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3,285,709 11/1966 Eannarino..... 60/30
 3,396,535 8/1968 Milos..... 60/30
 3,435,613 4/1969 Eannarino..... 60/30

FOREIGN PATENTS

1,012,568 12/1965 Great Britain..... 60/30

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[54] **EMISSION CONTROL MEANS**
2 Claims, 3 Drawing Figs.

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23/277 C

[51] Int. Cl..... **F01n 3/14**

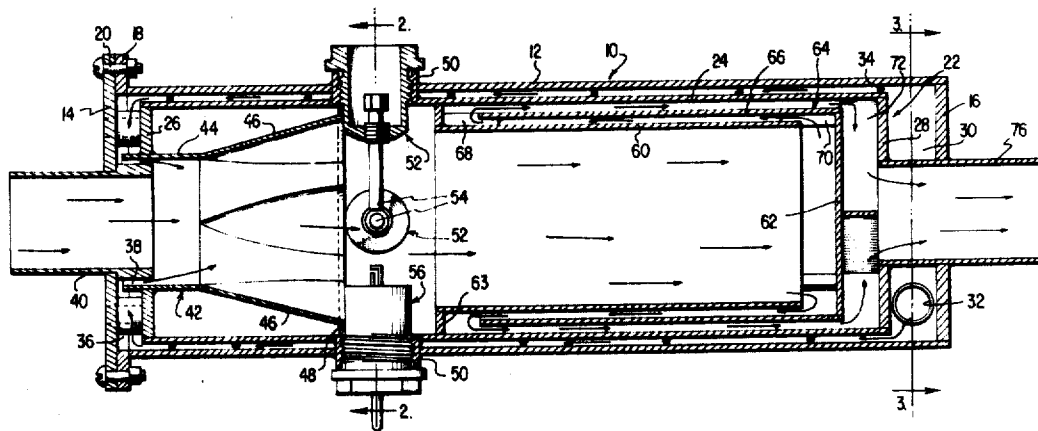
[50] Field of Search..... **60/29, 30;**
23/2 C, 277 C

[56] **References Cited**

UNITED STATES PATENTS

1,605,484 11/1926 Thompson..... 60/29
 2,829,730 4/1958 Barkeley..... 60/30
 3,061,416 10/1962 Kazokas..... 60/30

ABSTRACT: The mixing chamber of a combined acoustical muffler and afterburner receives exhaust gas and air at one end and beyond this region the chamber is provided with divergent cusps to form an expansion chamber wherein the exhaust gas and air are mixed and their velocity decreased for discharge through an ignition and burning zone. The ignition and burning zone is formed by a plurality of radially inwardly directed flame holding rods for sustaining the flame and a similarly located ignition device for initiating the flame. Downstream of this zone the burning gas may be caused to follow a tortuous path which effects acoustical muffling and preheating of the incoming air.



