Oct. 19, 1937. W. C. MILES 2,096,000

MUFFLER

Filed July 11, 1936 2 Sheets-Sheet 1

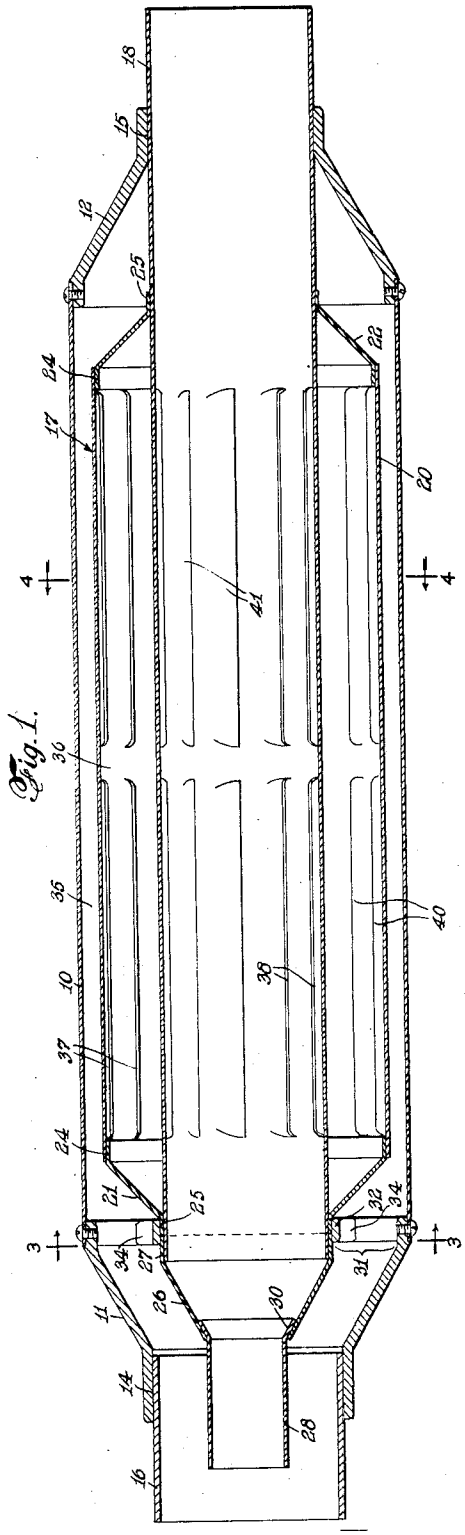


Fig. 1.

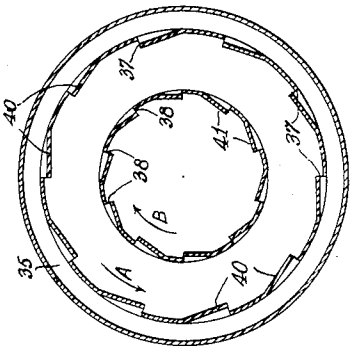


Fig. 4.

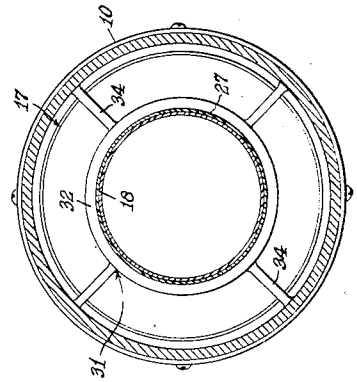


Fig. 3.

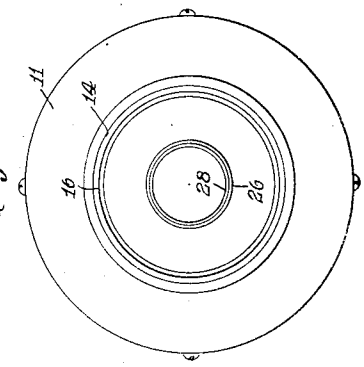


Fig. 2.

