Jan. 31, 1967 E. R. KNOPP 3,300,964

ANTI-SMOG DEVICE

Filed June 14, 1965 2 Sheets-Sheet 1

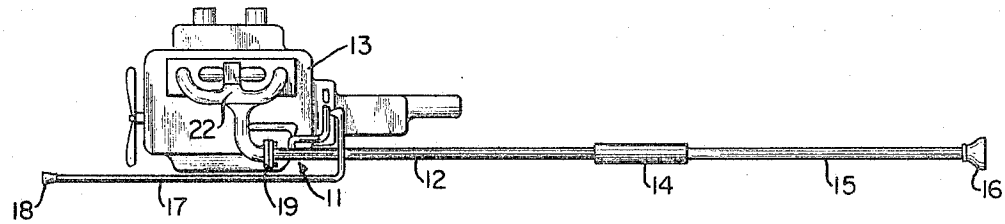

FIG. 1

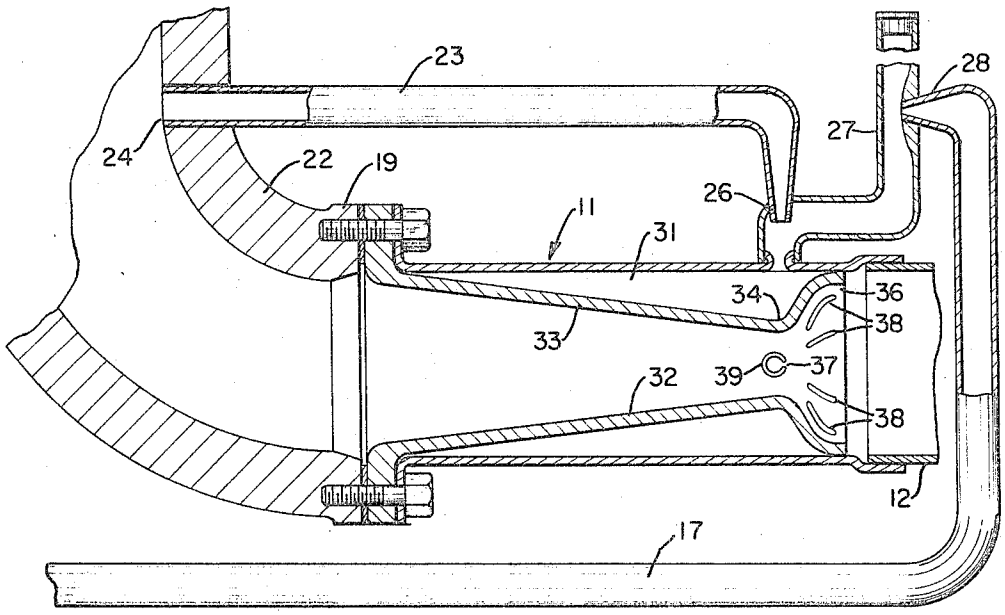

FIG. 2

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ANTI-SMOG DEVICE

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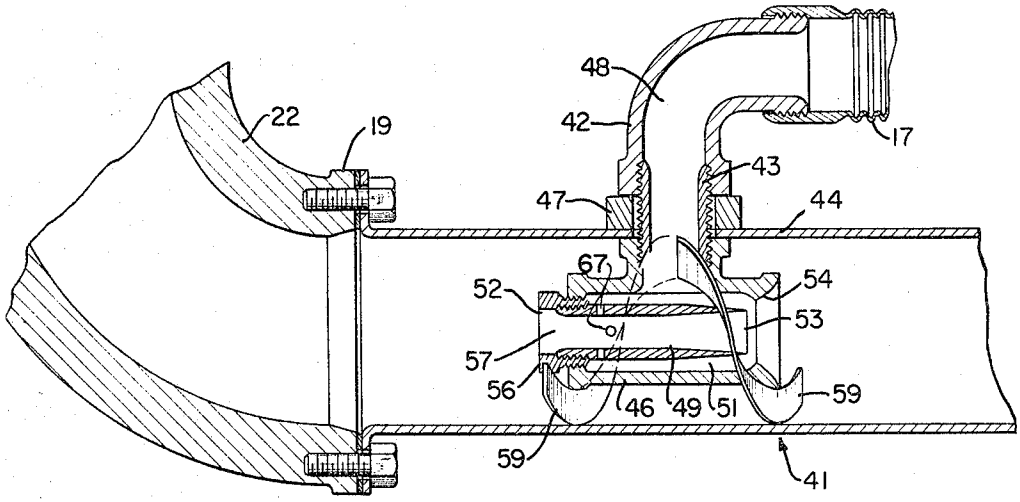