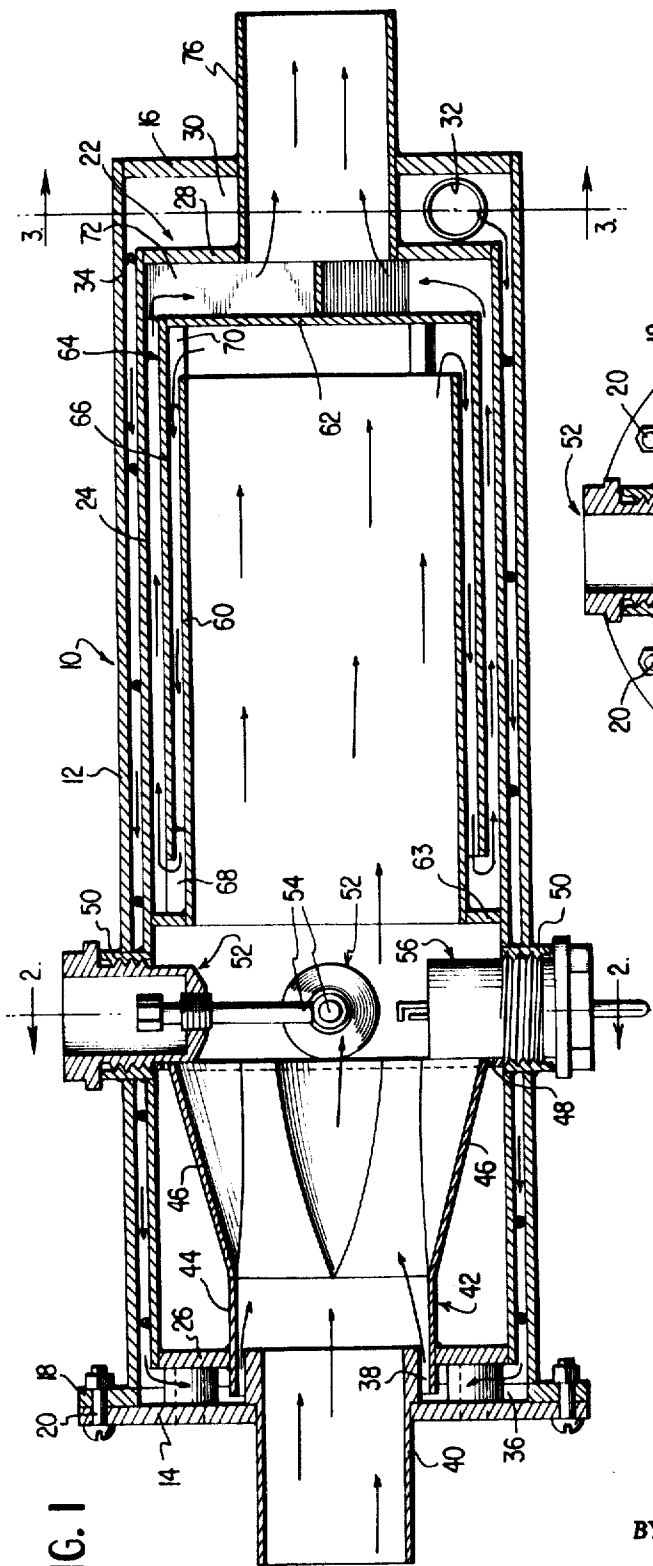


FIG. 1

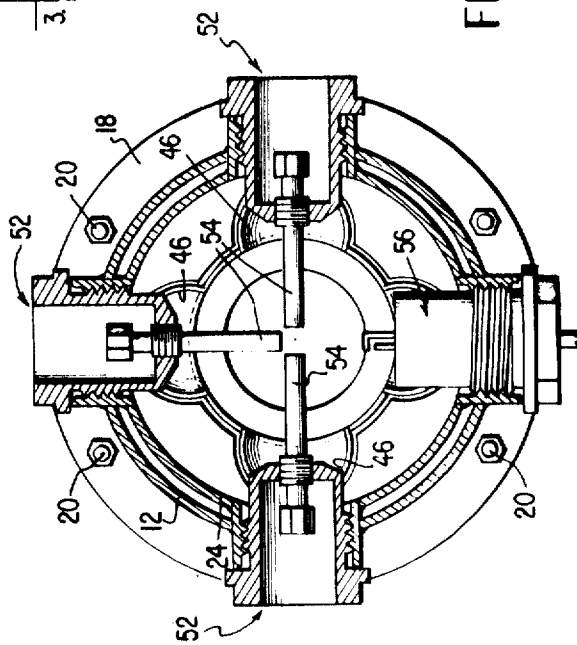


FIG. 2

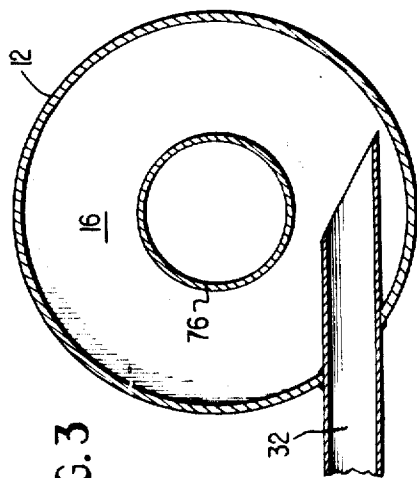


FIG. 3

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EMISSION CONTROL MEANS

BACKGROUND OF THE INVENTION

The emission of unburned hydrocarbon and carbon monoxide components in the exhaust gases emanating from the internal combustion engines is known to constitute a major source of air pollution in many localities and various proposals have been offered for lowering the level of such emission.

The internal combustion engines used to power vehicles operate over a wide range of conditions of load and engine speed and several of these conditions are particularly conducive to the emission of high percentages of unburned hydrocarbons and carbon monoxide in the engine exhaust gas. In fact, almost any condition other than constant speed under moderate load will produce unacceptable levels of unburned hydrocarbons and carbon monoxide in the exhaust gas. However, the different unacceptable emission-producing conditions display different and unique characteristics which, although they may be dealt with individually, have for the most part defied efforts directed toward providing a single device or system which will reduce the emission to acceptable levels under all of these conditions. Thus, for example, a system which reduces the emission under engine idling—no load condition may be woefully inadequate during conditions of acceleration under load or deceleration under load, etc.