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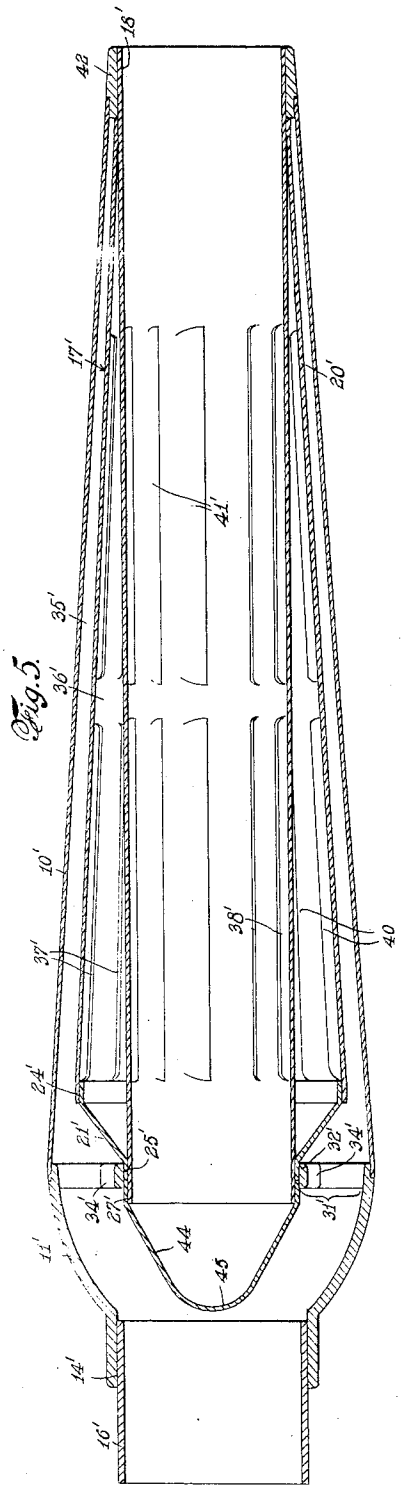


Fig. 5.

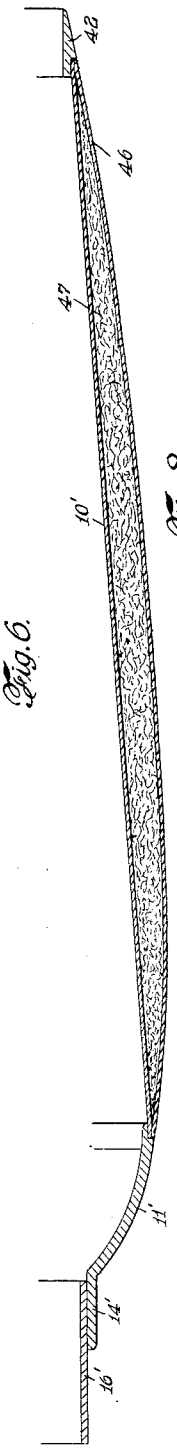


Fig. 6.

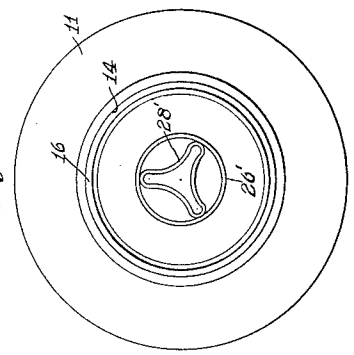


Fig. 8.

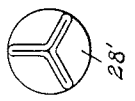


Fig. 9.

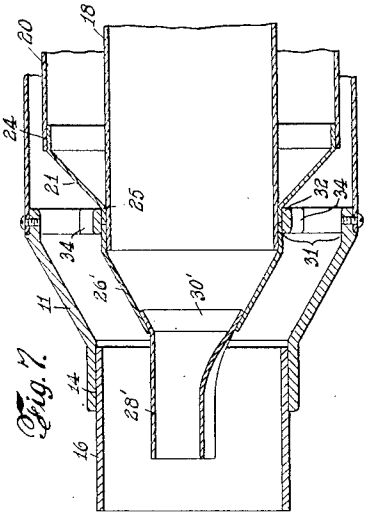


Fig. 7.

