Feb. 21, 1967 E. A. EASTMAN 3,304,711

EXHAUST CONVERTER

Filed Sept. 21, 1965 4 Sheets-Sheet 1

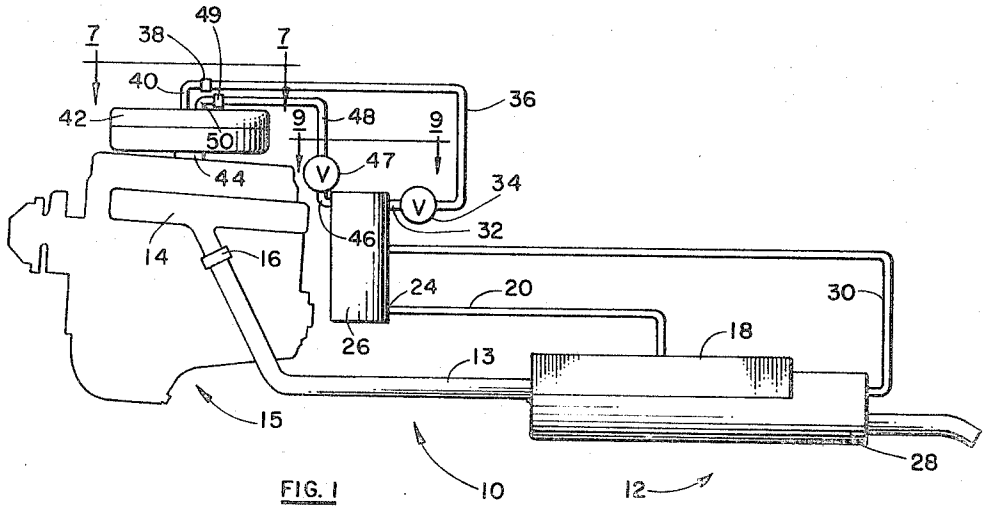


FIG. 1

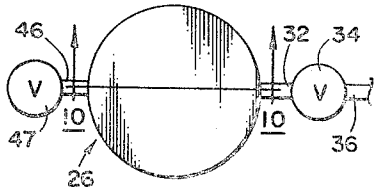


FIG. 9

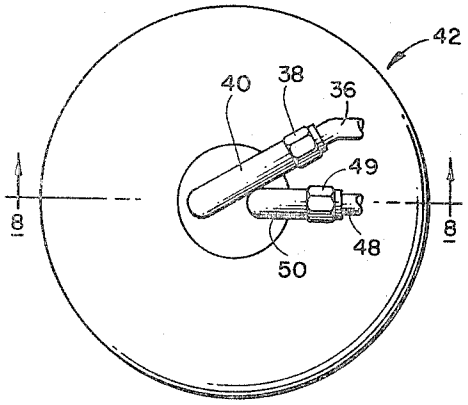


FIG. 7

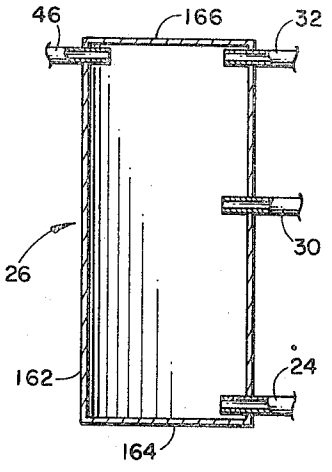


FIG. 10

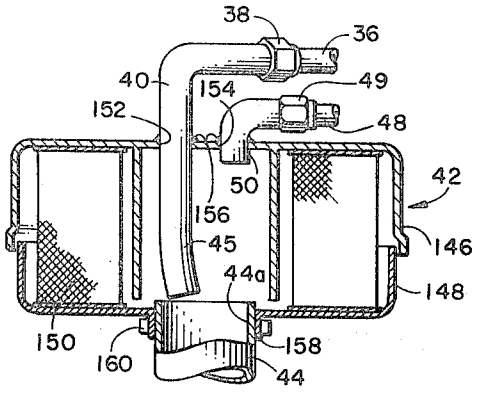


