell and casing respectively. If as is desirable they may be adjustable in connection therewith relatively to the end members so as to adjust the relative angular position of the openings to promote the interference suppression of sound waves in these annular whirl chambers. It is also desirable to provide one or more of the initial whirl chambers with which the inlet opening for the exhaust gases communicates with a series of accelerating discharge apertures, on its inner side for instance, to promote the passage of the initial gas impulses into the equalizing chamber within; and each of the whirl chambers may be provided with retarding discharge openings in the separating diaphragms to promote the dissipation of the kinetic energy of the gases in each of the chambers before they are allowed to discharge therefrom.

In the accompanying drawing showing in a somewhat diagrammatic way an illustrative embodiment of this invention Figure 1 is a longitudinal section, parts being shown in elevation for greater clearness; and Fig. 2 is a transverse view partly in section.

The silencer casing which may be of any suitable form and material may with advantage be provided with a casing body and with relatively adjustable end members in

which the inlet and outlet openings are formed so as to facilitate the angular adjustment of these parts under some conditions. The end members 1 may as indicated be provided with end partitions and with substantially cylindrical connecting flanges, such as 11, preferably having projecting ribs 12 thereon. The end members which may be formed of cast iron or any other suitable material may also be provided with an inner supporting flange or collar, such as 2, with which the internal shell 4 of substantially cylindrical form may cooperate so as to make a substantially tight joint and form an inner cylindrical equalizing chamber 36. The casing body 13 which may be formed of sheet metal or other suitable material may cooperate with the ends of the connecting flanges 11 so as to be forced against the ribs 12 thereon when the parts are fastened together in any suitable way as by being secured by one or more fastening bolts 21 and nuts 22 which may pass longitudinally through the silencer. A single central bolt such as indicated permits the convenient angular adjustment of any of these parts after the fastening has been loosened and all the parts are instantly secured firmly together by tightening up this single bolt. The inlet and outlet openings are preferably formed in the end members and the inlet at least is preferably so arranged as to direct the exhaust gases substantially tangentially into the initial chamber which they enter within the silencer casing. The inlet 3 for this purpose may, if desired, be cast integral with the end member and a similarly arranged substantially tangential outlet opening 10 may also be formed in the other end member.

This silencer preferably comprises a series of continuous passages around which the sound waves may be directed in both directions from the opening into each of these passages until they are admitted into the succeeding passage through the discharge opening thereinto. These passages may with advantage be given a substantially circular or annular form and by making the communicating openings relatively adjustable it is possible to secure desirable interference, suppression or dissipation of the sound waves of the exhaust if the two branches of each passage between the inlet and outlet opening thereof are given such length as to

have the undesirable sound waves passing therethrough arrive at the outlet opening out of phase, preferably about a half wave length out of phase with each other, so that the particular tone or sound wave in question may be largely or considerably suppressed and different noise elements or sound waves may in this way be eliminated in different duplex or continuous passages by making the effective length of the two branches thereof differ by about a half wave length of the objectionable noise or sound vibration to be suppressed or eliminated from the engine exhaust. It is desirable that the discharge openings by which the gases are allowed to pass from one of the passages or whirl chambers to the next shall be so arranged as to be in each case a retarding discharge opening so as to retard the discharge of gases from the whirl chamber in question in proportion to the speed of initial movement of the gases in such chamber. This has an important action in smoothing or evening out the sharp puffs or gas impulses of the usual gas engine exhaust and a series of substantially annular whirl chambers, each having such a retarding discharge opening into the succeeding chamber, has an important action in equalizing the gas discharge from the silencer. This action is also considerably promoted by providing an equalizing chamber preferably communicating with the first one or two whirl chambers to which the exhaust gases are admitted in the silencer and by making this equalizing chamber of relatively large capacity as compared to the communicating initial chamber or chambers and especially by providing accelerating discharge apertures or openings leading into the equalizing chamber, the force or speed of the initial movement of the gases in this whirl chamber promotes to a considerable extent the passage of the gases into the equalizing chamber, where they are retained until the kinetic energy of the gas impulse is considerably exhausted by this whirling action and by discharge of gas into succeeding chambers before the gases which may be of somewhat higher static pressure in the equalizing chamber can be discharged therefrom into the communicating series of whirl chambers. These accelerating discharge apertures into the equalizing chamber act selectively in promoting the periodic flow of gas into the equalizing chamber while the peak or high pressure gas impulse is entering the communicating silencer chamber and the periodic discharge of part of these stored high pressure gases during the relatively low pressure period or pause in the engine exhaust, so that a valuable equalizing action is thus secured. This action is largely proportionate to the capacity of the equalizing chamber and the effectiveness of

the accelerating apertures communicating therewith which may be so arranged as to promote the discharge of gas from the equalizing chamber when the movement of gas in the communicating whirl chamber is reversed during the discharging movement.

