Dec. 31, 1968 W. M. WAGNER ETAL 3,419,892

EXHAUST EJECTOR

Filed March 13, 1967

FIG. 2

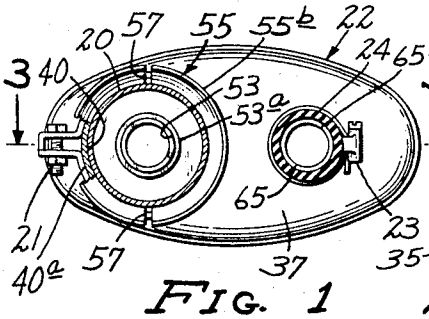

FIG. 1

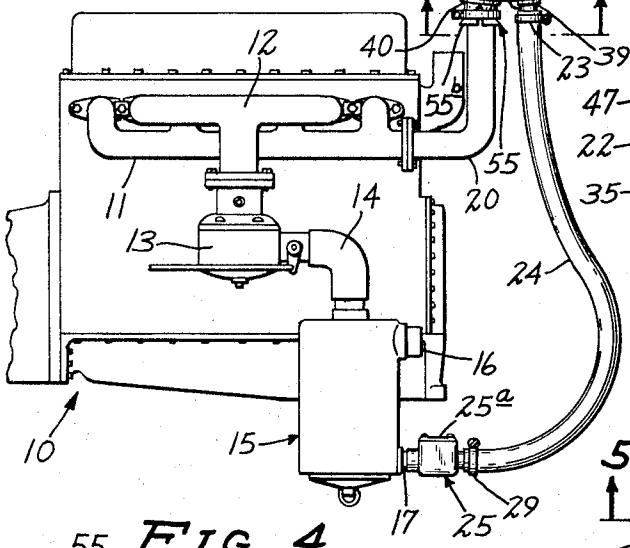

FIG. 4

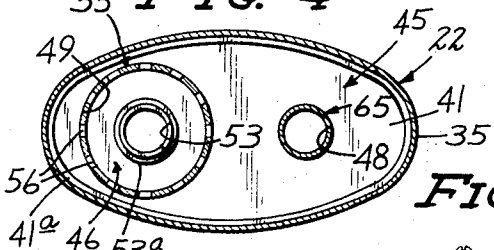

FIG. 5

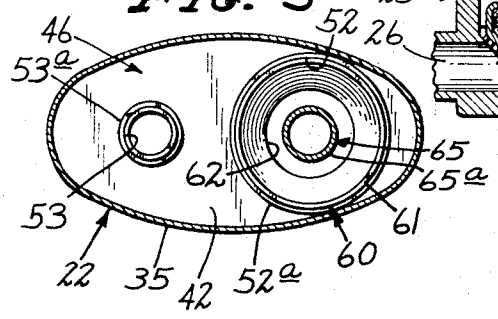

FIG. 6

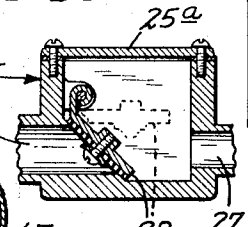

FIG. 3

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EXHAUST EJECTOR

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ABSTRACT OF THE DISCLOSURE

A combination muffler and air ejector unit for internal combustion engines that utilize an air cleaner incorporating means to scavenge the dust therefrom to improve efficiency. The muffler housing contains a plurality of chambers into which the exhaust gases are introduced. The expanded gases are then forced through an ejector tube mounted in the muffler housing. The ejector tube comprises a venturi through which the gases pass at an increased velocity causing a reduction in static pressure. One end of an air intake tube is mounted in the venturi and the other end is connected to the air cleaner by a flexible scavenging line, preferably having a check valve mounted therein, to scavenge dirty air from the cleaner during engine operation.

BACKGROUND OF THE INVENTION

Field of the invention.—This invention relates generally to the field of exhaust ejector systems for internal combustion engines, and more particularly relates to a combined muffler and air ejector unit that both muffles the exhaust noises and utilizes the exhaust gas flow to develop a vacuum that can be used to scavenge the dirty air from an air cleaner.