FIG. 8

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EXHAUST CONVERTER

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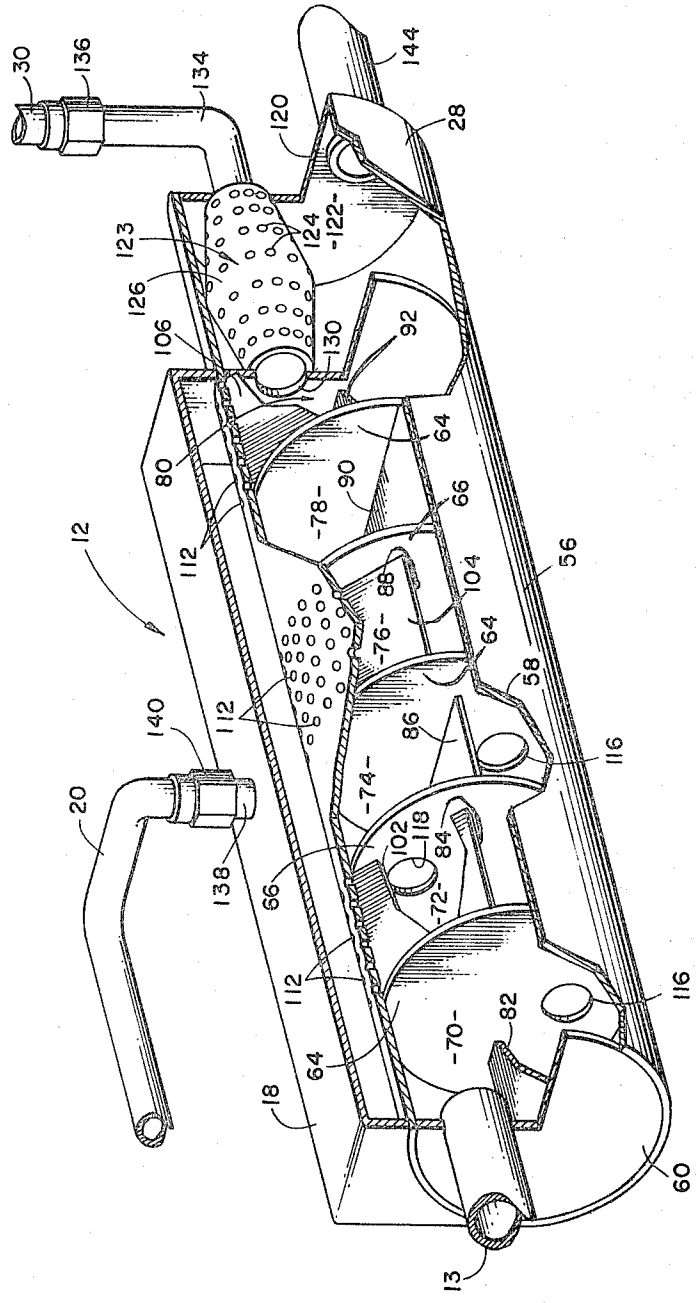


FIG. 2

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EXHAUST CONVERTER

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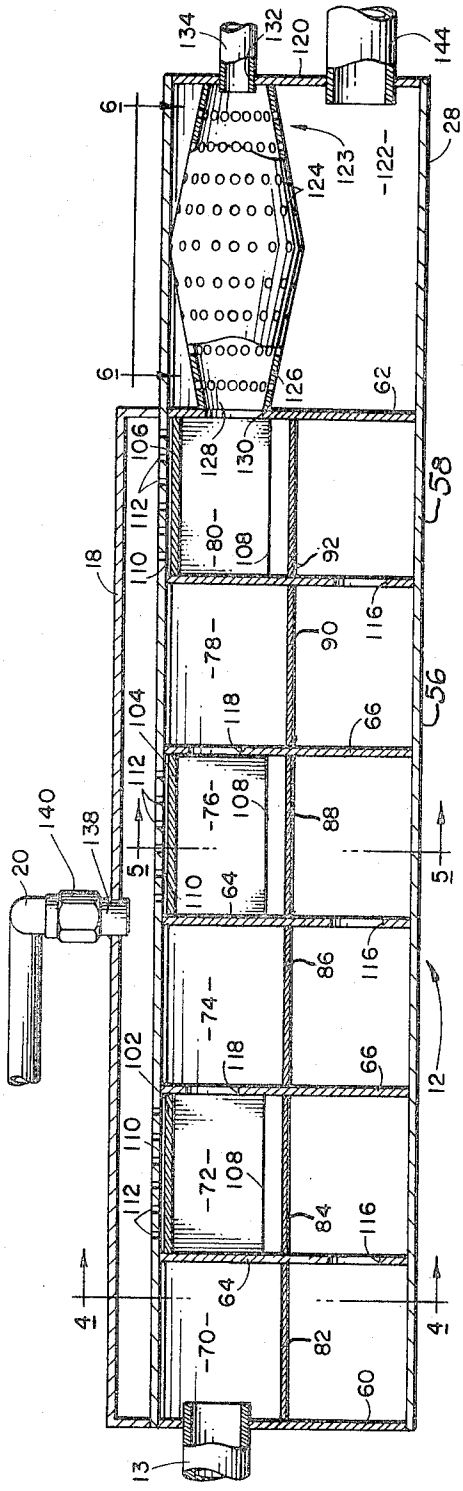