A series of sound passages may be formed in the silencer by providing substantially circular or annular partitions, such as 6, 7, 8 and 9, arranged at suitable intervals apart and provided with any suitable form of opening so as to preferably provide a single discharge opening between each sound passage and the succeeding one in the series. These partitions may be so arranged that with a gas engine operating under standard conditions one or more of these sound passages has a sound suppressing action through the interference of the sound waves transmitted in both directions from its inlet to its outlet or discharge opening which is most pronounced when the effective length of the two branches of this continuous passage vary by about a half of the wave length of the particular sound vibration to be suppressed.

The relative location of the initial inlet and outlet opening of the silencer and of the discharge openings in the intermediate partitions may be so arranged as to suppress or minimize in this way several of the objectionable sound vibrations in the engine exhaust, the pronounced objectionable noise usually having several components which can with advantage be suppressed or minimized in this way. It is, however, desirable, to have the discharge openings in some at least of these partitions relatively adjustable and for this purpose the partitions may be secured part to the inner silencer shell and part to the outer casing body and may be more or less adjustable angularly with respect to these elements so as to allow a considerable range of adjustment by moving the various parts of the silencer. As indicated the partition 6 preferably formed of heavy sheet steel or other suitable material, which may be stamped up into the desired form, may have an integral flange such as 26 formed thereon which may be riveted or otherwise secured to the casing body 13 as by the rivets 23. Another of these partitions, such as 9, may have an inner strengthening flange 30 stamped up or otherwise formed thereon for cooperation with the inner shell 4 to which it may be secured in any suitable way as by the rivets 37. This partition may, if desired, also have an outer flange 29 to closely engage the outer casing body 13. In this way by angularly adjusting the casing body with respect to the shell an angular movement is effected between the discharge openings in these two partitions and still other partitions may be mounted on these elements permanently, or, if de-

sired, adjustably so as to secure still further adjustments for the purpose outlined. The partition 7 may, for example, have a flange 27 thereon adjustably secured to the casing body 13 to which it may be clamped by suitable clamping or securing members such as the suitable flat headed clamping bolts 24 which tightly hold these parts together when the nuts 25 are screwed down on the bolts.

The partition 8 may have its flange 28 secured in a similar way to the casing body 13 so that the desired angular adjustment between these flanges and the casing body may be made at any time and then all of these flanges 6, 7, and 8 may be angularly adjusted in unison with the casing body so as to secure the desired angular position of the discharge openings in these intermediate partitions with respect to the opening in the partition 9 and the initial inlet and discharge opening of the silencer.

The exhaust gases from the inlet opening 3 move around the initial passage or whirl chamber 31 in the direction of the full line arrows and during the time when the high pressure and high velocity initial puffs enter this whirl chamber a rapid and forcible whirling movement is set up therein and if the discharge opening 16 from this initial whirl chamber extends in the opposite direction to the initial whirling movement of the gases in this chamber it retards their discharge therefrom as long as this whirling movement continues and a considerable pressure is thus built up due to the kinetic energy of the gases beyond the pressure in the succeeding whirl chamber 32. It is thus possible by having any suitable openings from this initial chamber to an equalizing chamber, such as the internal cylindrical equalizing chamber to effect the passage or momentary discharge into the equalizing chamber of a considerable volume of the gases discharged during these sharp impulses and this action is considerably promoted by forming a series of accelerating discharge apertures or openings into the equalizing chamber 36 which may be located on the inner circumferential face of the initial whirl chamber 31, although still greater accelerating discharge action can be secured if such accelerating openings are located on the outer circumferential face of the whirl chamber so that the whirling gases tend to still more strongly crowd out through these apertures from the whirl chamber within. These accelerating apertures may be formed by the bending up of the flaps or deflecting guides 15 so as to form guiding vanes preferably cooperating with each one of the apertures 5 so that when the gases in the whirl chamber 31 are whirling in the direction of the arrow in Fig. 2 they tend to bank up and crowd inward and be directed into the equalizing chamber 36 within due to