Description of the prior art.—The prior art shows various systems for employing the exhaust gas flow from an internal combustion engine to develop a vacuum that can be utilized to scavenge the dirty air from an air cleaner. None of the prior art systems, however, show that the ejector unit can be made an integral part of the muffler that is normally attached to the exhaust manifold of an internal combustion engine. Further, the prior art systems of which we are aware fail to provide any means to prevent the damage that occurs to the air cleaner when a sudden increase in back pressure in the exhaust system drives the hot exhaust gases into the air cleaner.

SUMMARY OF THE INVENTION

Our invention provides a unitary muffler and ejector assembly that can be quickly attached to the exhaust manifold of an internal combustion engine in the same manner as a standard muffler. In addition to muffling the exhaust noises, our invention utilizes the flow of exhaust gases through the ejector portion of the assembly to create a vacuum that can be used to perform useful work, in this case, the scavenging of dirty air from an air cleaner for the internal combustion engine. Also provided, if desired, is a check valve in the scavenging line between the ejector and the air cleaner to prevent the back flow of hot gases to the air cleaner in case of a pressure reversal in the assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side elevational view of an internal combustion engine having an air cleaner mounted thereon, and having the unitary muffler-ejector assembly of our invention attached to the engine and air cleaner;

FIGURE 2 is an enlarged view of the bottom end of the muffler-ejector assembly taken along line 2—2 of FIGURE 1, portions thereof being shown in section and portions thereof being broken away;

FIGURE 3 is a longitudinal sectional view of the muffler-ejector assembly taken along line 3—3 of FIGURE 2.

FIGURE 4 is a sectional view of the muffler-ejector assembly taken along line 4—4 of FIGURE 3;

FIGURE 5 is a sectional view of the muffler-ejector assembly taken along line 5—5 of FIGURE 3; and

FIGURE 6 is an enlarged view, in vertical section, of the check valve assembly shown in FIGURE 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is disclosed in FIGURE 1 an internal combustion engine **10** having an exhaust manifold **11** and an air intake manifold **12**. Attached to air intake manifold **12** is a carburetor **13**, and attached to carburetor **13** by means of a mounting elbow **14** is an air cleaner **15** having means to scavenge dirty air therefrom. Forming a part of air cleaner **15** is an air intake port **16** and a vacuum nozzle **17**. During normal engine operation, air for combustion enters port **16**, is filtered, and is drawn into carburetor **13** via mounting elbow **14**.

Securely attached to one end of the exhaust manifold **11** is an exhaust pipe **20** to carry the exhaust gases away from engine **10**. Attached to the free end of exhaust pipe **20** by means of a clamp **21**, is the unitary muffler-air ejector assembly **22** of our invention. Attached to assembly **22** by means of a clamp **23** is a flexible scavenging line **24**.

A check valve assembly **25** is securely attached to vacuum nozzle **17** on air cleaner **15**. As best shown in FIGURE 6, check valve assembly **25** has a removable cover **25***a* to provide access to the interior thereof. Check valve assembly **25** includes an air entrance port **26** and an air exit port **27**. Entrance port **26** is directly connected to vacuum nozzle **17**. Mounted within check valve assembly **25** is a hinged flapper valve **28** that is movable from the valve closed position shown in full lines in FIGURE 6 to the valve open position shown in phantom. During normal engine operation, flapper valve **28** occupies the position shown in phantom to permit air to be drawn from port **26** out through port **27**. In case a reversal of pressure occurs in the system, causing the air to flow from port **27** to port **26**, flapper valve **28** closes to prevent hot exhaust gases from entering air cleaner **15**. As shown in FIGURE 1, scavenging line **24** is attached to exit port **27** of check valve assembly **25** by means of a clamp **29**.

Referring now to FIGURE 3, there is disclosed a longitudinal sectional view of the muffler-ejector assembly **22**. Assembly **22** includes an elongated hollow housing having side walls **25**, a generally oval top end plate **36** and a generally oval bottom end plate **37**. In the preferred embodiment of our invention, side walls **35** define a housing having a generally oval cross section, although this particular shape is not critical to the invention and could be changed to a circular cross section, for example. Top end plate **36** and bottom end plate **37** have flanged edges **36***a* and **37***a* fit tightly within the opposite open ends of the housing, and are secured to the side walls **35** by welding or the like.