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Patented Oct. 19, 1937

2,096,000

UNITED STATES PATENT OFFICE

2,096,000

MUFFLER

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Application July 11, 1936, Serial No. 90,079

36 Claims. (Cl. 181—44)

This invention relates to mufflers for use with internal combustion engines.

An important object of the invention is to provide an improved muffler which is effective, efficient, simple in construction, small in size, light in weight and inexpensive to manufacture.

Other objects and advantages of the invention will become apparent from the following description when taken in connection with the accompanying drawings, in which—

Fig. 1 is a central, longitudinal, sectional view of a muffler embodying one form of the invention.

Fig. 2 is an end elevation of the muffler as viewed from the left in Fig. 1.

Fig. 3 is a transverse sectional view taken on line 3—3 of Fig. 1.

Fig. 4 is a transverse sectional view taken on line 4—4 of Fig. 1.

Fig. 5 is a central, longitudinal, sectional view of a modified form of muffler.

Fig. 6 is a fragmental, longitudinal, sectional view illustrating the manner in which a housing may be applied to the muffler of Fig. 5 for streamlining purposes.

Fig. 7 is a central, longitudinal, sectional view of a modified form of equalizing tube fitting.

Fig. 8 is an end elevation of the fitting of Fig. 7, and

Fig. 9 is a view showing the forward end of the fitting of Figs. 7 and 8 as completely closed.

Referring particularly to Figs. 1 to 4, the numeral 10 indicates a sheet metal casing, to opposite ends of which are suitably connected a pair of heads 11 and 12. The heads 11 and 12 are provided, respectively, with flanged tube-receiving openings 14 and 15, the former of which is adapted to receive a coupling flange or tube 16 by which the muffler may be conveniently connected to the exhaust pipe of an internal combustion engine.

Disposed within the muffler casing is an equalizing unit 17 which functions to direct the exhaust gases through the muffler in such a manner that exhaust noises are eliminated to a very marked degree without substantially detracting from the normal efficiency of the engine under any and all operating conditions.

The above mentioned equalizing unit 17 is constructed wholly of sheet metal and includes an equalizing tube 18, about which is disposed a cylindrical shell 20. The shell 20 is held in a concentric relation to the equalizing tube 18 by a pair of end walls 21 and 22. These end walls are substantially frustro-conical in shape and are provided at their opposite ends with flanges 24 and 25, the former of which are suitably connected, as by welding, to opposite ends of the shell 20 and the latter of which embrace and are similarly connected to the equalizing tube 18.

To the forward end of the equalizing tube 18, there is connected a fitting 26 which is of a shape similar to that of each of the end walls 21 and 22. The larger end of the fitting 26 is formed with a flange 27 which embraces and is welded to the forward end of the equalizing tube in an abutting relation to the flange 25 of the adjacent end wall 21. Within the smaller end of the fitting 26, there is disposed a deflector tube 28, having at one end a flange 30 which is welded to the inner wall of the fitting.

The equalizing unit 17 is held in a coaxial relation to the casing 10 by reason of the fact that the equalizing tube 18 is supported at its outlet end by the head 12 and at its other end by a spider-like structure 31, which includes a ring 32, having a plurality of radially disposed web-like arms 34, connected at their outer ends to the inner wall of the head 11. In order to insure the equalizing unit 17 against displacement with relation to the casing 10, the equalizing tube 18 is suitably connected, as by welding, to the head 12 in the vicinity of the opening 15 thereof.

From the foregoing it will become apparent that the casing 10, the equalizing tube 18 and the shell 20 are so disposed with relation to each other that the shell forms with the casing an annular feeder tube or passage 35 and with the equalizing tube a reservoir 36, which is closed at its opposite ends by the end walls 21 and 22.

