May 12, 1964 G. W. CORNELIUS Re. 25,576

APPARATUS FOR CONSUMING THE UNBURNED PRODUCTS OF COMBUSTION OF AN INTERNAL COMBUSTION ENGINE

Original Filed Nov. 1, 1954 4 Sheets-Sheet 1

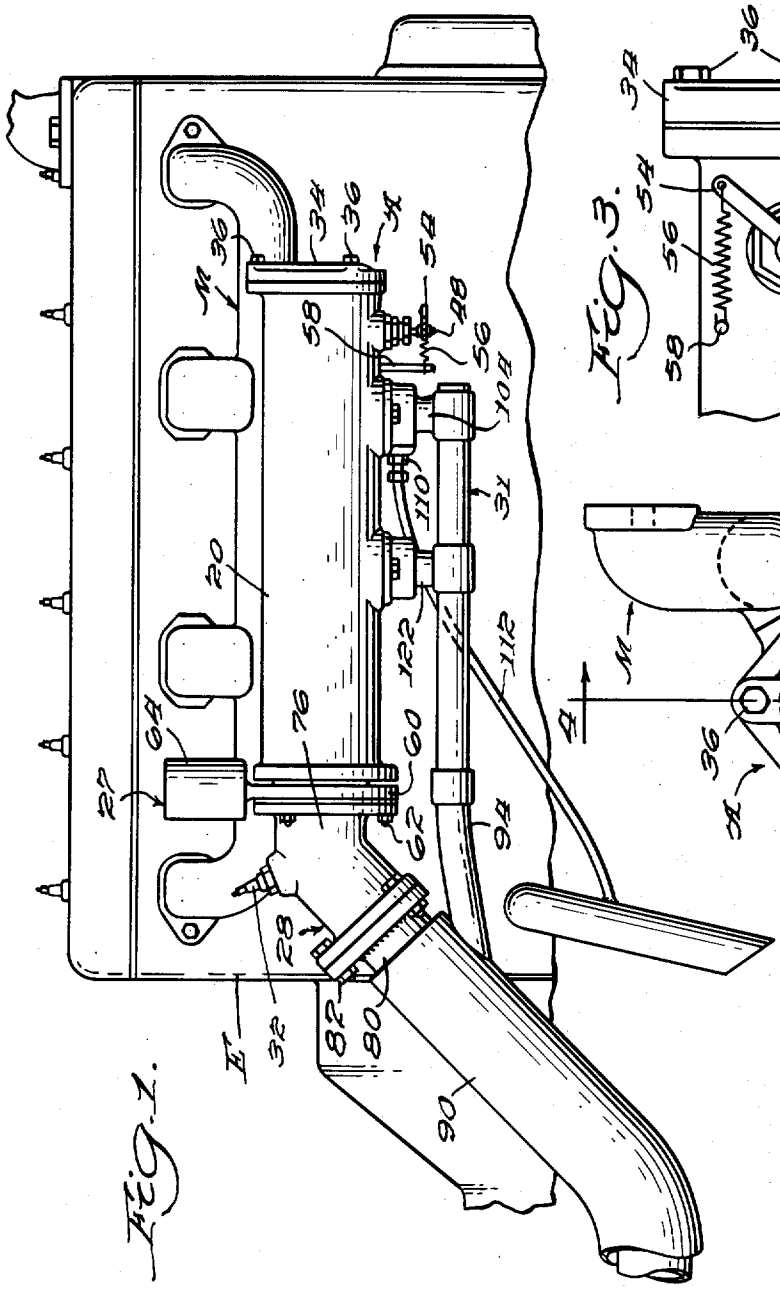


Fig. 1.

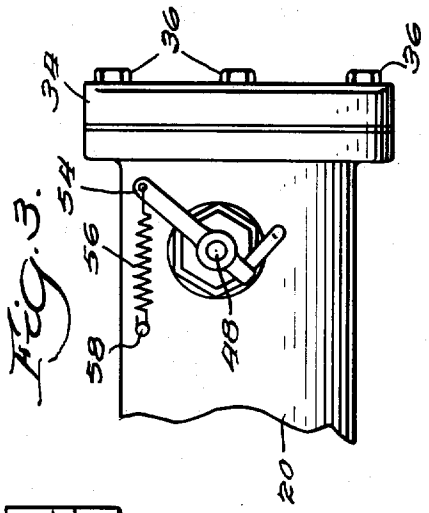


Fig. 3.

