May 2, 1933. S. B. GOLD 1,906,956

EXHAUST SILENCER

Filed Sept. 18, 1929 3 Sheets-Sheet 1

Fig. 1.

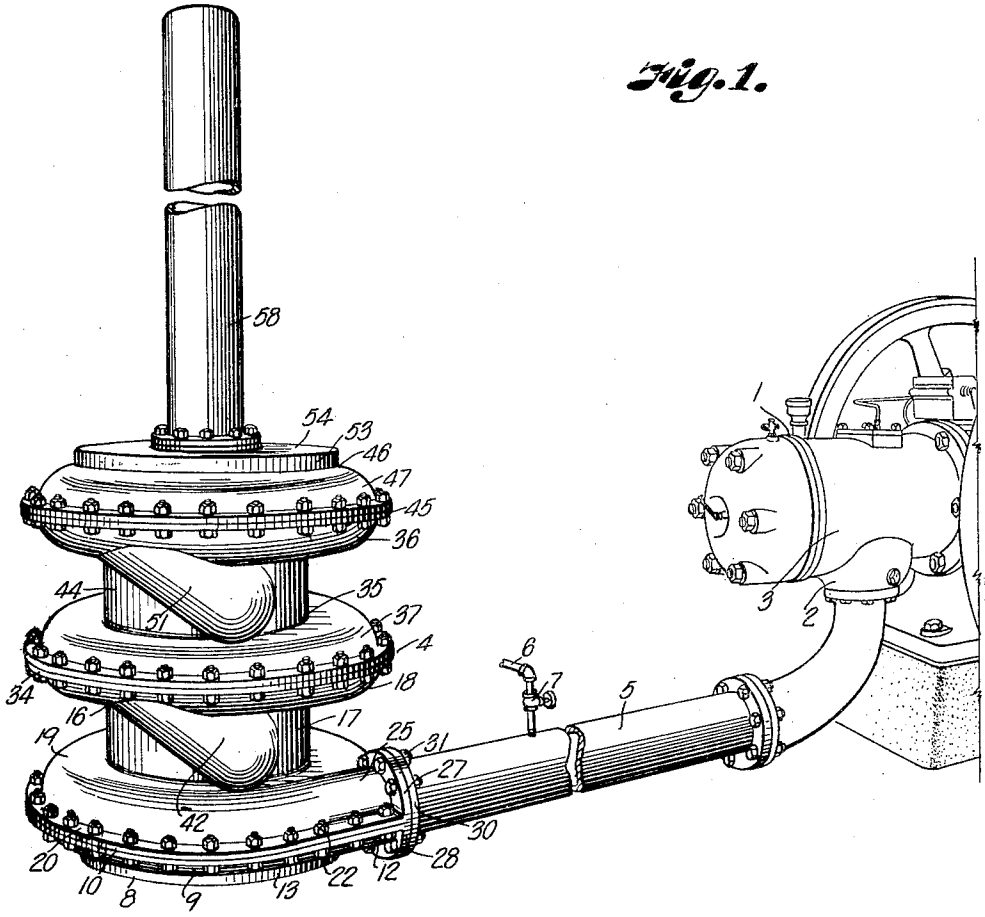
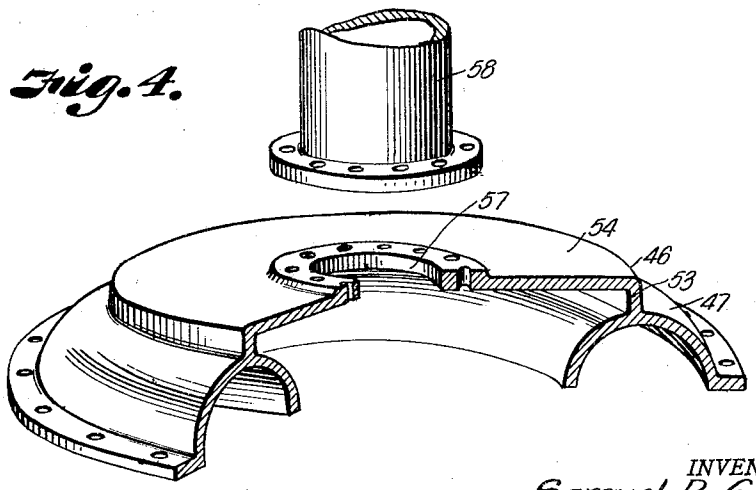


Fig. 4.