In order that a path of communication may be afforded between the feeder tube 35 and the equalizing tube 18 by way of the reservoir 36, the side wall (shell 20) of the feeder tube and the side wall of the equalizing tube are provided with a plurality of slot-like ports 37 and 38, with which are associated deflecting lips 40 and 41, respectively. As to the ports 37 and 38, they may be readily formed by shearing the metal of the feeder tube wall (shell 20) and the metal of the wall of the equalizing tube 18 at definitely located intervals and depressing or distorting the lip-forming metal adjacent such points of shearing, the desired width and inclination, respectively, of the slot-like ports and deflecting lips thus formed being easily obtainable by suitably constructed metal-working dies.

Referring to Fig. 5, wherein prime reference characters are employed to indicate elements already described in connection with Figs. 1 to 4, it will be noted that the casing 10' and shell

20' are each frustro-conical and that they, at their smaller ends, are substantially the same size as the equalizing tube 18' to which the shell is directly connected and to which the casing is indirectly connected by a collar 42 which is welded to the equalizing tube and to which the casing is similarly secured.

Aside from the structural features just described which differentiate the muffler of Fig. 5 from the muffler of Figs. 1 to 4, the two mufflers are substantially identical except that the equalizing tube 18' is closed at its forward end by a fitting 44. As to the fitting 44, it will be observed that it is secured to the equalizing tube 18' in the manner in which the fitting 26 is secured to the equalizing tube 18 (Fig. 1), but that it differs from the fitting 26 in that its inclined wall terminates in a concave-convex bottom 45 by which direct communication between the equalizing tube 18' and the coupling flange or tube 16' is blocked. It is, of course, obvious that, if desired, the fitting 26 of Fig. 1 may be employed in the form of muffler shown in Fig. 5 and that the fitting 44 of Fig. 5 may be employed in the form of muffler shown in Fig. 1.

Aside from the fact that the muffler of Fig. 5 contains less metal and is therefore lighter than the muffler in Figs. 1 to 4, it more readily lends itself to streamlining as will be readily understood when it is taken into account that it, as indicated in Fig. 6, may be provided with a sheet metal housing or sheath 46, the contour of which may vary from a so-called pure streamlined shape, such as is approximated herein, to a lesser streamlined shape according to requirements as determined, for example, by the position that the muffler may occupy on an airplane. As to the sheath 46, it will be noted that its opposite ends are suitably connected to the head 11' and the ring 42, as by welding, and that the space intermediate itself and the casing 10' may be filled with a suitable sound absorbing material 47, such as mineral wool, for the purpose of obviating objectionable vibrating or "drumming" effects in the sheath itself.

In the event it becomes desirable to restrict the inlet passage area of the fitting 26, regardless of whether that fitting is employed in the form of muffler of Fig. 1 or in the form of muffler of Fig. 5, such fitting may be modified to obtain the form of fitting 26', which is shown in Figs. 7 and 8 and which is characterized by the fact that the wall of its deflector tube 28' is so distorted as to partially close the passage therethrough.

It is, of course, obvious that the deflector tube 28' may be completely closed by further distorting the wall thereof, as indicated in Fig. 9, and that when the deflector tube is thus closed the fitting 26' may be employed, in the capacity of the fitting 44, to block the forward end of either the equalizing tube 18 of the muffler of Fig. 1 or the equalizing tube 18' of the muffler of Fig. 5.

Although it is believed that the present invention may be readily constructed by one skilled in the art in view of the foregoing description, it might be well to here set forth certain of the dimensions employed in connection with a muffler constructed in accordance with the disclosure of Figs. 1 to 4 and subjected to decibel meter and back pressure tests which were conducted, with highly satisfactory results, in connection with a P. & W. Wasp airplane engine—Series C—rated 420 H. P. at 2000 R. P. M. The dimensions were as follows: Casing 10—23⅛" long, 8" I. D.; shell 20—19⅛" long, 7" O. D.; equalizing tube 18—3.834" I. D., 4" O. D., 21½" long as measured from its front end to that end of the shell nearest the outlet end of the muffler; deflector tube 28—1.805" I. D., 1⅞" O. D., feeder tube ports 37—$\frac{1}{16}$" wide and having a combined area of 10.86 sq. in.; equalizing tube ports 38—$1\frac{1}{20}$" wide and having a combined area of 8.069 sq. in.