FIG. 3

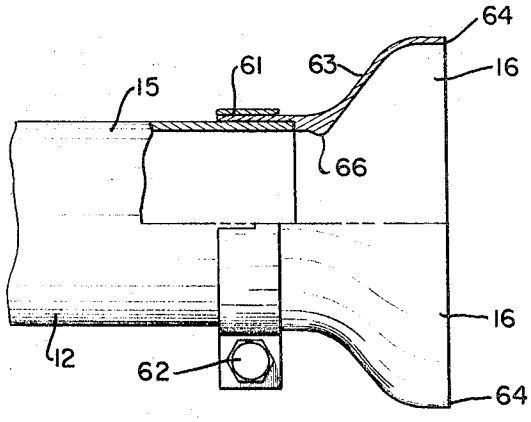

FIG. 4

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ANTI-SMOG DEVICE

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4 Claims. (Cl. 60—30)

The present invention relates to an anti-smog attachment for automobile exhausts and, more particularly, to an automotive exhaust gas contaminates reduction system.

The present apparatus is directed to the elimination of unburned hydrocarbons in the exhaust gases of automotive vehicles. A main purpose and objective is to reduce the quantity of unburned hydrocarbons and other deleterious substances discharged from the exhaust of automotive vehicles, so excess pollutants will not be accumulated in the atmosphere to cause smog conditions.

In accomplishment of such objective, it is an object of the invention to provide apparatus for inducing the burning of such materials before they are discharged from the exhaust.

Another object of the invention is to provide apparatus for the introduction of supplementary air to the exhaust stacks of an internal combustion engine in such manner as to obtain an efficient mixing of the air with unburned materials in the exhaust product of the engine to promote the burning of such materials.

The foregoing objects of the invention have been recognized by others as a potential solution for the elimination of smog creating factors in the atmosphere of large communities. Accordingly, while it is the intent of the present invention to provide an air pollution control device that will satisfy the foregoing objectives, it is a further object of the invention to provide apparatus which will accomplish the desired purpose in a more efficient manner to thereby further reduce the percentage of air pollution. It is also an overall objective to provide a mechanism that may be more economically installed and used on automotive equipment.

Specific objects of the invention include the provision of a mechanism which will efficiently intermix the exhaust gases and a suplementary quantity of make-up air in proper proportions to efficiently support the combustion of such unburned products.

Another object of the invention is to provide apparatus which uses the natural flow characteristics of gases to induce the efficient introduction and mixing of supplementary air to the exhaust system of an internal combustion engine.

A further object of the invention is to provide a combination of flow devices which conjointly contribute to the desired intermixing and burning without substantial increase in the back pressure for the exhaust system.

Further objects and advantages of the present invention will be apparent from the appended description and drawings, in which

FIG. 1 is a side elevation illustrating the installation of components of a first embodiment of the invention in an automotive exhaust system,

FIG. 2 is an enlarged cross-sectional elevation of a first type of apparatus,

FIG. 3 is a partial cross-sectional elevation showing a separate embodiment of the invention, and

FIG. 4 is a side elevation in quarter-section illustrating the configuration for a tail pipe flow inducing apparatus used to reduce system back pressures.