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Fig. 2.

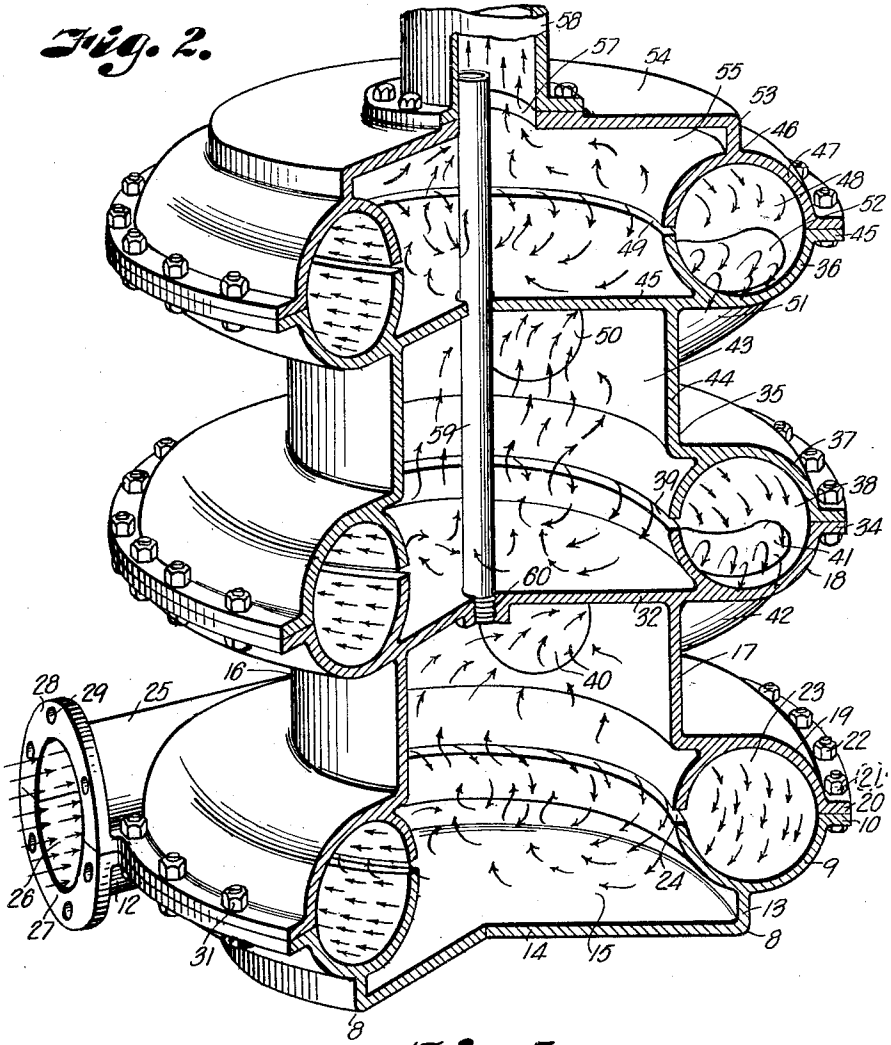
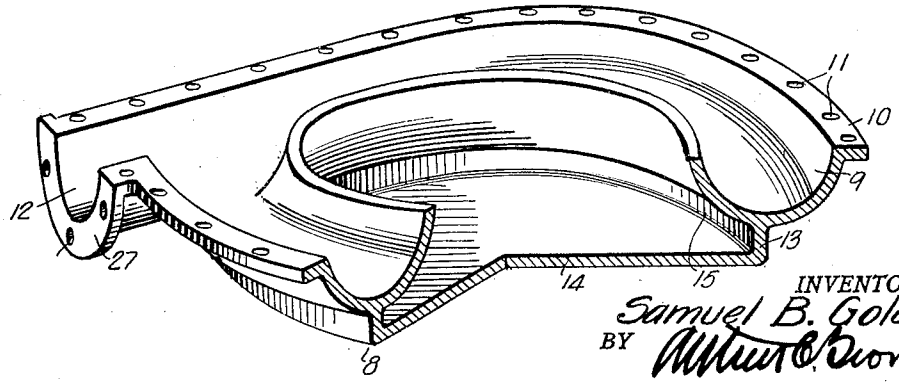


Fig. 5.