In addition, the time history of engine operation introduces other variables with which difficulty is encountered. For example, the problems encountered in controlling emission of unburned hydrocarbons and carbon monoxide with respect to an engine which has been started after a long period of inactivity and which therefor is operating relatively "cold" are specifically different from the problems encountered with the same engine after it has come up to operating temperature.

Furthermore, no matter what proposal is offered, it must not only be efficient in terms of emission control, but also it must be capable of continuing operation substantially at its initial level of efficiency without requiring an inordinate amount of maintenance and, in addition, all of this must be accomplished within the realm of reasonable initial cost.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide a device for reducing the emission of unburned hydrocarbons and carbon monoxide to acceptable levels in the exhaust gas of an internal combustion engine, which device is operative under the most adverse circumstances or conditions of engine operation.

Specifically, the present invention is directed to a device of the afterburner type which is effective to complete the combustion of unburned hydrocarbons and carbon monoxide sufficiently well as to reduce these components to acceptable levels.

The present invention is directed to an afterburner device for emission control in which incoming air is efficiently preheated and then mixed with incoming exhaust gas in a mixing chamber which includes an expansion portion discharging the mixture to an ignition zone. The ignition zone contains a plurality of circumferentially spaced flame holding rods and an ignition device or devices such as a glow plug, the latter of which initiates burning and the former of which assures continuity of the flame. A flow reverser for the burning gas may be used to maintain the wall of an inner housing hot so that incoming air flowing between the wall of the inner housing and an outer housing wall is preheated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal section taken through a device constructed according to the invention.

FIG. 2 is a transverse section taken substantially along the plane of section line 2—2 in FIG. 1.

FIG. 3 is a transverse section taken substantially along the plane of section line 3—3 in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As is illustrated in FIG. 1, the device includes an outer housing 10 including a tubular sidewall 12 and opposite end walls 14 and 16, the former of which is removably secured to the sidewall 12 through the intermediary of the annular flange 18 fixed to the wall 12 and the fasteners 20. Disposed within the outer housing 10 is an inner housing indicated generally by the reference character 22 and which includes a tubular side wall 24 spaced radially inwardly from the sidewall 12 in substantially uniform relationship and which includes the opposite end walls 26 and 28 spaced respectively inwardly from the corresponding end walls 14 and 16 of the outer housing 10.

The spacing between the walls 16 and 28 defines an inlet chamber 30 into which air is pumped through a tangentially disposed pipe 32 so that a swirling action is set up in the chamber 30. The walls 12 and 24 define a passageway therebetween and the wall 24 is provided on its outer surface with a helically extending wire 34 or similar means for substantially bridging between it and the inner surface of the wall 12 so as to form a continuation of the swirling path and to effectively lengthen the path for the incoming air as it passes over the inner housing outer wall 24. In this fashion, the incoming air is heated to a temperature in the order of at least about 1,000° F.

The incoming air is discharged into the manifold chamber 36 defined between the walls 14 and 26 and flows therefrom into the inlet end of the inner housing 22 through the annular passage 38 formed between the inner end of the inlet conduit 40 and the inlet end of the mixing chamber indicated generally by the reference character 42. Thus, in the cylindrical portion 44 of the mixing chamber, the incoming air and exhaust gases are comingled and then are immediately introduced into the expansion chamber portion of the device 42 formed by the divergent cusps 46 which extend to the end flange 48 of the device 42. The flange 48 extends radially outward into contact with the inner surface of the inner housing wall 24.