A first opening **38** is provided in top end plate **36**. A first opening **39** and a second opening **40** are formed in bottom end plate **37**. Outwardly turned flanges **38***a*, **39***a*, and **40***a* are formed around the edges of the openings. A first baffle plate **41** and a second baffle plate **42**, both having a generally oval shape, are mounted within the housing in parallel with each other and with end plates

36 and 37. Baffle plates 41 and 42 have flanged peripheral edges 41*a* and 42*a* respectively, which are tightly secured to the interior of side walls 35.

Baffle plates 41 and 42 are spaced from each other and from end plates 37 and 37 to form a first sound attenuation chamber 45, a second centrally located expansion chamber 46, and a third sound attenuation chamber 47. Formed in first baffle plate 41 are a first opening 48 and a second opening 49. Formed around the edges of openings 48 and 49 are upturned flanges 48*a* and 49*a* respectively. Formed in baffle plate 42 are a first opening 52 and a second opening 53 having downwardly turned flanges 52*a* and 53*a* formed around their respective edges. In the preferred embodiment of my invention, all of the first openings 38, 39, 48, and 52 are coaxially aligned. Second openings 40 and 49 are also coaxially aligned, and laterally offset from the first openings.

An exhaust tube 55 is mounted in second openings 40 and 49 with the outer surface thereof being securely attached to flanges 40*a* and 49*a*. In this embodiment of our invention, the top end 55*a* of exhaust tube 55 extends into second expansion chamber 46 while the bottom end 55*b* extends out of the housing from opening 40. A plurality of performations such as 56 are formed in the walls of exhaust tube 55 within chamber 45 to permit the flow of exhaust gases from tube 55 into sound attenuation chamber 45. As shown in FIGURE 1, bottom end 55*b* of exhaust tube 55 is designed to fit over exhaust pipe 21 and is slotted as at 57 to permit the effective use of clamp 21.

An ejector tube 60 is mounted in the aligned first openings 38 and 52 and its outer surface is securely attached to flanges 38*a* and 52*a*. Ejector tube 60 comprises a gas inlet portion 61 having a relatively large diameter and extending into second chamber 46, a reduced diameter throat portion 62 connected to inlet portion 61, and an outlet portion 63 connected to throat portion 62. The top end of outlet portion 63 extends from opening 38 to discharge the spent exhaust gases into the atmosphere. The diameter of outlet portion 63 gradually increases from its connection with throat portion 62 toward its top end.

An air intake tube 65 is mounted in the aligned first openings 39 and 48 with the outside surface thereof securely attached to flanges 39*a* and 48*a*. A top end 65*a* of air intake tube 65 extends upwardly through inlet portion 61 of ejector tube 60 and terminates in throat portion 62 thereof. The bottom end 65*b* of tube 65 extends from the housing through opening 39. As shown in FIGURE 1, scavenging line 24 fits tightly over bottom end 65*b* and is clamped tightly thereto by clamp 23.

Operation

The operation of the air cleaner 15, shown in FIGURE 1, is well known in the air cleaning art and need not be described in detail here. Generally speaking, air cleaners of this type have a primary separation stage in which the heavier dirt particles are separated from the air entering the carburetor. This primary separation can be accomplished, for example, by causing the air entering the port 16 to whirl at a high velocity around the filter element of the air cleaner. The dirt particles in the whirling air tend to be forced outwardly due to centrifugal force where they can be skimmed off and removed from the cleaner by means of a vacuum applied to vacuum nozzle 17. The remaining cleaner air is carried into the carburetor in the normal manner.

The purpose of our invention is to provide a vacuum source for the air cleaner 15 that will operate whenever the engine is running. With the engine running, high pressure exhaust gases are discharged from exhaust pipe 20 and are carried by exhaust tube 55 into the chambers 45, 46, and 47. The exhaust gases then are discharged from the muffler-ejector assembly 22 through ejector tube 60. Ejector tube 60 functions in the following manner. The exhaust gas enters inlet portion 61 and is then squeezed through the reduced diameter throat portion 62 where an increase in gas velocity occurs. The increase in gas velocity causes a reduction in static pressure in throat portion 62. The high velocity exhaust gases are then discharged from the assembly through gas outlet portion 63 which, because of its gradually increasing diameter, effects a reduction in velocity accompanied by a gradual pressure increase.