After testing the above dimensionally identified muffler with the equalizing tube 28 fully open, further tests were carried out with that muffler to determine what effect, if any, might be obtained by partially closing and by completely closing the deflector tube. Partial closing of the deflector tube was effected by introducing therein plug-like bushings provided with inlet passages of 1½" and 1", respectively, whereas complete closing of that tube was effected by introducing therein a solid plug.

During the above tests, which were conducted at engine speeds of 800, 1000, 1200, 1400, and 1600 R. P. M., it was observed that as the inlet area of the deflector tube 28 was varied from maximum to zero, muffling ability was improved at the expense of a slight increase in back pressure, as will become apparent from the following table wherein muffler "A" is the muffler of Fig. 1 with fully open deflector tube, muffler "B" is muffler "A" equipped with a deflector-tube-reducing-bushing having a 1½" opening, muffler "C" is muffler "A" equipped with a deflector-tube-reducing-bushing having a 1" opening and muffler "D" is muffler "A" with the deflector tube completely closed by a solid plug:

R. P. M.	No muffler	"A" muffler	"B" muffler	"C" muffler	"D" muffler
	Decibel level				
800	78	75	74	74	71
1000	85	83	83	81	75
1200	95	89	89	87	83
1400	102	95	93	92	88
1600	114	100	98	97	93

R. P. M.	No muffler	"A" muffler	"B" muffler	"C" muffler	"D" muffler
	Back pressure—In.Hg.				
800	0	.0	.0	.0	.0
1000	0	.1	.1	.10	.1
1200	0	.15	.15	.15	.2
1400	0	.20	.25	.30	.35
1600	0.1	.40	.45	.50	.60

Operation

In view of the fact that any attempt to here describe the operation of the invention from a purely technical standpoint might possibly lend to confusion, and since such technical explanation is not here required, it will suffice to trace the paths which the exhaust traverses in passing through the muffler and to comment on the same wherever necessary for the sake of clarity.

Referring to Fig. 1, it will appear that when the coupling tube 16 of the muffler is attached to the exhaust pipe of an internal combustion engine and such engine is operated at various speeds under its own power, a portion of the exhaust emitted from the engine will pass directly into the equalizing tube 18 by way of the deflector tube 28 (assuming the deflector tube to be either fully open or partially open) and another portion of such exhaust will enter the equalizing tube by way of the feeder tube 35, the ported side wall area (namely the feeder tube ports 37) of the

feeder tube **35**, the reservoir **36**, and the ported side wall area (namely the equalizing tube ports **38**) of the equalizing tube **18**. Such exhaust as passes from the feeder tube **35** into the reservoir **36** by way of the feeder tube ports **37** will be impingingly directed against the inner wall surface of the reservoir and whirled under its own impetus in a whirl path along that surface in the direction of the arrow A appearing in Fig. 4. As the exhaust is whirled along the inner wall surface of the reservoir **36** its energy is expended not only by reason of such factors as surface friction, but also by reason of the fact that the whirling exhaust is utilized to perform a useful work function, namely, the setting up of an ejector action at the feeder tube ports **37**. Such ejector action is effected by reason of the presence of the deflecting lips **40**, over which the whirling exhaust passes, and is utilized to scavenge the feeder tube **35**, thus relieving the same of internal pressure which, at least in part, accounts for the low back pressure performance of the muffler. As the energy of the whirling exhaust within the reservoir **36** is dissipated, such exhaust moves into the immediately surrounding vicinity of the equalizing tube where it assumes, or at least approaches, a static-pressure-condition, following which it is directed under pressure into the equalizing tube **18** by way of the equalizing tube ports **38**. As the exhaust enters the equalizing tube **18** by way of its ports **38**, it is whirled under its own impetus in a whirl path along the inner wall of the equalizing tube in the direction of the arrow B appearing in Fig. 4. As the exhaust is whirled along the inner wall surface of the equalizing tube **18**, its energy is expended in the manner described in connection with the whirling exhaust within the reservoir **36**, it being observed that the expenditure of such energy as accounts for the ejector action set up in the vicinity of the ports **38** by the whirling exhaust passing over the deflecting lips **41** is utilized to facilitate movement of exhaust from the static areas of the reservoir, namely, the immediately surrounding vicinity of the equalizing tube.