Just downstream of the mixing assembly 42 are a plurality of circumferentially spaced sleeves 50 which project through aligned openings in the walls 12 and 24 and are welded therewithin, these sleeves being adapted to receive a series of externally threaded plug members 52 for receiving the igniting means. One or more flame holding rods 54 may be so mounted and at least one spark or glow plug 56 is also provided. The flame holding rods 54 and igniting device 56 are removably received in the plugs 52 and extend radially inwardly in the fashion shown best in FIG. 2 so that as the velocity of the mixed gas passes through the expansion chamber portion of the mixing device 42 as provided for by the cylindrical cusps 46, the gas mixture will be ignited. The flame is maintained by virtue of the base recirculation effect of the flame holding rods 54 so that even under the most adverse conditions the gases as they are ignited will be at a temperature of at least about 1,700° F. and will thus enter the sleeve 60 in burning condition. This sleeve may be fixed by means of the annular ring 63 to the inner surface of the wall 24 and terminates short of the baffle plate 62 of the flow reverser indicated generally by the reference character 64. The flow reverser 64 includes a skirt 66 surrounding and spaced outwardly from the sleeve 60 substantially midway between the sleeve and the wall 24 so that the still burning gas first reverses direction within the passage defined between the sleeve 60 and skirt 66 and again reverses direction to extend through the passage defined between the skirt 66 and the wall 24, the latter passage assuring preheating of the incoming air. The flow reversing device is supported from the sleeve 60 by means of the spaced ears 68 and 70 and is secured to the outer housing through the intermediary of the Y-shaped member 72 which serves also to afford uniform flow in the transverse cross section of the passages between the skirts 60, 66 and 24. The outlet conduit 76 extends from the end wall 28 of the inner housing 22 and projects through the end wall 16 of the outer housing.

The incoming air is supplied by a pump driven at or proportional to engine speed and having sufficient capacity to supply

the requisite amount of incoming air under all conditions. Since the mass rate of exhaust gas flow is dependent not only upon engine speed but also upon engine load, the pump for incoming air may be controlled as to volumetric output as a function of inlet manifold vacuum as well as a function of engine speed. Ideally, the pump will deliver just that mass rate of incoming air as will substantially assure theoretically complete combustion of unburned hydrocarbons and carbon monoxide in the exhaust gas.

It should be noted that the present invention is not to be limited to the specific elements shown and described herein but is subject to modification. For example, the parts can be assembled in a manner which allows for disassembly, or can be completely welded together with no threaded connections. The ignition device can be threaded into the housing or can be permanently positioned in place as can the flame holding rods. Also, the spiral air passage can be formed in other manners than by the use of wire as disclosed hereinabove.

I claim:

1. An afterburner device for effecting substantially complete combustion of unburned hydrocarbons and carbon monoxide which may be present in the exhaust gas of an internal combustion engine, comprising, in combination:

an elongate housing having an inlet for exhaust gas adjacent one end and an outlet for exhaust gas adjacent its other end, said housing also having an inlet chamber at said other end thereof;

means for introducing incoming combustion-supporting air in swirling fashion into said inlet chamber;

burner chamber means communicating at one end with said inlet and at its opposite end with said outlet and having a divergent portion spaced downstream from said inlet;

passage means for conducting incoming air from said inlet chamber toward said one end of the housing in spiralling, heat-exchange relation around said burner chamber means, and including a passage communicating with said inlet for exhaust gas upstream of said burner chamber means; and

ignition means downstream of and adjacent to said divergent portion of the burner chamber means for igniting the mixture of exhaust gas and incoming air thereat, said ignition means including an externally powered ignition device for igniting the mixture and a plurality of circum-

ferentially spaced and radially inwardly directed flame holding rods to sustain burning of the mixture.

2. A combined acoustical muffler and afterburner for effecting substantially complete combustion of unburned hydrocarbons and carbon monoxide which may be present in the exhaust gas of an internal combustion engine, comprising in combination:

an elongate outer housing forming an enclosure;

an elongate inner housing disposed within said outer housing, said inner and outer housings having respective tubular walls disposed in substantially uniformly spaced relation defining a passageway therebetween extending along the length of said outer housing;

an exhaust gas inlet conduit extending through said outer housing at one end thereof and discharging into the corresponding one end of said inner housing;

a burner chamber having a tubular inlet end projecting through said one end of the inner chamber in surrounding, spaced relation to the inner end of said inlet conduit to communicate with said one end of the outer housing;

means for introducing air into the other end of said outer housing to flow air through said passageway and into said burner chamber through said inlet end thereof whereby the incoming air and exhaust gas are intermixed thereat; said burner chamber inlet end being divergent in a downstream direction;

means for igniting the gas mixture adjacent said inner end of the burner chamber;

a flow reverser downstream of said burner chamber and including a transverse baffle plate and a tubular skirt extending toward said one end of the inner housing in inwardly spaced relation to the tubular wall of the latter;

a sleeve nested within said skirt for directing burning gas from said burning chamber toward said baffle plate and forming a passage with said skirt for reversal of burning gas leading to the space between said skirt and said tubular wall of the inner housing; and

an outlet conduit extending from said other end of the inner housing through said outer housing;

said ignition means being in the form of a plurality of circumferentially spaced and radially inwardly directed flame holding rods, and an externally powered ignition device.