the guiding or directing action of the accelerating apertures; so that as long as this rapid whirling movement continues the adjacent gases are forced into the equalizing chamber and their emergence therefrom retarded as long as the gases continue to circulate in this direction in the communicating whirl chamber. When, however, the sharp initial gas impulse has ceased and the energy of the gases has been more or less dissipated by friction and eddy losses in the whirl chamber the gas is more and more crowded through the discharge opening 16 into the adjacent whirl chamber 32 by static pressure which also forces out of the equalizing chamber 36 part of the gases therein which tends to momentarily reverse the gas current in the whirl chamber 31 and promote this discharge into the succeeding whirl chambers 32, 33, 34 and 35 each of which has an equalizing action due to the inertia of the whirling gases and the consequent friction and eddy losses as well as the cooling effects secured by contact with the silencer casing from which more or less heat is constantly dissipated. The gases passing through the discharge opening 16 are indicated by the dot and dash line in Fig. 1 and as shown therein tend to set up a whirling movement around this whirl chamber in the direction of the full line arrow, so that the discharge opening 17 from this chamber is a retarding discharge opening making necessary a reversal of the direction of this gas movement before discharge can take place as indicated by the dot and dash arrow in connection with this opening 17. Although it is not necessary in all cases retarding discharge openings of progressively increasing area as indicated may be employed in each case so as to promote successive reversals of movement of the gases passing from the whirl chamber 33 through the discharge opening 18 and from the whirl chamber 34 through the discharge opening 19 as indicated by the dot and dash arrow in connection therewith, the normal movement of the gases in each whirl chamber being indicated by the full line arrow therein.

This invention has been described in connection with a number of illustrative embodiments, forms, proportions, materials, constructions, numbers and arrangements of parts, to the details of which disclosure the invention is not of course to be limited, since

What is claimed as new and what is desired to be secured by Letters Patent is set forth in the appended claims.

1. In silencers adapted for use with gas engines or the like, a casing comprising end members having substantially tangential inlet and outlet openings and formed with end partitions and connecting flanges, a relatively adjustable casing body mounted on

said flanges, an internal shell mounted on said end members to form an inner substantially cylindrical equalizing chamber within said casing and a substantially axial fastening bolt releasably holding said casing members together, annular intermediate partitions providing whirl chambers each having a discharge opening and mounted on said shell and casing respectively to be adjustable in connection therewith relatively to said end members to adjust the relative angular position of said openings to promote interference suppression of sound waves in the series of annular whirl chambers between said partitions, an initial whirl chamber with which said inlet opening communicates being provided on its inner side with an annular series of accelerating discharge apertures to effect the passage of the initial gas impulses into said equalizing chamber and each of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

2. In silencers adapted for use with gas engines or the like, a casing comprising end members having inlet and outlet openings, a relatively adjustable casing body, an internal shell mounted on said end members to form an inner substantially cylindrical equalizing chamber within said casing and a substantially axial fastening bolt releasably holding said casing members together, annular intermediate partitions providing whirl chambers each having a discharge opening and mounted on said shell and casing respectively to be adjustable in connection therewith relatively to said end members to adjust the relative angular position of said openings to promote interference suppression of sound waves in the series of annular whirl chambers between said partitions, an initial whirl chamber with which said inlet opening communicates being provided with a series of accelerating discharge apertures to effect the passage of the initial gas impulses into said equalizing chamber.

3. In silencers adapted for use with gas engines or the like, a casing comprising end members having inlet and outlet openings, a relatively adjustable casing body, an internal shell mounted on said end members to form an inner substantially cylindrical equalizing chamber within said casing and a substantially axial fastening bolt releasably holding said casing members together, annular intermediate partitions providing whirl chambers each having a discharge opening and mounted to be adjustable relatively to said end members to adjust the relative angular position of said openings to promote interference suppression of sound waves in the series of annular whirl chambers between said partitions, an initial whirl

chamber with which said inlet opening communicates being provided with a series of discharge apertures to effect the passage of the initial gas impulses into said equalizing chamber.

4. In silencers adapted for use with gas engines or the like, a casing comprising end members having inlet and outlet openings and a relatively adjustable casing body, adjustable intermediate partitions providing whirl chambers each having a discharge opening and mounted in said casing to adjust the relative angular position of said openings to promote interference suppression of sound waves in the series of whirl chambers between said partitions and each of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

5. In silencers adapted for use with gas engines or the like, a casing comprising end members having inlet and outlet openings and a relatively adjustable casing body, intermediate partitions providing whirl chambers each having a discharge opening and mounted in said casing to promote interference suppression of sound waves in the series of whirl chambers between said partitions and some of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