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Fig. 3.

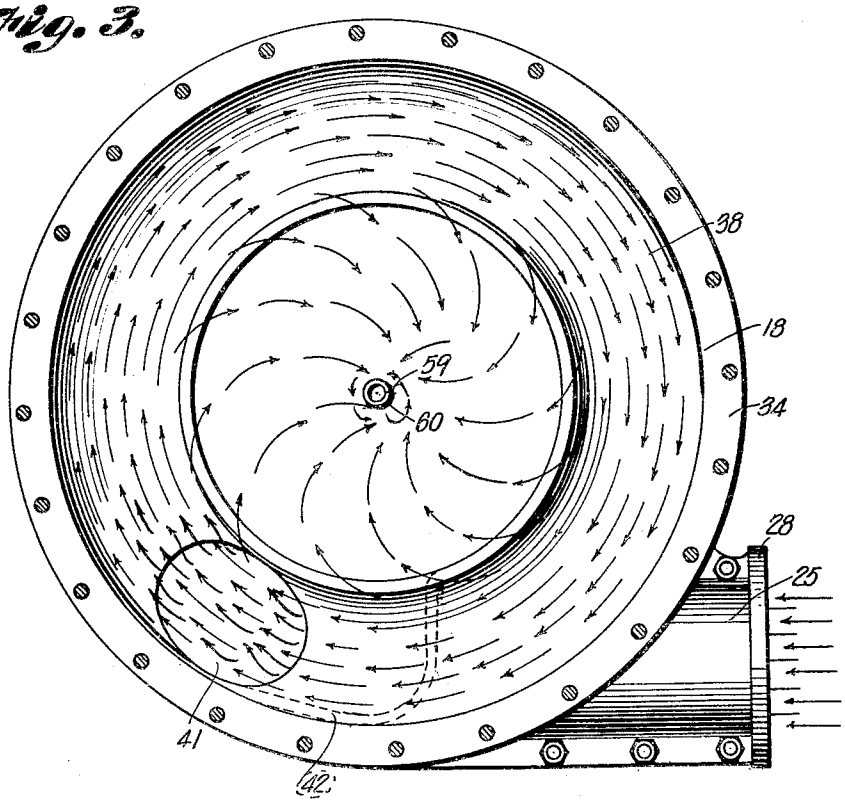
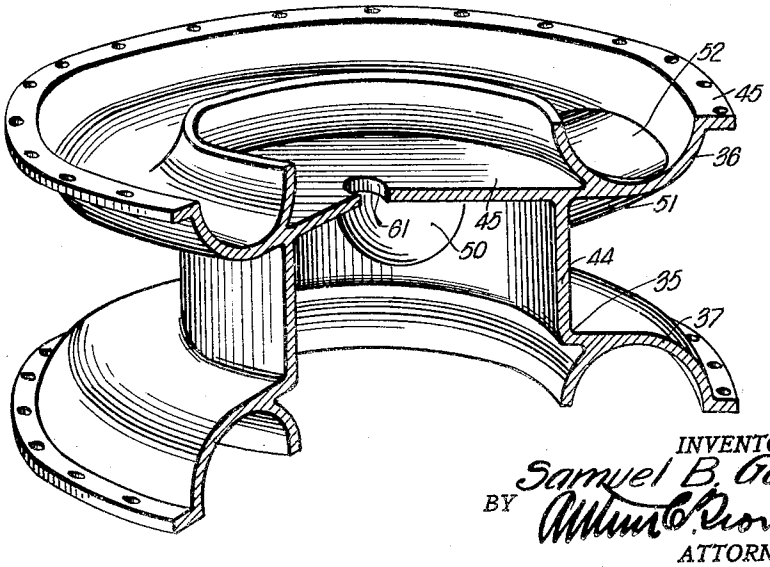


Fig. 6.