Briefly stated, the present invention provides attachments for the exhaust system of an internal combustion engine so that a regulated quantity of make-up air under impact pressures may be introduced into the flow of exhaust gases from the engine to be intermixed therewith as necessary to induce the combustion of the unburned

hydrocarbons included in the discharged exhaust gases. Separate embodiments of the invention are presented in which the desirable intermixing of the make-up impact air is accomplished in separate ways. In a first embodiment of the invention the impact air is premixed with a minor quantity of separated or bleed exhaust gases before such intermixture is introduced in the main exhaust system for further intermixing with the main stream flow of exhaust gases. In the second embodiment of the invention the impact air is added directly to a separated component of exhaust gases and almost immediately further intermixed with the main exhaust system for further intermixing with the main stream flow exhaust gases. In all embodiments of the invention various channel shapes and flow guide elements are used to take advantage of gaseous stream flow characteristics to increase the efficiency of introduction, mixing and discharge operations.

FIGURES 1 and 2 illustrate a first embodiment of the invention in which the anti-smog device **11** is applied in the exhaust system **12** of an internal combustion engine **13**. As shown, the exhaust system may include a muffler **14** and a tail pipe **15** of conventional configuration as typically used in specific automotive vehicles. A tail pipe extension **16** is desirably provided for inclusion in the system when the anti-smog device **11** is used. As an addition to a conventional exhaust system, a make-up impact air tube **17** is shown in FIGURE 1. This impact tube **17** is provided with an entrance opening **18** which preferably is disposed toward the front of the automotive vehicle so that ram air will be received in the tube. The entrance opening may be positioned adjacent the bumper, radiator or other element of the vehicle so long as the opening **18** is disposed forwardly to receive free air under the influence of impact forces resulting from the forward movement of the vehicle.

The manner in which the impact make-up air is introduced to the exhaust system for the vehicle is further illustrated in FIG. 2. In this figure it will be seen that the anti-smog device **11** is applied to the outlet flange **19** of the exhaust header **22** for the engine **13**. In order to make such installation on existing vehicles, a short length of exhaust pipe is removed, and the anti-smog device **11** is substituted so that the exhaust gases which normally would pass from the exhaust header **22** to the exhaust system **12** will be constrained to flow through the anti-smog device **11**. With the device **11** installed, a bleed pipe **23** is connected to the header **22** so a portion of exhaust gases from the engine **13** are extracted from the header **22** at a position above the flange **19** by the bleed system **23**. This bleed pipe, which has an inner end **24** communicating with the exhaust gas flow through the header **22** is provided with a discharge end **26** which delivers a small quantity of bleed exhaust gases to a bounce or surge chamber **27**. In such surge chamber the bleed exhaust gases will be premixed with the impact air delivered to such surge chamber by the impact tube **17**. Preferably, the impact air is introduced in the surge chamber by a nozzle formed outlet **28** connected to the surge chamber upstream from the point of introduction for the bleed gases. Operation of the device has further shown that the flow characteristics can be improved if the impact air is introduced in the surge chamber at a restriction or vena in such chamber. Introduction at this point of reduced pressure not only provides for induced flow of the impact air but tends to further eliminate a back flow of exhaust gases into the impact tube due to the pulsing pressure pattern in the exhaust header **22** or in the bleed pipe **23**.

In an efficient installation of the present type, a surge chamber that was approximately five feet in length has

been provided. Use of such elongated surge chamber materially reduces the pulse pressure characteristics so that an even flow of premixed bleed gases and impact air is available for introduction into an external chamber **31** of the anti-smog device **11**. From this external chamber the premixed materials are directed into the main exhaust flow channel which passes through a nozzle apparatus **32**. The nozzle apparatus **32** provides a tapered entrance channel **33**, a constriction or vena contractu **34** and an outlet flare segment **36**. The premixed materials are introduced into such nozzle at the vena by passage through a diametrically disposed jet slot or aspirational orifice **37** provided by a roll pin **39** extending through the walls of the nozzle **32** and communicating directly with the chamber **31**. Additional premixed gases are also introduced through the radially disposed slots **38** in the flared segment **36**. Through use of these components the main flow exhaust gases and the premixed product will be efficiently intermixed downstream from the constriction **34**, and if a proper temperature is maintained, combustion of unburned products in the exhaust gases will result.