The vacuum developed in throat portion 62 is designed to be greater than the vacuum in the tube chamber of the air cleaner 15. This vacuum applied to vacuum nozzle 17 causes a flow of air from cleaner 15 through check valve assembly 25, scavenging line 24, and air intake tube 65. This air is, of course, discharged from ejector tube 60 along with the spent exhaust gases.

Under some operating conditions, the pressure in outlet portion 63 of ejector tube 60 will build up and cause the absolute pressure in throat portion 62 to increase. If the pressure in throat portion 62 increases sufficiently, it can exceed the absolute pressure in the tube chamber of air cleaner 15. If this pressure reversal occurs, a reverse flow or "backflow" condition can arise in which hot exhaust gases are forced downwardly through air intake tube 65 into air cleaner 15. This "backflow" can cause considerable damage to air cleaner 15. To prevent such damage to the air cleaner, check valve assembly 25 can be mounted in scavenging line 24 to prevent the "backflow" of exhaust gases to the air cleaner.

Our invention provides an exceedingly compact muffler-ejector assembly that is compatible with existing exhaust systems. The assembly can be mounted in the space normally occupied by the muffler. Although the ejector is normally used for removing dirt from the air cleaner, it could be used for other purposes such as the removal of air from the engine compartment to provide cooling. Regardless of how it is used, the particular advantage of this assembly is that it supplies a vacuum source to the vehicle without appreciably altering the size of the engine package.

From the above description, it will be evident that changes can be made by those skilled in the art without departing from the spirit and scope of the invention. Therefore, we intend to be bound only by the scope of the appended claims.

We claim:

1. A combination muffler and ejector unit for internal combustion engines, comprising:

(a) an elongated hollow housing having side walls defining generally uniform oval cross sections throughout its length, having a generally oval top end plate with a first opening therein, and having a generally oval bottom end plate with first and second openings therein, said top and bottom end plates being secured to the opposite ends of said side walls around the edges thereof in a generally parallel relationship.

(b) first and second generally oval baffle plates mounted within said housing in parallel with said end plates, said baffle plates having their entire peripheral edges secured to the interior of said side walls and being spaced from each other and from said end plates to form a first sound attenuation chamber between said bottom end plate and said first baffle plate, a second centrally located expansion chamber between said baffle plates, and a third sound attenuation chamber between said second baffle plate and said top end plate, each of said baffle plates having first and second openings formed therein, all of said first openings being coaxially aligned, and all of said second openings being coaxially aligned;

(c) an exhaust tube mounted in said aligned second openings in said bottom end plate and said first baffle plate, one end thereof extending into said second chamber, and the other end thereof extending from said opening in said bottom end plate and adapted to be connected to the exhaust manifold of an internal

combustion engine, said exhaust tube having perforations in the walls thereof communicating with said first chamber;

(d) an ejector tube mounted in said aligned first openings in said top end plate and said second baffle plate, said ejector tube comprising a venturi having a gas inlet portion extending into said second chamber, a throat portion connected to said inlet portion and an outlet portion connected to said throat portion extending from said first opening in said top end plate, said exhaust tube and said ejector tube being sealed in said openings so that the exhaust gases from said exhaust tube exit to the atmosphere through said ejector tube to develop an area of reduced pressure in said throat portion; and

(e) an air intake tube mounted in said aligned first openings in said bottom end plate and said first baffle plate, one end of said air intake tube terminating in said throat portion of said ejector tube and the other end thereof extending from said bottom end plate, said air intake tube being sealed in each of said openings so that outside air is drawn therethrough by said reduced pressure in said throat area during operating of the internal combustion engine.

2. The apparatus of claim **1** in combination with flexible scavenging line means adapted to connect said air intake tube to the vacuum nozzle of an air cleaner for the internal combustion engine, said scavenging line means including a check valve mounted therein to permit gas flow only in the direction from said air cleaner to said intake tube.