From the foregoing, it will be observed that the exhaust in passing from the feeder tube **35** into the equalizing tube **18** undergoes a cyclic change, as will be readily appreciated when taking into account that the direction of whirl of the exhaust within the equalizing tube **18** is in direct opposition to the direction of whirl of the exhaust within the reservoir **36**. This change in direction of flow accounts, in itself, for a dissipation of energy, and therefore supplements the above mentioned energy consuming factors which are peculiar to the present invention. Additionally it will be understood that the exhaust entering the equalizing tube **18** by way of its ports **38** is not only whirled within that tube, as above explained, but is also commingled with the exhaust entering that tube by way of the deflector tube **28**, with the result that the entire contents of the equalizing tube traverses a generally helical path as it proceeds toward the exit end of the muffler.

Although the foregoing description of the operation of the muffler of Fig. 1 assumes the deflector tube **28** to be either fully open or partially open, it is believed unnecessary to describe the operation of that muffler if modified, as previously suggested herein, by substituting for its fitting **26** the fitting **44** of Fig. 5 in order to close the forward end of the equalizing tube **18**.

Moreover, it is believed that no detailed description of the operation of the muffler of Fig. 5, either as shown therein or as modified in accordance with the suggestions previously made herein, is necessary other than to point out that the whirling exhaust within the reservoir **36'** will at least tend to "creep" toward the larger end of the reservoir in seeking a larger or more extensive whirl path and to further point out that the feeder tube **35'** and the reservoir **36'**, each present a progressively varying cross-sectional area with the result that the muffler structure, when considered in its entirety, will effectively extenuate vibrations over a wide range of frequencies, including fundamentals and their harmonics.

Aside from the modifications either herein shown and described, or suggested, it will be understood that various other changes may be resorted to without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

2. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

3. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional

whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path.

4. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

5. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

6. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path.

7. In a muffler, an equalizing tube closed at one end and having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

8. In a muffler, an equalizing tube closed at one end and having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

9. In a muffler, an equalizing tube closed at one end and having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly re-

ceive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path.

10. In a muffler, an equalizing tube closed at one end and having a ported side wall area and adapted to carry exhaust, a feeder tube disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

11. In a muffler, an equalizing tube closed at one end and having a ported side wall area and adapted to carry exhaust, a feeder tube disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

12. In a muffler, an equalizing tube closed at one end and having a ported side wall area and adapted to carry exhaust, a feeder tube disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path.

13. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube surrounding said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

14. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube surrounding said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

15. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube surrounding said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a undirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from

that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path.

16. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube surrounding and disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

17. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube surrounding and disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

18. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube surrounding and disposed in a contiguous relation to said equalizing tube and having a ported side wall area and adapted to carry exhaust, a reservoir surrounding said equalizing tube and communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path.

19. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, and means functioning in response to movement of exhaust in said whirl path within said reservoir for producing an ejector action with reference to said feeder tube.

20. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, and means functioning in response to movement of exhaust in said whirl path within said equalizing tube for producing an ejector action with reference to said reservoir.

21. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner

wall surface of said equalizing tube definining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path, and means functioning in response to movement of exhaust in said whirl paths within said reservoir and within said equalizing tube for producing an ejector action with reference to said feeder tube and said reservoir.

22. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, and means functioning in response to movement of exhaust in said whirl path within said reservoir for producing an ejector action with reference to said feeder tube, said ejector means including deflecting lips associated with said ported area of said feeder tube.

23. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, and means functioning in response to movement of exhaust in said whirl path within said equalizing tube for producing an ejector action with reference to said reservoir, said ejector means including deflecting lips associated with said ported area of said equalizing tube.

24. In a muffler, an equalizing tube having a ported side wall area and adapted to carry exhaust, a feeder tube having a ported side wall area and adapted to carry exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path, and means functioning in response to movement of exhaust in said whirl paths within said reservoir and within said equalizing tube for producing an ejector action with reference to said feeder tube and said reservoir, said ejector means including deflecting lips associated with said ported areas of said feeder tube and said equalizing tube.

25. In a muffler, means for dividing a column of exhaust, an equalizing tube having a ported side wall area and adapted to convey one portion of the divided exhaust, a feeder tube having a ported side wall area and adapted to carry another portion of the divided exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

26. In a muffler, means for dividing a column of exhaust, an equalizing tube having a ported side wall area and adapted to convey one portion of the divided exhaust, a feeder tube having a ported side wall area and adapted to carry another portion of the divided exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

27. In a muffler, means for dividing a column of exhaust, an equalizing tube having a ported

side wall area and adapted to convey one portion of the divided exhaust, a feeder tube having a ported side wall area and adapted to carry another portion of the divided exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of the ported wall area thereof and deliver it to said equalizing tube by way of its ported wall area, the inner wall surface of said reservoir defining a closed circuitous whirl path and being located with relation to the ported wall area of said feeder tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said reservoir being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said feeder tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-mentioned closed circuitous path.

28. In a muffler of the type including a casing, an equalizing unit disposed within said casing and comprising an equalizing tube having a ported side wall area, a reservoir surrounding said equalizing tube and including a shell forming with said casing a feeder tube and serving as a feeder tube wall, said feeder tube wall having a ported area by way of which exhaust is delivered from said feeder tube into said reservoir to be thereafter delivered into said equalizing tube by way of its ported wall area, the inner wall surface of said shell defining a closed circuitous whirl path and being located with relation to the ported area of said feeder tube wall to impingingly receive exhaust issuing from that ported area, the inner wall surface of said shell being disposed with relation to the line of flow of exhaust issuing from the ported area of said feeder tube wall to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

29. In a muffler of the type including a casing, an equalizing unit disposed within said casing and comprising an equalizing tube having a ported side wall area, a reservoir surrounding said equalizing tube and including a shell forming with said casing a feeder tube and serving as a feeder tube wall, said feeder tube wall having a ported area by way of which exhaust is delivered from said feeder tube into said reservoir to be thereafter delivered into said equalizing tube by way of its ported wall area, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

30. In a muffler of the type including a casing, an equalizing unit disposed within said casing and comprising an equalizing tube having a ported side wall area, a reservoir surrounding said equalizing tube and including a shell forming with said casing a feeder tube and serving as a feeder tube wall, said feeder tube wall having a ported area by way of which exhaust is delivered from said feeder tube into said reservoir to be thereafter delivered into said equalizing tube by way of its ported wall area, the inner wall surface of said shell defining a closed circuitous whirl path and being located with relation to the ported area of said feeder tube wall to impingingly receive exhaust issuing from that ported area, the inner wall surface of said shell being disposed with relation to the line of flow of exhaust issuing from the ported area of said feeder tube wall to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to the ported wall area of said equalizing tube to impingingly receive exhaust issuing from that ported area, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from the ported wall area of said equalizing tube to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-named closed circuitous path.