Since it is recognized that the placement of the anti-smog device in the exhaust system will tend to increase the back pressure for the engine **13**, it is desirable that a flare outlet **16** be provided on the exhaust system **12** so that the efficiency of discharge from the exhaust system will be increased and so that the increase of back pressure will be kept to a minimum. It should be noted that in order to provide maximum efficiency for this type of anti-smog device, it is necessary that the exhaust gases and the make-up air be efficiently intermixed one with the other so that all unburned products may be burned to eliminate the undesirable discharge from the exhaust for the engine. Some turbulence of stream flow is required at the point of intermixing, and it has been found that the reversed presentation for the nozzle **32** is desirable. With the nozzle disposed in what would ordinarily be considered a reversed direction, as illustrated, an efficient intermixing is obtained, and the unburned products may be efficiently burned without the introduction of surplus quantities of air. Efficient mixing of reduced quantities of air, of course, prevents undue cooling of the exhaust gases so that a proper kindling temperature can be maintained when the anti-smog device is joined to the exhaust header **22** of an engine in position closely adjacent to the exhaust ports for the engine. Inasmuch as the outlet flange **19** for most exhaust headers on internal combustion engines is closer than shown in the present illustration, a device of the foregoing type can usually be connected directly to the outlet flange **19** for such engines.

A separate embodiment of the invention is shown in FIGURE 3. In this embodiment the overall operation is comparable to that previously described. However, in place of the extraction of a small quantity of bleed exhaust gases for premixture with the impact air by use of a separate bleed pipe, the present installation first separates a central flow of exhaust gases for premixture with the impact air, then intermixes the premixed product with the full stream flow of exhaust gases.

A suitable arrangement for this modified system, as shown in FIGURE 3, again uses an impact air entrance tube **17** which is connected directly to the anti-smog device **41**. As in the previous embodiment, the impact air pickup may be disposed toward the front of the vehicle so that the air will be delivered under a slight pressure to the device **41**. At the unit the air tube **17** is interconnected to an elbow or other fitting **32**, which is threaded to a nipple **43** passing through the wall **44** of the smog device **41**. The through nipple **43** is also secured interiorly of anti-smog device **41** to a pipe T **46**, which is disposed with its cross axis aligned with the axis of flow for the device **41**. By tightening the fitting

42 against the seal collar **47**, the orientation of the T within the device **41** may be established, and any leakage from the device will be avoided by the contact between the collar **47** and the fitting **42**. With this arrangement a flow passage **48** is provided from the impact tube **17** through the fitting **42** and and the nipple **43** to the cross axis flow channel **51** of the T **46**.

In order to separate a small quantity of the exhaust products and to intermix these separated gases with the incoming make-up impact air to provide a premixture of air and engine exhaust products, a separator guide cylinder **49** is provided interiorly of the cross axis flow channel **51**. This guide cylinder **49** is provided with an entrance opening **52** disposed upstream of the T **46** and an outlet **53** that is downstream from the impact air introduction passage **48**. In a preferred installation the downstream outlet **53** is positioned adjacent to a flow constriction **54** at the outlet of the cross axis channel **51**. The described assembly is attained through use of a tapped fitting **56** which is threaded into the upstream end of the T **46** in such manner that the threads will provide for minor adjustments in the positioning of the outlet **53**.

With this overall arrangement a portion of the impact air which is introduced through the openings **67** is premixed with the gaseous discharge flowing through the passage **57** in the guide cylinder **49**. These premixed products can produce a preliminary combustion within the guide cylinder **49**, or due to the pulsations in the system as induced by the impact air, or by the pulsing gaseous discharge from the valves of the internal combustion engine, some air might be introduced upstream from the entrance opening **52** to institute such precombustion of a portion of the impact air and the exhaust gas discharge. Whether combustion is started in the manner described or not, the premixed products will be expanded as they pass the constriction **54** to be discharged into the central flow area for the anti-smog device **41**. Upon exit from the T **46** these premixed gases which will include a surplus of air for the quantity of entrained unburned products will be available for combustion and intermixture with the main flow of exhaust gases which pass exteriorly of the T structure **46** and are directed along a spiral path by guide vane **59** before being mixed with the premixed products from the T **46**.