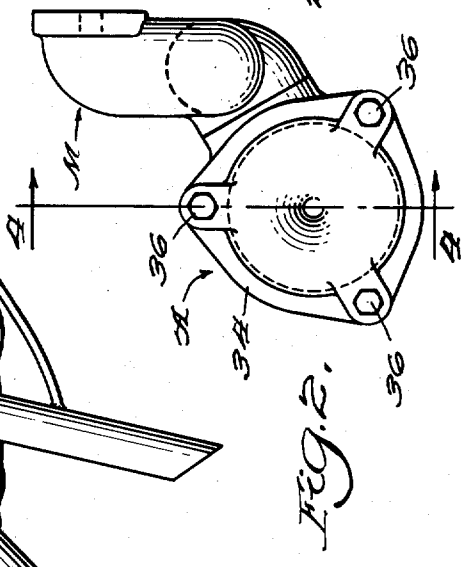


Fig. 2.

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Fig. 8.

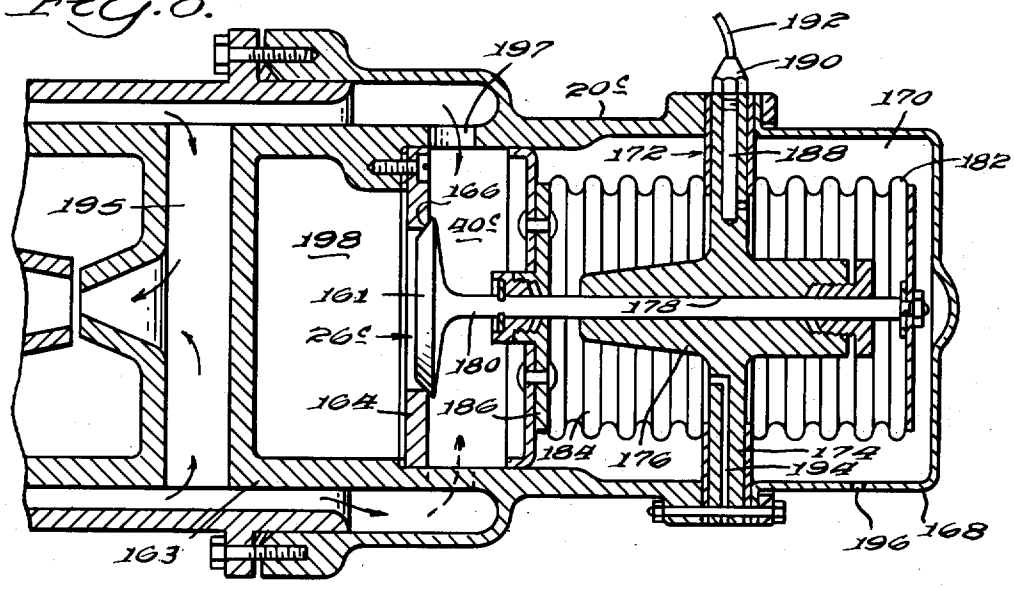
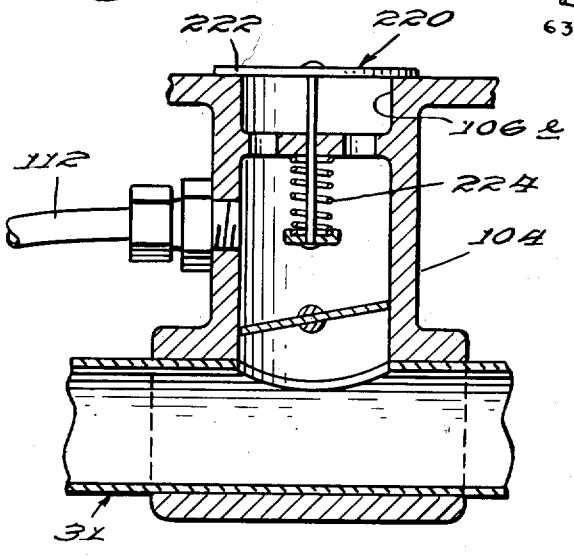


Fig. 10.