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UNITED STATES PATENT OFFICE

SAMUEL B. GOLD, OF KANSAS CITY, MISSOURI, ASSIGNOR TO WEBER ENGINE COMPANY, OF KANSAS CITY, MISSOURI, A CORPORATION OF IOWA

EXHAUST SILENCER

Application filed September 18, 1929. Serial No. 393,543.

My invention relates to mufflers and more particularly to a method of and apparatus for silencing exhaust of highly compressed gases, particularly such as are emitted from internal combustion engines, and has for its principal object to effectively silence such exhaust substantially without loss of engine power.

In accomplishing these and other objects of the invention, I have provided improved details of structure, the preferred form of which is illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective view of an internal combustion engine equipped with an exhaust silencer constructed in accordance with my invention.

Fig. 2 is an enlarged perspective sectional view through the silencer, particularly illustrating the passage of exhaust gases therethrough.

Fig. 3 is a horizontal sectional view through the silencer illustrating action of gases passing through the whirl and expansion chambers.

Fig. 4 is a perspective sectional view of the upper section of the silencer illustrating the gas outlet stack.

Fig. 5 is a perspective sectional view of the lower section of the silencer.

Fig. 6 is a perspective view of one of the intermediate sections of the silencer.

Referring in detail to the drawings:

1 designates an internal combustion engine, of conventional (two-cycle, single cylinder) type having an exhaust outlet 2, through which the exhaust gases are discharged from a combustion cylinder 3, and 4 the silencer, connected with the outlet 2 by a pipe 5. A water inlet line 6, valved at 7, may be tapped into the gas exhaust line for supplying water for initially cooling the exhaust gases, before their delivery into the silencer.

The silencer comprises a plurality of circumferential gas receiving or whirl chambers, preferably of larger volume than the engine cylinder, and interconnected by gas expansion chambers, the surfaces of which are exposed to atmosphere for cooling the gases during their passage therethrough, the number of stages depending upon the degree of silencing desired and the size and type of engine used, and each section preferably including upper and lower semi-circular circumferential members adapted for mating with like members of other sections to form the whirl chambers, connecting expansion chamber walls and partitions for separating successive expansion chambers, the preferred construction being, in detail, substantially as follows:—

A base section 8 includes a circumferential, trough-shaped portion 9 substantially semi-circular in cross section, provided on its outer periphery, with a laterally projecting flange 10 having bolt openings 11 and having a throat portion 12, also semi-circular in cross section, and communicating tangentially with the trough of the portion 9. Extending downwardly and centrally from the trough portion 9 is a depending wall 13 formed integral with a bottom plate 14 constituting the floor of an expansion chamber 15 later described.

16 designates the next upward section preferably including a central, cylindrical wall portion 17 connecting upper and lower reversely arranged, circumferential, trough-shaped portions 18 and 19 complementary with the trough-shaped portion 9 of the section 8 and with a corresponding member of a next upper section, the lower trough portion 19 having a peripheral flange 20 complementary to the flange 10 of the base section, and provided with openings 21 aligning with the openings 11 previously described, the sections 8 and 16 being secured together by bolts 22 projected through the openings 11 and 21, as best shown in Fig. 2.

The complementary trough-shaped portions 9 and 19 thus cooperate to form a circumferential gas whirl chamber 23 of circular cross section, the inner peripheries of said portions being spaced apart to form a slot 24, providing an inner, annular gas outlet for the chamber as later described.

The inverted trough portion 19 is also provided with a trough-shaped neck portion 25 which co-operates with the neck portion 12 on the section 8 to provide the tubular gas inlet 26 tangential to the chamber 23. The neck portions 12 and 25 are provided with laterally extending end flanges 27 and 28, each having openings 29 aligning with similar openings in a flange 30 formed on the end of the exhaust pipe 5, bolts 31 being projected through the aligning openings to secure the silencer and the exhaust pipe together as shown in Fig. 1.