As illustrated, the guide vane **59** imparts a swirling motion to the exhaust gases, which materially increases the turbulence in the gas flow pattern downstream from T **46**. This turbulence improves the intermixture of unburned hydrocarbons and the available oxygen in the impact air contributes to the full combustion of such unburned hydrocarbons.

While the separation functions and the premixing operations for the guide cylinder **49** might be dispensed with in the provision of a working apparatus, it has been found desirable in the operation of both embodiments of the invention to premix a small portion of exhaust gases with an excess of air before a second mixing step in which the premixed exhaust gases and air is mixed with the remainder of the exhaust gases. Apparently the provision of an excess of air in the premixed product contributes to better initial combustion and, accordingly, the temperature of the total gas flow is re-elevated so that combustion of the remaining unburned gases may proceed. With direct mixture of all make-up air and all exhaust gases, the temperature may be reduced below a proper burning or kindling temperature for the admixture.

As in the previous embodiment of the invention, it should be noted that flow guiding structures are used in order to accomplish the desired intermixing and also to reduce undesirable friction in the flow system. For these purposes the nozzle constriction **54** is provided at the outlet of the T segment **46**, and the guide cylinder **49** is provided with tapered shapes in order to provide passages and outlets having minimum resistance to stream flow. As in

the earlier embodiment, it is desirable that a tail pipe flow inducing extension **16** be provided at the outlet to the exhaust system **12** so that the back pressure acting against the engine will not be materially increased by reason of the inclusion of the anti-smog device in the exhaust system.

Small structural features of a desirable type flow inducing tail pipe extension are shown in FIGURE 4. Here it is seen that the tail pipe extension **16** is provided with an upstream collar **61** which fits over the end of the exhaust tail pipe **15**, and the collar **61** is formed so that the extension may be secured to the tail pipe **15** by means of a clamp and bolt **62**. The extension itself provides a flared shape downstream from the tail pipe **15** so that the flow passage for the gases will be substantially expanded before the gases are exhausted from the system. This expansion of flow area together with the syphon effect created by passage of surrounding air along the exterior curved face **63** and past the outlet edge **64** of the extension induces an increased flow out of the exhaust system **12** which reduces the overall back pressure for the system. As in the previous constructions, a constriction **66** is provided to increase the efficiency of gas flow.

It should be noted that the working parts of the device **41** could be provided as separate components to be inserted into the interior of an existing exhaust pipe which might even be bent at the point of installation. To effect such installation it would only be necessary to drill a three-quarter inch hole in the wall of the pipe. Thereafter the T **46** would be placed within the pipe with the nipple extending through the opening, and a seal would be established between the pipe and such components by the collar **47** when the fitting **42** is tightened on the nipple **43**. For such installation the collar **47** would necessarily be of a shape to fit tightly against the exterior surface of the exhaust pipe.

In the operation of this insert component or in the operation of a complete device as illustrated in FIGURE 3, it should be noted that a portion, which might be described as a bleed portion, of the exhaust gases are extracted from the main flow of such gases in a position upstream from the main components of said device and at the center of the device for movement through the passage **57**. The central disposition for this point of extraction is believed to be of importance, since the carbon monoxide components in the exhaust gases which are of less density than most of the gases discharged by an internal combustion engine could be of higher percentage concentration at the center of any spirally moving flow pattern. Heat losses due to convection and radiation effects will likewise be reduced at such central location, and, accordingly, it is expected that the portion of exhaust gases introduced into the passage **57** will be at a high temperature, which will contribute to the efficiency of any initial combustion.

Either of the embodiments of the invention incorporate an important safety feature, inasmuch as they provide a channel for the escape of exhaust gas products if the tail pipe or tail pipe extension **16** should at any time become clogged. Upon the happening of such event, exhaust gases could escape through the impact tube **17** to prevent excess leakage of such exhaust gases from the exhaust system that might accumulate in the passenger compartment of the vehicle.

While separate embodiments of the invention have been shown and described, it should be recognized that the principles of the invention are adaptable to various modifications and changes. All such modifications which come within the scope of the appended claims are considered as a part of this invention.