FIG. 6

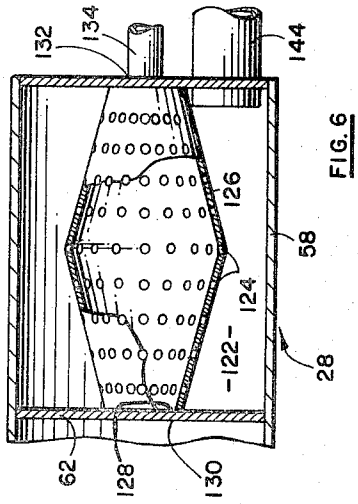


FIG. 5

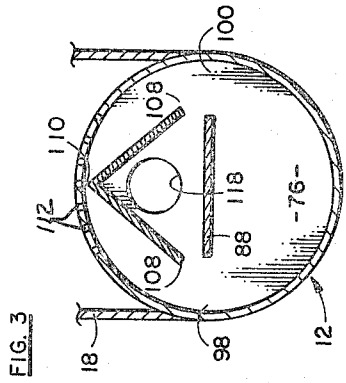


FIG. 3

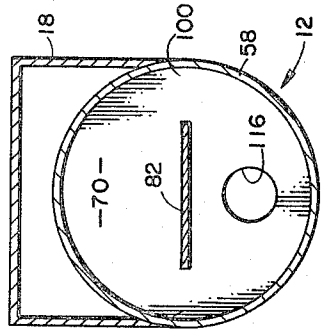


FIG. 4

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EXHAUST CONVERTER

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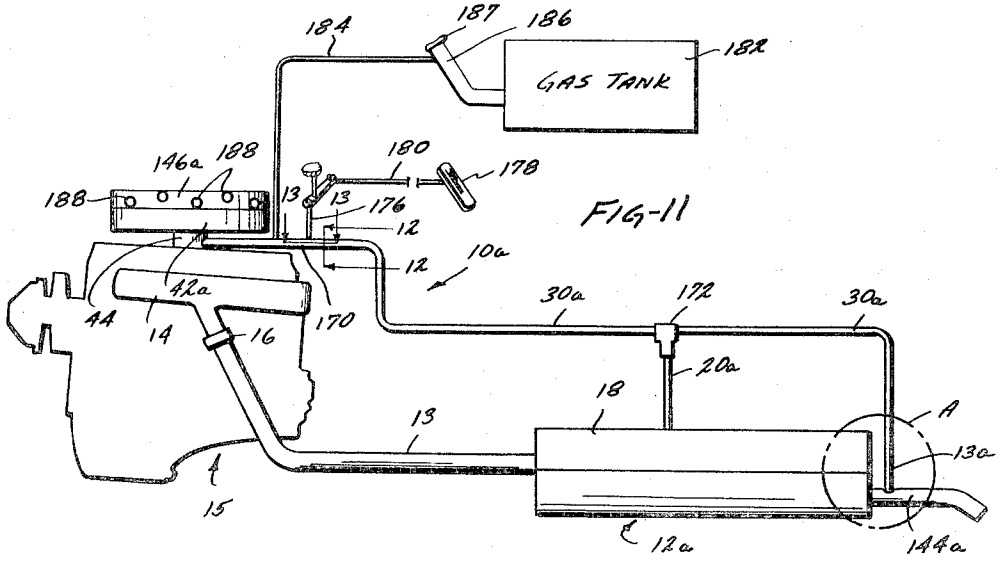