6. In silencers adapted for use with gas engines or the like, a substantially cylindrical casing having substantially tangential inlet and outlet openings, an internal shell to form an inner substantially cylindrical equalizing chamber within said casing, annular intermediate partitions mounted between said shell and casing to form a series of communicating annular whirl chambers between said partitions, the initial whirl chamber with which said inlet opening communicates being provided on its inner side with an annular series of accelerating discharge apertures having cooperating deflecting guides projecting into said whirl chamber to promote the periodic passage of part of the initial gas impulses into said equalizing chamber and each of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

7. In silencers adapted for use with gas engines or the like, a substantially cylindrical casing having inlet and outlet openings, an internal shell to form an inner substantially cylindrical equalizing chamber within said casing, annular intermediate partitions mounted between said shell and casing to form a series of communicating annular whirl chambers between said partitions, the

initial whirl chamber with which said inlet opening communicates being provided on its inner side with an annular series of accelerating discharge apertures having cooperating deflecting guides projecting into said whirl chambers to promote the periodic passage of part of the initial gas impulses into said equalizing chamber and the first of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

8. In silencers adapted for use with gas engines or the like, a substantially cylindrical casing having inlet and outlet openings, an internal shell to form an inner substantially cylindrical equalizing chamber within said casing, intermediate partitions mounted between said shell and casing to form a series of communicating whirl chambers between said partitions, the initial whirl chamber with which said inlet opening communicates being provided on its inner side with a series of accelerating discharge apertures having cooperating deflecting guides projecting into said whirl chamber to promote the periodic passage of part of the initial gas impulses into said equalizing chamber and the first of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

9. In silencers adapted for use with gas engines or the like, a casing having inlet and outlet openings, an internal shell to form an inner equalizing chamber within said casing, intermediate partitions mounted between said shell and casing to form a series of communicating whirl chambers between said partitions, the initial whirl chamber with which said inlet opening communicates being provided on its inner side with a series of accelerating discharge apertures having cooperating deflecting guides projecting into said whirl chambers to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

10. In silencers adapted for use with gas engines or the like, a casing having inlet and outlet openings, an internal shell to form an inner equalizing chamber within said casing, intermediate partitions mounted between said shell and casing to form a series of communicating whirl chambers between said partitions, the initial whirl chamber with which said inlet opening communicates being provided on its inner side with a series of accelerating discharge apertures to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

11. In silencers adapted for use with gas engines or the like, a casing having inlet and

outlet openings, a substantially cylindrical equalizing chamber cooperating with said casing, annular intermediate partitions mounted in said casing to form a series of communicating annular whirl chambers between said partitions, an initial whirl chamber with which said inlet opening communicates being provided with an annular series of accelerating discharge apertures having cooperating deflecting guides to promote the periodic passage of part of the initial gas impulses into said equalizing chamber and each of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

12. In silencers adapted for use with gas engines or the like, a casing having inlet and outlet openings, an equalizing chamber cooperating with said casing, intermediate partitions mounted in said casing to form a series of communicating annular whirl chambers between said partitions, an initial whirl chamber with which said inlet opening communicates being provided with a series of accelerating discharge apertures having cooperating deflecting guides to promote the periodic passage of part of the initial gas impulses into said equalizing chamber and each of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

13. In silencers adapted for use with gas engines or the like, a casing having inlet and outlet openings, an equalizing chamber cooperating with said casing, intermediate partitions mounted in said casing to form a series of communicating whirl chambers between said partitions, an initial whirl chamber with which said inlet opening communicates being provided with a series of accelerating discharge apertures to promote the periodic passage of part of the initial gas impulses into said equalizing chamber and the first of said whirl chambers being provided with retarding discharge openings to promote the dissipation of the kinetic energy of the gases before the discharge thereof.

14. In silencers adapted for use with gas engines or the like, a casing having inlet and outlet openings, an equalizing chamber cooperating with said casing, intermediate partitions mounted in said casing to form a series of communicating whirl chambers between said partitions, and an initial whirl chamber with which said inlet opening communicates being provided with a series of accelerating discharge apertures to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

15. In silencers adapted for use with gas engines or the like, a casing having inlet and outlet openings, an equalizing chamber co-

operating with said casing, intermediate partitions mounted in said casing to form a series of communicating whirl chambers between said partitions, and an initial whirl chamber with which said inlet opening communicates being provided with a series of discharge apertures to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

16. In silencers adapted for use with gas engines or the like, a casing having an inlet opening and silencing means comprising a whirl chamber communicating with said inlet opening, an equalizing chamber located within said casing, said whirl chamber being provided with a retarding discharge opening and with a series of accelerating discharge apertures to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