I claim:

1. An anti-smog device for use on the exhaust system of internal combustion engines in position adjacent the exhaust valves thereof for inducing the more complete combustion of unburned products included in the heated gaseous discharge from said engine comprising a gaseous discharge flow conduit, a duct member disposed to extract a bleed portion of said gaseous discharge at a position upstream with respect to the main components of said device, a flow constriction downstream therefrom, an air tube disposed to deliver a quantity of makeup air to said device, means within said device for introducing a part of said makeup air into said bleed portion of said discharge gases at a point upstream from said flow constriction, a chamber downstream from said point of introduction for the initial premixture or combustion of said unburned products, means for the introduction of the remainder of said makeup air in a zone ahead of said flow constriction for passage therethrough, and an outlet from said flow constriction disposed centrally of said flow conduit, whereby an oxygen rich mixture from said flow constriction is subsequently discharged centrally of the flow passage for said discharge gases and in the turbulence zone downstream from said flow constriction.

2. An anti-smog device for use on the exhaust system of internal combustion engines for vehicles in position adjacent the exhaust valves thereof for inducing the more complete combustion of unburned products included in the heated gaseous discharge from said engine comprising a gaseous discharge flow conduit, a duct member disposed to extract a bleed portion of said gaseous discharge at a position upstream with respect to the main components of said device, a flow constriction downstream therefrom, an impact air tube disposed toward the front of the vehicle to deliver a quantity of makeup air under super-atmospheric pressure to said device, means within said device for introducing a part of said makeup air into said bleed portion of said discharge gases at a point upstream from said flow constriction, a chamber downstream from said point of introduction for the initial premixture or combustion of said unburned products, means for the introduction of the remainder of said makeup air in a zone ahead of said flow constriction for passage therethrough, and an outlet from said flow constriction disposed centrally of said flow conduit whereby an oxygen rich mixture from said flow constriction is subsequently discharged centrally of the flow passage for said discharge gases and in the turbulence zone downstream from said flow constriction.

3. An anti-smog device for use on the exhaust system of internal combustion engines for vehicles in position adjacent the exhaust valves thereof for inducing the more complete combustion of unburned products included in the heated gaseous discharge from said engine comprising a gaseous discharge flow conduit, a duct member disposed to extract a bleed portion of said gaseous discharge at a position upstream with respect to the main components of said device, a flow constriction downstream therefrom and disposed centrally of said gaseous flow conduit, an impact air tube disposed at the front of the vehicle to deliver a quantity of makeup air under super-atmospheric pressure to said device, means within said device for introducing a part of said makeup air into said bleed portion of said discharge gases at a point upstream from said flow constriction, a chamber downstream from said point of introduction for the initial premixture or combustion of said unburned products, and means for the introduction of the remainder of said makeup air in a zone ahead of said flow constriction for passage therethrough whereby an oxygen rich mixture from said flow constriction is subsequently discharged centrally of the flow passage for said discharge gases and in the turbulence zone downstream from said flow constriction.

4. An anti-smog device for use on the the exhaust system of internal combustion engines for vehicles in position adjacent the exhaust valves thereof for inducing the more complete combustion of unburned products included in the heated gaseous discharge from said engine comprising a gaseous discharge flow conduit, a duct mem-

ber disposed to extract a bleed portion of said gaseous discharge at a position upstream with respect to the main components of said device, a flow constriction in the flow path of said duct member disposed downstream therefrom and centrally of said gaseous flow conduit, an air tube disposed to deliver a quantity of makeup air to said device, means within said device for introducing a part of said makeup air into said bleed portion of said discharge gases at a point upstream from said flow constriction, a chamber downstream from said point of introduction for the initial premixture or combustion of said unburned products, means for the introduction of the remainder of said makeup air in a zone ahead of said flow constriction for passage therethrough, and a spiral guide vane in said flow conduit for inducing a spiral vortex flow pattern in the remainder of said gaseous discharge at a discharge point adjacent the discharge

from said flow constriction whereby the oxygen rich mixture from said flow constriction is discharged centrally of said gaseous discharge and in the spirally moving turbulence zone downstream from said flow constriction.

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