FIG-11

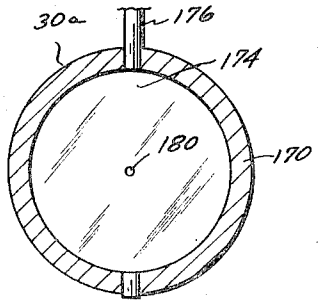


FIG-12

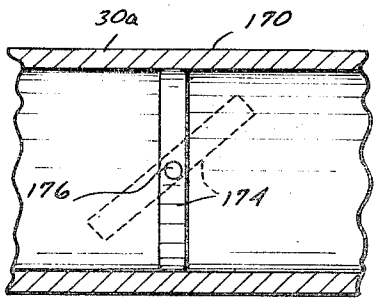


FIG-13

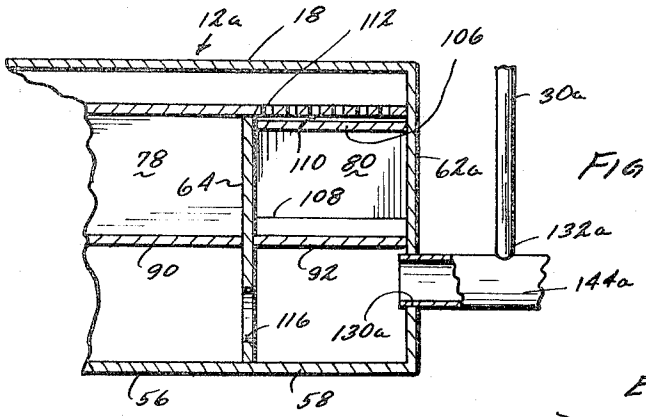


FIG-14

INUENTOR

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United States Patent Office 3,304,711
Patented Feb. 21, 1967

3,304,711

EXHAUST CONVERTER

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Filed Sept. 21, 1965, Ser. No. 493,611
11 Claims. (Cl. 60—29)

This application is a continuation-in-part of a copending application, now abandoned, filed July 29, 1963, under Serial No. 298,182 by the applicant herein.

This invention relates to an exhaust converter and more particularly to a device for separating carbon monoxide and hydrocarbons from the exhaust emissions of an internal combustion engine and returning the separated products to the engine for combustion therein.

The formation of photochemical air pollution or "smog" has been attributed, in part, to emissions from automobiles and other devices employing internal combustion engines. It has long been known that carbon monoxide is toxic in high concentrations such as occur when a motor vehicle is operated in a closed garage. Public health authorities are now concerned with the increasing atmospheric concentration levels of carbon monoxide. Exhaust gases from motor vehicles are considered to be a main source of this atmospheric concentration.

It is very difficult to control exhaust emissions from internal combustion engines. Two prior art approaches to the problem of controlling exhaust emissions have been with a catalytic device and a direct-flame afterburner.

These devices reduce the concentration of pollutants in the exhaust by the addition of secondary combustion air and the attainment of sufficient temperature to complete the combustion of these products not burned completely in the engine. Both of these devices require a separate air pump which adds to the cost of an automobile and may pose installation-space problems. Also, the devices do not warm up and become effective immediately, so that a percentage of the exhaust is discharged into the atmosphere untreated during the first several minutes of operation of a motor vehicle. The catalytic devices are subject to destruction from high temperature which might be attained in severe mountain driving or with a car having unusually high emissions. The catalytic device also has a relatively short useful life and both devices have the disadvantage that it is difficult to combine the functions of an exhaust purifier and muffler in the available space on modern automobiles.

In view of the foregoing factors and conditions characteristic of exhaust converter devices for removing pollutants from internal-combustion-engine exhaust emissions, it is a primary object of the present invention to provide a new and useful exhaust converter not subject to the disadvantages enumerated above and having means for separating carbon monoxide and hydrocarbons from exhaust emissions and returning the separated products to the engine for combustion by the engine efficiently, safely and expeditiously.

Another object of the present invention is to provide a device of the type described which functions effectively as both a muffler and an exhaust converter for an internal combustion engine.

Yet another object of the present invention is to provide an exhaust converter having a long useful service life and requiring a minimum amount of upkeep in use.

A further object of the present invention is to provide an exhaust converter which increases the gasoline mileage of an automobile by directing carbon monoxide, vapor and hydrocarbons from the exhaust converter to the carburetor of the automobile for consumption by the engine.

A still further object of the present invention is to provide an exhaust converter which separates carbon monoxide and hydrocarbons from the exhaust stream of an internal combustion engine by inertial separation.

Another object of the present invention is to direct fumes from an automobile's gasoline tank and combustion products from a converter of the present invention to the intake manifold of the automobile.

According to the present invention, a combined exhaust converter and muffler is provided with a plurality of partitioned chambers in which carbon monoxide and hydrocarbons are separated by inertial separation from the exhaust stream issuing from an internal combustion engine. The exhaust converter includes a first collection chamber for collecting the separated carbon monoxide and directing it back to the engine's intake manifold to be burned in the engine and a second chamber for collecting the separated hydrocarbons and directing them back of the intake manifold.