17. In silencers adapted for use with gas engines or the like, a casing having an inlet opening and silencing means comprising a whirl chamber communicating with said inlet opening, an equalizing chamber located within said casing, said whirl chamber being provided with a discharge aperture to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

18. In silencers adapted for use with gas engines or the like, a casing having an inlet opening and silencing means comprising a chamber communicating with said inlet opening, an equalizing chamber located within said casing, said chamber being provided with a discharge aperture to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

19. In silencers adapted for use with gas engines or the like, a casing having an inlet opening and silencing means comprising an initial whirl chamber communicating with said inlet opening and a cooperating equalizing chamber, said initial whirl chamber being provided with a retarding discharge opening and with a series of accelerating discharge apertures having cooperating deflecting guides to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

20. In silencers adapted for use with gas engines or the like, a casing having an inlet opening and silencing means comprising an initial chamber communicating with said inlet opening and a cooperating equalizing chamber, said initial chamber being provided with a retarding discharge opening and with a series of accelerating discharge apertures having cooperating deflecting guides to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

21. In silencers adapted for use with gas engines or the like, a casing having an inlet

opening and silencing means comprising an initial chamber communicating with said inlet opening and a cooperating equalizing chamber, said inlet chamber being provided with a discharge opening and with a series of accelerating discharge apertures to promote the periodic passage of part of the initial gas impulses into said equalizing chamber.

22. In silencers adapted for use with gas engines or the like, a substantially cylindrical casing having substantially tangential inlet and outlet openings, an internal shell mounted to form an inner substantially cylindrical equalizing chamber within said casing, to periodically receive part of the exhaust gases, and annular intermediate partitions each having a discharge opening and mounted on said shell and casing respectively to be adjustable in connection therewith to adjust the relative angular position of said openings to promote interference suppression of sound waves in the series of annular sound passages between said partitions.

23. In silencers adapted for use with gas engines or the like, a substantially cylindrical inlet and outlet opening, an internal shell mounted within said casing and annular intermediate partitions each having a discharge opening and mounted on said shell and casing respectively to be adjustable in connection therewith to adjust the relative angular position of said openings to promote interference suppression of sound waves in the series of annular sound passages between said partitions.

24. In silencers adapted for use with gas engines or the like, a substantially cylindrical casing having inlet and outlet openings, an internal shell mounted within said casing, and annular intermediate partitions each having a discharge opening and a number of said partitions being mounted to be adjustable to adjust the relative angular position of said openings to promote interference suppression of sound waves in the series of annular sound passages between said partitions.

25. In silencers adapted for use with gas engines or the like, a casing having inlet and outlet openings and an internal shell mounted within said casing and intermediate partitions each having a discharge opening and a number of said partitions being mounted to be adjustable to adjust the relative position of said openings to promote interference suppression of sound waves in the series of annular sound passages between said partitions.

26. In silencers adapted for use with gas engines or the like, a casing provided with inlet and outlet openings and formed with a series of communicating annular sound passages each having a single dis-

charge opening through which sound may pass, the angular distance between each of the adjacent openings being adjustable to promote interference suppression of sound waves in the two branches of the interposed passages.

27. In silencers adapted for use with gas engines or the like, a casing formed with a series of communicating endless sound passages each having a single discharge opening through which sound may pass, the distance between each of the adjacent openings being adjustable to promote interference suppression of sound waves in the two branches of the interposed passages.

28. In silencers adapted for use with gas engines or the like, a casing provided with inlet and outlet openings and formed with a series of communicating endless sound passages each having a single discharge opening through which sound may pass, the angular distance between two of the adjacent openings being adjustable to promote interference suppression of sound waves in the two branches of the interposed passage.

29. In silencers adapted for use with gas engines or the like, a casing formed with a series of communicating endless sound passages each having a single discharge opening through which sound may pass, the distance between two of the adjacent openings being adjustable to promote interference

suppression of sound waves in the two branches of the interposed passage.

30. In silencers adapted for use with gas engines or the like, a casing formed with a series of communicating endless sound passages each having a single discharge opening through which sound may pass, the distance between two of the adjacent openings being arranged to promote interference suppression of sound waves in the two branches of the interposed passage.

31. In silencers adapted for use with gas engines or the like, a casing formed with a series of communicating endless sound passages each having a discharge opening through which sound may pass, the distance between several of the adjacent openings being arranged to promote interference suppression of sound waves in the two branches of the interposed passages.

32. In silencers adapted for use with gas engines or the like, a casing formed with an endless sound passage having an inlet and a discharge opening through which sound may pass, the distance between said openings being arranged to promote interference suppression of sound waves in the two branches of the interposed passage.

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