31. In a muffler of the type including a casing, an equalizing unit disposed within said casing and comprising an equalizing tube having a ported side wall area, a reservoir surrounding said equalizing tube and including a shell forming with said casing a feeder tube and serving as a feeder tube wall, said feeder tube wall having a plurality of slots extending lengthwise of the same and arranged in a contiguous relation to each other and constituting feeder tube ports by way of which exhaust is delivered from said feeder tube into said reservoir to be thereafter delivered into said equalizing tube by way of its ported wall area, the inner wall surface of said shell defining a closed circuitous whirl path and being located with relation to said feeder tube ports to impingingly receive exhaust issuing from such ports, the inner wall surface of said shell being disposed with relation to the line of flow of exhaust issuing from said feeder tube ports to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

32. In a muffler of the type including a casing, an equalizing unit disposed within said casing and comprising an equalizing tube having its wall provided with a plurality of slots extending lengthwise of the same and arranged in a contiguous relation to each other and serving as equalizing tube ports, a reservoir surrounding said equalizing tube and including a shell forming with said casing a feeder tube and serving as a feeder tube wall, said feeder tube wall having a ported area by way of which exhaust is delivered from said feeder tube into said reservoir to be thereafter delivered into said equalizing tube by way of said equalizing tube ports, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to said equalizing tube ports to impingingly receive exhaust issuing from such ports, the inner wall surface of said equalizing tube being disposed with relation to

the line of flow of exhaust issuing from said equalizing tube ports to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path.

33. In a muffler of the type including a casing, an equalizing unit disposed within said casing and comprising an equalizing tube having its wall provided with a plurality of slots extending lengthwise of the same and arranged in a contiguous relation to each other and serving as equalizing tube ports, a reservoir surrounding said equalizing tube and including a shell forming with said casing a feeder tube and serving as a feeder tube wall, said feeder tube wall having a plurality of slots extending lengthwise of the same and arranged in a contiguous relation to each other and constituting feeder tube ports by way of which exhaust is delivered from said feeder tube into said reservoir to be thereafter delivered into said equalizing tube by way of said equalizing tube ports, the inner wall surface of said shell defining a closed circuitous whirl path and being located with relation to said feeder tube ports to impingingly receive exhaust issuing from such ports, the inner wall surface of said shell being disposed with relation to the line of flow of exhaust issuing from said feeder tube ports to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along said closed circuitous path, the inner wall surface of said equalizing tube defining a closed circuitous whirl path and being located with relation to said equalizing tube ports to impingingly receive exhaust issuing from such ports, the inner wall surface of said equalizing tube being disposed with relation to the line of flow of exhaust issuing from said equalizing tube ports to direct such exhaust both incident and pursuant to impingement in a unidirectional whirl along the second-named closed circuitous path.

34. In a muffler, means for dividing a column of exhaust, an equalizing tube having a ported side-wall area and adapted to convey one portion of the divided exhaust, a feeder tube having a ported side-wall area and adapted to convey another portion of the divided exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of its ported wall area and to deliver such exhaust to said equalizing tube by way of its ported wall area, and deflector means for so directing exhaust from said feeder tube into said reservoir as to there impart to itself a whirling action.

35. In a muffler, means for dividing a column of exhaust, an equalizing tube having a ported side-wall area and adapted to convey one portion of the divided exhaust, a feeder tube having a ported side-wall area and adapted to convey another portion of the divided exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of its ported wall area and to deliver such exhaust to said equalizing tube by way of its ported wall area, and deflector means for so directing exhaust passing from said reservoir into said equalizing tube as to there impart a whirling action to itself and to said one portion of the divided exhaust.

36. In a muffler, means for dividing a column of exhaust, an equalizing tube having a ported side-wall area and adapted to convey one portion of the divided exhaust, a feeder tube having a ported side-wall area and adapted to convey another portion of the divided exhaust, a reservoir communicating with said tubes by way of their ported wall areas and adapted to receive exhaust from said feeder tube by way of its ported wall area and to deliver such exhaust to said equalizing tube by way of its ported wall area, deflector means for so directing exhaust from said feeder tube into said reservoir as to there impart to itself a whirling action, and deflector means for so directing exhaust passing from said reservoir into said equalizing tube as to there impart a whirling action to itself and to said one portion of the divided exhaust.

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