In a modified form of the present invention, the second chamber is replaced by a line which connects the engine's exhaust pipe to the intake manifold. A butterfly valve is included in this line and is connected to the engine's accelerator pedal for control thereby. In addition, fumes from the engine's gas tank are routed to the intake manifold to improve the operation of the engine at low speeds.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, can best be understood by reference to the following description taken in connection with the accompanying drawings in which:

FIGURE 1 is a diagrammatic view showing the device of the present invention connected to an internal combustion engine;

FIGURE 2 is a perspective view, with parts broken away to show the internal construction, of an exhaust converter of the present invention;

FIGURE 3 is a longitudinal cross-sectional view of the device of FIGURE 2;

FIGURE 4 is a transverse, cross-sectional view taken along line 4—4 of FIGURE 3;

FIGURE 5 is a transverse, cross-sectional view taken along line 5—5 of FIGURE 3;

FIGURE 6 is a longitudinal, cross-sectional view taken along line 6—6 of FIGURE 3;

FIGURE 7 is a plan view taken along line 7—7 of FIGURE 1;

FIGURE 8 is a vertical, cross-sectional view taken along line 8—8 of FIGURE 7;

FIGURE 9 is a plan view taken along line 9—9 of FIGURE 1;

FIGURE 10 is a vertical, cross-sectional view taken along line 10—10 of FIGURE 9;

FIGURE 11 is a view similar to FIGURE 1 of a modified form of the present invention;

FIGURE 12 is an enlarged cross-sectional view taken along line 12—12 of FIGURE 11;

FIGURE 13 is an enlarged cross-sectional view taken along line 13—13 of FIGURE 11; and

FIGURE 14 is an enlarged cross-sectional view of the area enclosed in circle A of FIGURE 11.

Referring again to the drawings and particularly to FIGURE 1, an exhaust converter constituting a presently preferred embodiment of the present invention, generally designated 10, includes an exhaust separator 12 which also serves as a muffler and which has an exhaust inlet 13 connected to the manifold 14 of an internal combustion engine 15 by a coupling 16. Exhaust emissions from the engine 15 flow through the inlet pipe 13 into the separator 12 where carbon monoxide and hydrocarbon particles are separated from the exhaust stream in a manner to be hereinafter described. The carbon monoxide collects in a

chamber 18 from which it flows through a pipe 20 and an inlet 24 into the lower portion of a collection tank 26. The hydrocarbon is collected in a device, to be hereinafter described, which is mounted in the rear portion 28 of the separator 12 and flows through a discharge pipe 30 into the tank 26 above the inlet pipe 24. Water also collects in the chamber 18 and flows through pipe 20, and inlet 24 into the tank 26. The carbon monoxide and hydrocarbon particles leave the tank 26 through an outlet 32, a regulator valve 34 and a discharge line 36 which is connected by a coupling 38 (FIGURE 8) to an inlet pipe 40 mounted in an air cleaner 42 above a carburetor 44 on engine 15. The inlet pipe 40 includes a depending leg 45 which terminates adjacent the inlet 44*a* of carburetor 44. Water flows from the tank 26 through an outlet 46, a regulating valve 47, a discharge line 48, a coupling 49 and an inlet 50 into the carburetor 44. The inlet 50 is mounted in the air cleaner 42 above the inlet 44*a* of carburetor 44 (FIGURE 8). It has been found that the gasoline mileage of the engine 15 may be substantially increased by burning the separated products therein.

Referring now to FIGURES 2–6, the separator 12 includes a cylindrical body portion 56 having an encompassing sidewall 58, a closed front or upstream wall 60 and a closed rear or downstream wall 62. First and second pluralities of circular, vertical partitions 64 and 66, respectively, are mounted on appropriate centers in the body portion 56 and form a plurality of gas treating chambers 70, 72, 74, 76, 78 and 80 therein. A plurality of horizontal partitions 82, 84, 86, 88 and 90 and 92 divide the chambers 70, 72, 74, 76, 78 and 80, respectively into upper and lower portions. The inlet 13 is mounted in front wall 60 in fluid communication with the upper portion of chamber 70.

The horizontal partitions 82–92 are spaced from the encompassing sidewall 58 forming arcuate passageways 98 and 100 therewith (FIGURES 4 and 5).

Gable-like, V-shaped partitions 102, 104 and 106 are mounted in the upper portions of chamber 72, 76 and 80, respectively, and have their lower edges 108 spaced slightly above the partitions 82–92. The upper edge 110 of the partitions 102, 104 and 106 extend longitudinally along the sidewall 58 subjacent a plurality of apertures or perforations 112 mounted therein. An aperture 116 is mounted in the lower portion of each vertical partition 64 and an aperture 118 is mounted in the upper portion of each vertical partition 66. The collection chamber 18 is mounted on the body portion 56, covers the apertures 112 in the sidewall 58 and is sealed thereto so that materials passing through the apertures 112 will be collected in the collection chamber 18.