The upper end of the cylindrical wall 17 is closed by a diaphragm 32 spaced from the floor 14 of the section 8 to form the upper end of the gas expansion chamber 15 which is of substantially larger volume than the circumferential chamber 23, so that gas entering the chamber 15 from the chamber 23 through the slot 24 may expand in the chamber 15.

The upper trough section 18 is provided with a peripheral flange 34 and bolted thereto is a section 35 similar to the section 17 except for the neck portion 25, the section 35 being also provided with reversely arranged circumferential trough-shaped portions 36 and 37 complementary to the trough-shaped portion 18 of the section 17 and with a corresponding member of a third section, presently described, the member 37 cooperating with the member 18 to form a second circumferential gas receiving chamber 38, having a slot 39 corresponding to the slot 24.

Formed in the cylindrical wall 17 of the section 16 is a gas outlet port 40 which communicates with a port 41 in the second chamber 38 through a conduit 42 formed integrally with the section 17, and preferably arranged at an angle with the trough section 18 so that gas will be impelled within the chamber 38. The chamber 38 has an inner slot 39 opening into a second expansion chamber 43 formed by the wall 44 of the second section 35 and a diaphragm 45 integral with said wall.

The upper trough-shaped portion 36 of the section 35 is provided with a peripheral flange 45 for supporting a cap section 46 including the circumferential, inverted trough-shaped portion 47 which cooperates with the trough-shaped portion 36 to provide a third circumferential gas receiving chamber 48 having a gas outlet slot 49 corresponding to the slots 24 and 39 in the two lower sections. Gases leave the second chamber 43 through a port 50 in the wall 44 through a conduit 51 and are delivered tangentially to the chamber 48 through a port 52 in the bottom member 36 of said chamber 48. Projecting upwardly from the trough portion 48 of the cap section is a cylindrical wall 53 carrying a cover plate 54 and forming a gas expansion chamber 55. The cover 54 has a gas outlet port 57 through which the chamber 55 communicates with a vertical exhaust stack or outlet pipe 58.

In order to create an induced current through the stack I lead a gas inductor tube 59 from the lower expansion chamber 15 to the stack 58 through which some of the relatively high pressure gases in the chamber 15 may escape directly through the tube and induce flow of the expanded gas through the stack from the chamber 55. The tube 59 may be threaded into an opening 60 formed in the diaphragm 32 and project through an opening 61 in the diaphragm 45 as best shown in Fig. 2.

With the silencer constructed and assembled as described exhaust gases from the engine are discharged through the port 26 tangentially into the circumferential chamber 23 of the first stage of the silencer, which, having several times the volume of the engine cylinder, permits unrestricted transfer of the gases from the cylinder and expansion of the gases in the chamber.

Entering the circumferential chamber the gases whirl circumferentially during their travel through the chamber and gradually escape centripetally through the slot 24 into the expansion chamber 15. Continued discharge of the gases into the chamber 23 causes an induced flow of gases through the chamber so that the gas currents are discharged through the slot 24 uniformly about its periphery in substantially sheet formation, the currents from opposite sides of the slot, meeting centrally of the chamber, causing counter currents and eddies to be created in the expansion chamber, mutual interference of which cause the gases to lose part of their kinetic energy.

Gases expanding in the chamber 15 are then discharged through the port 40, the conduit 42, and port 41, into the second whirl chamber 38, where they move circumferentially induced by the inlet of new gases through the port into the chamber and are discharged into the second expansion chamber 43 through the slot 39 in the same manner as they were discharged through the slot 24 into the first chamber.

The counter currents formed by the inrush of gases through the slot 39 further dispense their kinetic energy, and the gases exhaust through the port 50, conduit 51, and port 52 into the third whirl chamber 48, then out through the slot 49 into the expansion chamber 55, being there further re-

lieved of kinetic energy in the same manner as in the chambers 15 and 43. The velocity of the gases passing through the stack are thus reduced and escape quietly through the stack 58 to atmosphere.

As the gases condense from the cooling effected during their travel through the apparatus, the expansion chambers 15, 43 and 55 of the successive stages are made of gradually reduced capacities to insure impelled contact of the gases in the respective chambers without back pressure.