3. A combination muffler and ejector unit for internal combustion engines, comprising:

(a) an elongated hollow housing having side walls defining generally uniform oval cross sections throughout its length, having a generally oval top end plate with a first opening therein, and having a generally oval bottom end plate with first and second openings therein, said top and bottom end plates being secured to the opposite ends of said side walls around the edges thereof in a generally parallel relationship;

(b) first and second generally oval baffle plates mounted within said housing in parallel with said end plates, said baffle plates having their entire peripheral edges secured to the interior of said side walls and being spaced from each other and from said end plates to form a first sound attenuation chamber between said bottom end plate and said first baffle plate, a second centrally located expansion chamber between said baffle plates, and a third sound attenuation chamber between said second baffle plate and said top end plate, each of said baffle plates having first and second openings formed therein, all of said first openings being coaxially aligned, and all of said second openings being coaxially aligned;

(c) an exhaust tube mounted in said aligned second openings in said bottom end plate and said first baffle plate, one end thereof opening into said second chamber, and the other end thereof extending from said opening in said bottom end plate and adapted to be connected to the exhaust manifold of an internal combustion engine, said exhaust tube having perforations in the walls thereof communicating with said first chamber;

(d) an ejector tube mounted in said aligned first openings in said top end plate and said second baffle plate, said ejector tube comprising a venturi having a gas inlet portion extending into said second chamber, a throat portion connected to said inlet portion and an outlet portion connected to said throat portion extending from said first opening in said top end plate, said exhaust tube and said ejector tube being sealed in said openings in said end plates so that the exhaust gases from said exhaust tube exit to the atmosphere through said ejector tube to develop an area of reduced pressure in said throat portion; and

(e) an air intake tube mounted in said aligned first openings in said bottom end plate and said first baffle plate, one end of said air intake tube terminating in said throat portion of said ejector tube and the other end thereof extending from said bottom end plate, said air intake tube being sealed in said opening in said bottom end plate so that outside air is drawn therethrough by said reduced pressure in said throat area during operating of the internal combustion engine.

4. A combination muffler and ejector unit for internal combustion engines, comprising:

(a) an elongated hollow housing having side walls defining generally uniform oval cross sections throughout its length, having a generally oval top end plate and a generally oval bottom end plate, said top and bottom end plates being secured to the opposite ends of said side walls around the edges thereof in a generally parallel relationship;

(b) first and second generally oval baffle plates mounted within said housing in parallel with said end plates, said baffle plates having their edges secured to the interior of said side walls and being spaced from each other and from said end plates to form a first sound attenuation chamber between said bottom end plate and said first baffle plate, a second centrally located expansion chamber between said baffle plates, and a third sound attenuation chamber between said second baffle plate and said top end plate;

(c) an exhaust tube mounted in said housing, said exhaust tube extending through said housing and adapted to be connected to the exhaust manifold of an internal combustion engine, said exhaust tube being in fluid communication with said chambers;

(d) an ejector tube mounted in said housing, said ejector tube comprising a venturi having a gas inlet portion extending into said second chamber, a throat portion connected to said inlet portion, and an outlet portion connected to said throat portion extending from said top end plate, said exhaust tube and said ejector tube being mounted in said housing so that all the exhaust gases entering said housing through said exhaust tube are muffled and then exit to the atmosphere through said ejector tube to develop an area of reduced pressure in said throat portion; and

(e) an air intake tube having first and second ends, said first end of said air intake tube extending into said gas inlet portion of said ejector tube coaxially therewith and terminating within said throat portion of said ejector tube, said second end extending from said housing, said air intake tube being sealed in said housing so that outside air is drawn therethrough by said reduced pressure in said throat portion during operation of the internal combustion engine.

5. A combination muffler and ejector unit for internal combustion engines, comprising:

(a) a muffler housing having a plurality of sound attenuation chambers therein, including a generally centrally located chamber;

(b) an exhaust tube mounted in said housing for introducing all of the engine exhaust gas directly into said sound attenuation chambers, said exhaust tube being in fluid communication with all of said chambers;

(c) an ejector tube mounted in said housing for permitting muffled exhaust gases to exit directly to the atmosphere from said centrally located chamber;

(d) said ejector tube comprising a venturi having a gas inlet portion opening into said centrally located

chamber, a throat portion, and a gas outlet portion extending through said housing to atmosphere;

(e) an air intake tube mounted in said housing to carry outside air into said venturi during engine operation, said air intake tube having a first end extending from said housing, and a second end extending into said gas inlet portion and terminating within said throat portion of said ejector tube; and

(f) said exhaust tube, said ejector tube and said air intake tube all being sealed with respect to said housing so that all exhaust gases entering said housing through said exhaust tube are first muffled in said chambers and then discharged through said ejector tube.

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U.S. Cl. X.R.

55—290; 123—198; 181—51, 43