A continuation of the sidewall 58 forms the rear portion 28 of the separator 12. A circular plate 120 closes the downstream end of the rear portion 28 and is mounted in spaced relation with the end 62 of body portion 56 to form a chamber 122 in the rear portion 28. A hydrocarbon collection trap 123 includes apertures 124 in its encompassing sidewall 126 and is mounted in the chamber 122. The hydrocarbon trap 123 also includes an open, upstream end 128 which is mounted in an aperture 130 formed in the upper portion of rear wall 62. The downstream end of the trap 123 includes an aperture 132 which extends through the plate 120. A hydrocarbon outlet 134 is mounted in aperture 132 and is connected to the hydrocarbon discharge pipe 30 by a union 136.

An outlet 138 is mounted in the collection chamber 18 and is connected to the pipe 20 by a union 140.

Materials which are not separated by the separator 12 and returned to the engine 15 are discharged from the separator 12 to atmosphere through an outlet pipe 144 mounted in the plate 120 in fluid communication with the chamber 122.

Referring now to FIGURES 7 and 8, the air cleaner 42 may comprise the conventional air cleaner for the engine 15 and includes a cover 146, a base portion 148, and a filter screen 150. The cover 146 is modified by mounting apertures 152 and 154 therein to receive the inlets 40 and 50, respectively. The inlets 40 and 50 may be retained in their respective apertures by the weldments 156. The base portion 148 includes a neck 158 which is secured to the carburetor 44 by a circular clamp 160.

Referring now to FIGURES 9 and 10, the collection tank 26 includes an encompassing sidewall 162, a closed bottom wall 164 and a closed top wall 166. The tank 26 is free of internal obstructions and the inlets 24 and 30 together with the outlets 32 and 46 communicate therewith through the sidewall 162.

Operation of the device will be readily understood. Exhaust emissions from the engine 15 are collected in manifold 14 and flow through the inlet pipe 13 in an exhaust stream with a swirling motion into chamber 70 above the horizontal partition 82 striking the upstream face of the vertical partition 64. The exhaust stream passes downwardly through the arcuate passageways 98 and 100 in chamber 70 to the lower portion thereof from whence they flow through aperture 116 into the lower portion of chamber 72. The exhaust stream then flows upwardly through the arcuate passageways 98 and 100 into the upper portion of chamber 72 where inertia causes the heavier carbon monoxide portion of the stream to flow upwardly between the encompassing sidewall 58 and the V-shaped partition 102, through apertures 112 and into the carbon monoxide collection chamber 18. The lighter constituents of the exhaust stream, including hydrocarbon particles, flow under the edges 108 of the partition 102 and then through the aperture 118 in vertical partition 66 into the upper portion of chamber 74. The exhaust stream then flows downwardly through the arcuate passageways 98 and 100 in chamber 74 into the lower portion thereof from which they flow through aperture 116 into the lower portion of chamber 76. The gas stream then flows upwardly through the arcuate passageways 98 and 100 into the upper portion of chamber 76 where inertia causes more carbon monoxide to flow upwardly between the encompassing sidewall 58 and the partition 104, through apertures 112 and into the collection chamber 18. The lighter constituents of the exhaust stream again flow under the edges 108 of the partition 104 from which they flow through aperture 118 into the upper portion of chamber 78. The gas stream then flows downwardly through the arcuate passageways 98 and 100 into the lower portion of the chamber 78 from which they flow through aperture 116 into the lower portion of chamber 80. Additional carbon monoxide flows upwardly through apertures 112 into the collection chamber 18. Additional lighter constituents flow upwardly through the arcuate passageways 98 and 100 and under the partition 106 into the upper portion of chamber 80 from which they flow through aperture 128 into trap 123. The portion of the gas stream which enters trap 123 contains hydrocarbon particles and constituents which are heavier than the hydrocarbon. These heavier constituents flow out through the apertures 124 into chamber 122 from which they flow through outlet 144 to atmosphere. Hydrocarbon particles within the trap 123 are conveyed through outlet 134 and pipe 30 to tank 26 from which they flow into the carburetor 44 to be burned in the engine 15.

A good deal of water vapor collects in the carbon monoxide chamber 18 along with the carbon monoxide and both are conveyed from the chamber 18 through outlet 138 and line 20 into the collection tank 26 from which they flow into the carburetor 44 to be burned in the engine 15.