From the foregoing it is apparent that the gases are induced from the expansion chambers by the whirling gases in the succeeding whirl chambers so that the gases travel by induction entirely through the muffler and the gases traveling through the successive whirl and expansion chambers contact large areas of the muffler exposed to atmosphere and are cooled thereby to substantially reduce their volume. Also, due to the extended travel of the gases, expansion of the gases is gradual and since the gases travel continuously toward the outlet pipe 57, unimpeded by the usual baffles and the like, frictional resistance between the gases and the silencer housing is reduced to a minimum, thereby substantially eliminating back pressure on the engine.

Extended travel of the gases also allows for overlapping of the discharge impulses and the gases escape through the stack 58 in substantially an unbroken flow thereby eliminating the noise of separated impulses and the gases are emitted at constant velocity.

What I claim and desire to secure by Letters Patent is:

1. In a device of the character described a circumferential whirl chamber for initially receiving compressed gases, an initial expansion chamber having communication with the whirl chamber, a second circumferential whirl chamber, a spiral conduit for admitting gases from the initial expansion chamber into the second whirl chamber, and a second expansion chamber coaxial with said first expansion chamber and in communication with the second whirl chamber and having an outlet for expanded gases.

2. In a device of the character described a plurality of whirl chambers, expansion chambers interconnecting the whirl chambers, means for discharging gases successively from whirl to expansion chambers, an outlet pipe for the last expansion chamber, and an induction pipe in concentric relation with said expansion and whirl chambers and with the outlet pipe communicating one of the initial expansion chambers with the outlet pipe for inducing a draft therethrough for aiding in the emission of the expanded gases.

3. In a device of the character described superimposed sections comprising successive circumferential whirl chambers and coaxial cylindrical expansion chambers, means for tangentially discharging gases into the lower whirl chamber, means for discharging gases from the whirl chambers radially into the expansion chambers to break the velocity of the gases, spiral conduits for discharging the gases tangentially from the expansion chambers into the succeeding whirl chambers, and an outlet stack for the upper expansion chamber.

4. In a device of the character described superimposed sections comprising successive circumferential whirl chambers and cylindrical expansion chambers, means for tangentially discharging gases into the lower whirl chamber, means for discharging gases from the whirl chamber radially into the expansion chamber to break the velocity of the gases, spiral conduits for discharging the gases tangentially from the expansion chambers into the succeeding whirl chambers, an outlet pipe for the upper expansion chamber, and means in concentric relation with said chambers and outlet pipe for inducing flow of expanded gases through the outlet pipe.

5. In an exhaust silencer of the kind described, a plurality of partitioned cylindrical sections arranged concentrically, a circular ring section in open communication with each cylindrical section and of greater diameter than the cylindrical section, there being means for the passage of gas from one cylindrical section to the ring section in communication with the adjacent cylindrical section.

6. In an exhaust silencer of the kind described, a plurality of partitioned cylindrical sections arranged concentrically, a circular ring section in open communication which each cylindrical section and of greater diameter than the cylindrical section, there being means to permit the passage of gas from one cylindrical section to the ring section in communication with the adjacent cylindrical section, and means to emit gas tangentially to said first ring section.

7. In a device of the character described, a cylindrical expansion chamber, a concentric whirl chamber of greater diameter than the expansion chamber and having peripheral radial communication therewith, an inlet for the whirl chamber, and a spiral outlet conduit for the expansion chamber.

8. In a device of the character described, a casing, a diaphragm dividing the casing into upper and lower expansion chambers, a concentric whirl chamber for each of said expansion chambers having radial communication therewith, a tangential inlet for the lower whirl chamber, and a spiral conduit communicating the lower expansion chamber with the upper whirl chamber.

9. In a device of the character described,

a vertical casing, diaphragms dividing the casing into consecutively reduced expansion chambers, a concentric whirl chamber for each of said expansion chambers having radial communication therewith, a tangential inlet for the lower whirl chamber, a spiral conduit connecting each expansion chamber with the whirl chamber in communication with the next higher expansion chamber, and an outlet for the uppermost expansion chamber.

In testimony whereof I affix my signature.

SAMUEL B. GOLD.