The outlet 144 must be of such a diameter that the recommended back pressure is maintained on the engine 15. It has been found satisfactory to adjust regulating valves 47 and 34 to maintain the same pressure at outlets 50 and 40, respectively, as the pressure existing at outlet 144.

Of course it is apparent that the separator **12** with its partitions also comprises a satisfactory attenuator to muffle the engine **15** and that it can be used for automobiles, boats, tractors, compressors or other instrumentality. It is also apparent that the number of chambers in separator **12** may be increased or reduced in accordance with the demands of engine **15**.

Referring now to FIGURES 11–14, a modified exhaust converter **10***a* includes an exhaust separator **12***a* which is identical to the separator **12** except that the rear portion **28** thereof has been eliminated, and the endwall **62** is replaced by an endwall **62***a* which eliminates the aperture **130** in the upper portion, but which has an aperture **130***a* provided in its lower portion for reception of an outlet pipe **144***a* which replaced the outlet pipe **144**.

In addition, the discharge pipe **30** is replaced by a discharge pipe **30***a* which has one end **132***a* connected to the outlet pipe **144***a* for recirculating a portion of the exhaust stream from the separator **12***a* to the engine **15**. Also, the tank **26** is eliminated by connecting the pipe **30***a* directly to the engine **15** under the carburetor **44** by an end **170** of pipe **30***a* and by connecting a pipe **20***a* from the chamber **18** to the pipe **30***a* by a T-connection **172**. Flow of unburned gases and other products from chamber **18** and outlet pipe **144***a* to the engine **15** is controlled by a butterfly valve **174** which is rotatably mounted in the end **170** of pipe **30***a* by a spindle **176**. The valve **174** is connected to the conventional accelerator pedal **178** for the engine **15** by linkage **180** for operation thereby. The more the engine **15** is accelerated by pressing on pedal **178**, the more the valve **174** is opened so that more reburned gases and other products from the exhaust stream can flow to the accelerated engine for reburning therein. This reburning permits setting the carburetor **44** much leaner than would otherwise be the case. Since the engine **15** then depends on a certain amount of these unburned products, an orifice **180** is provided in the valve **174** so that some unburned products will continue flowing to the engine **15** when the valve **174** is closed. It has been found that a $\frac{1}{64}$ inch orifice in a $\frac{3}{8}$ inch diameter valve **174** is satisfactory for an eight cylinder engine. However, the $\frac{1}{64}$ inch orifice sometimes permits more of the products from the exhaust stream to be returned to the engine than it can handle while decelerating. This situation is remedied by carrying fumes from the engine's gasoline tank **182** to the engine **15** through a pipe **184** connecting the tank's filler neck **186** to the end **170** of pipe **30***a*. The tank **182** includes a vented cap **187** and the pipe **184** is connected to the neck **186** above the liquid level in the tank **182**.

In the modified form of the invention, the air cleaner **42** is replaced by an air cleaner **42***a* having a plurality of apertures **188** provided in its cover **146***a* to assume that sufficient air will be admitted to engine **15** so that it will handle a leaner mixture of fuel from carburetor **44** than would otherwise be the case.

While the particular exhaust converter herein shown and described in detail is fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that it is merely illustrative of the presently preferred embodiment of the invention and that no limitations are intended to the details of construction or design shown other than as defined in the appended claims.

What is claimed is:

1. A device for separating heavier constituents from lighter constituents in the exhaust stream of an internal combustion engine having a carburetor comprising:

a body portion having an encompassing sidewall, a closed front wall forming a first vertical partition at its upstream end and a closed rear wall forming a second vertical partition at its downstream end, said first vertical partition being provided with an aperture at its upper portion, said second vertical partition being provided with an aperture in its lower portion;

inlet means mounted in said aperture in said front wall in fluid communication with said body portion for receiving said exhaust stream from said engine; and

outlet pipe mounted in said aperture in said rear wall in fluid communication with said body portion for discharging fluids therefrom;

partition means mounted in said body portion in the flow path from said inlet means to said outlet means, said partition means comprising:

(a) a third vertical partition mounted in said body portion downstream of said front wall, said third vertical partition having an aperture mounted in a bottom portion thereof;

(b) a first horizontal partition means mounted in said body portion between said front wall and said third vertical partition, said first horizontal partition means forming a first arcuate passageway with said encompassing sidewall;

(c) a fourth vertical partition mounted in said body portion downstream of said third vertical partition, said fourth vertical partition having an aperture provided in the upper portion thereof;

(d) second horizontal partition means mounted in said body portion between said third and fourth vertical positions, said second horizontal partition means forming a second arcuate passageway with said encompassing sidewall, said second horizontal partition means being mounted intermediate said apertures in said third and fourth vertical partitions;

(e) third horizontal partition means mounted in said body portion between said fourth vertical partition and said end wall intermediate their associated apertures, said third horizontal partition means forming a third arcuate passageway with said encompassing sidewall, said encompassing sidewall having aperture means provided therein above said second horizontal partition means intermediate said third and fourth vertical partitions;

(f) fourth horizontal partition means mounted in said body portion between said aperture means and said second horizontal partition means, said fourth horizontal partition means including a portion extending outwardly adjacent said aperture means and lower edges forming a passageway with said second partition means for the flow of the lighter constituents of said exhaust stream under said fourth partition means; and

(g) a collection chamber connected to said body portion above said aperture means for collecting said heavier constituents from said apertures in said sidewall portion.

2. A combination as stated in claim **1** including an accelerator pedal controlling flow of fuel to said engine, a butterfly valve mounted in said conduit means for controlling the flow of said heavier constituents to said engine and linkage means connecting said butterfly valve to said accelerator pedal for operation thereby.

3. A combination as stated in claim **1** including a return pipe connecting said outlet pipe to said conduit means between said chamber and said carburetor for returning a portion of said stream thereto.

4. A combination as stated in claim **1** including a tank for supplying said fuel to said engine for combustion therein, said fuel comprising gasoline, and also including a fuel line connecting said engine to said tank above its liquid level for conducting gasoline vapor from said tank to said engine.

5. The device of claim **1** including hydrocarbon separating means mounted downstream of said partition means in the path of flow from said inlet to said outlet

for separating hydrocarbons from the portion of said exhaust stream which remains after said heavier constituents have been separated therefrom.

6. The device of claim 1 including conduit means connecting said collection chamber to said carburetor, said heavier constituents flowing from said collection chamber to said carburetor for combustion in said engine.

7. The device of claim 5, including conduit means connecting said hydrocarbon separating means to said carburetor for conveying hydrocarbon from said hydrocarbon separating means to said carburetor for combustion in said engine.

8. A device for separating heavy constituents from light constituents in an exhaust stream of an internal combustion engine comprising:

a body portion having an encompassing sidewall, a front wall at its upstream end and a rear wall at its downstream end;

a vertical partition mounted in said body portion downstream of said front wall, said vertical partition having an aperture mounted in a bottom portion thereof;

a first horizontal partition mounted in said body portion between said front wall and said vertical partition, said first horizontal partition forming a first arcuate passageway with said encompassing sidewall;

a second horizontal partition mounted between said vertical partitions and said rear wall, said second horizontal partition forming a second arcuate passageway with said encompassing sidewall;

an outlet pipe mounted in said rear wall;

a plurality of apertures mounted in said encompassing sidewall above said second partition;

a V-shaped partition mounted in said body portion between said apertures in said encompassing sidewall and said second horizontal partition with the point of said V-shaped partition extending upwardly adjacent the apertures in said encompassing sidewall and with the lower edges of said V-shaped partition forming a passageway with said second horizontal partition for the flow of the lighter constituents of said exhaust stream under said V-shaped partition;

an inlet pipe mounted in said front wall for connecting

said body portion to said engine for introducing the exhaust stream therefrom into said body portion above said first horizontal partition, said exhaust stream flowing through said first arcuate passageway into the portion of said body portion below said first horizontal partition and through said aperture in the lower portion of said vertical partition into the portion of said body portion lying below said second horizontal partition from which said exhaust stream flows upwardly through said second arcuate passageway in such a manner that the heavier constituents of said exhaust stream will flow upwardly through said apertures in said encompassing sidewall and the lighter constituents will flow under said V-shaped partition and out of said outlet pipe in said rear wall; and

a collection chamber connected to said body portion for receiving the flow of said heavier constituents from said apertures in said sidewall portion.

9. The device of claim 8, including conduit means connecting said collection chamber to said engine for combusting said separated heavier constituents therein.

10. The device of claim 8, including a trap mounted downstream of said V-shaped partition for collecting the lighter constituents separated by said V-shaped partition.

11. The device of claim 9, including a conduit connecting said trap to said engine for burning said lighter constituents therein.

References Cited by the Examiner

UNITED STATES PATENTS

2,354,179	7/1944	Blanc	123—119
2,664,966	1/1954	Moore	55—338 X
2,860,618	11/1958	Mansfield	123—119
2,986,133	5/1961	Mattson	123—136
3,019,780	2/1962	Nuding	123—119

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