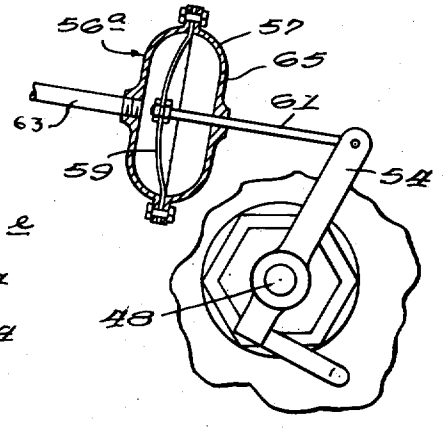


Fig. 3a.

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APPARATUS FOR CONSUMING THE UNBURNED PRODUCTS OF COMBUSTION OF AN INTERNAL COMBUSTION ENGINE

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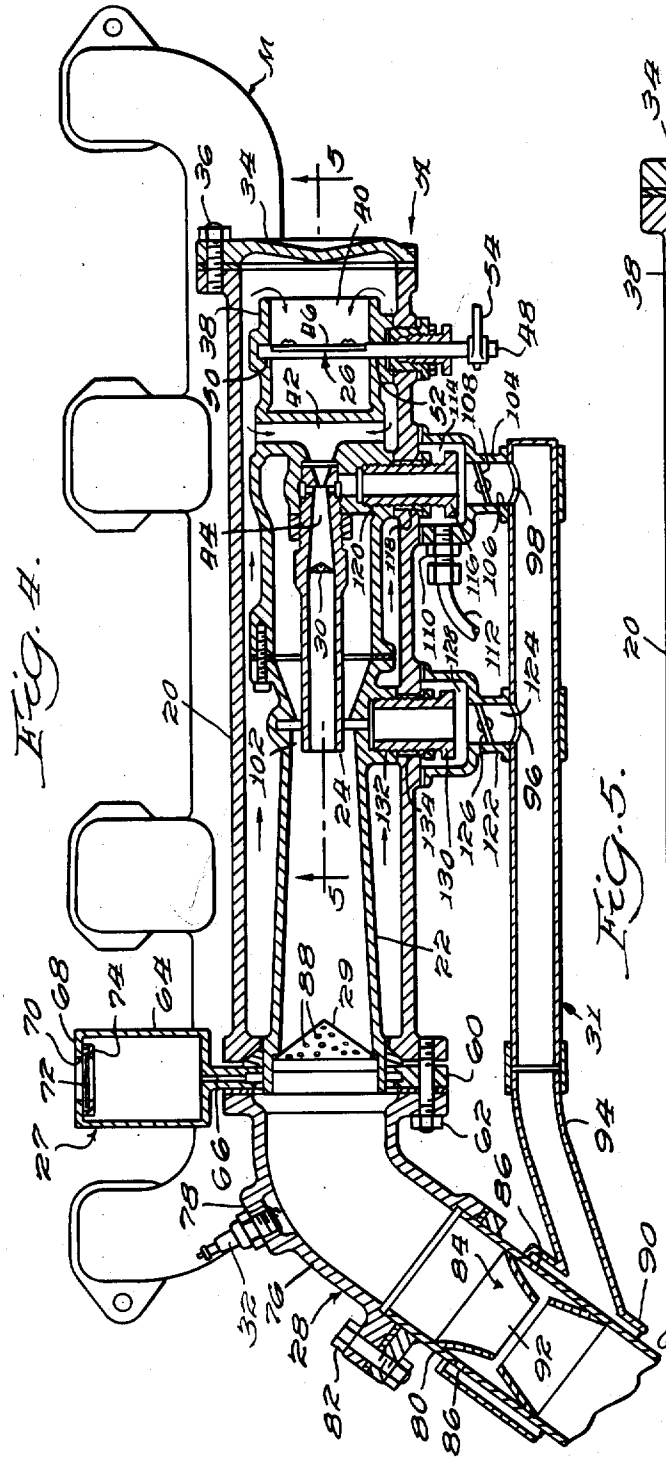


Fig. 4.

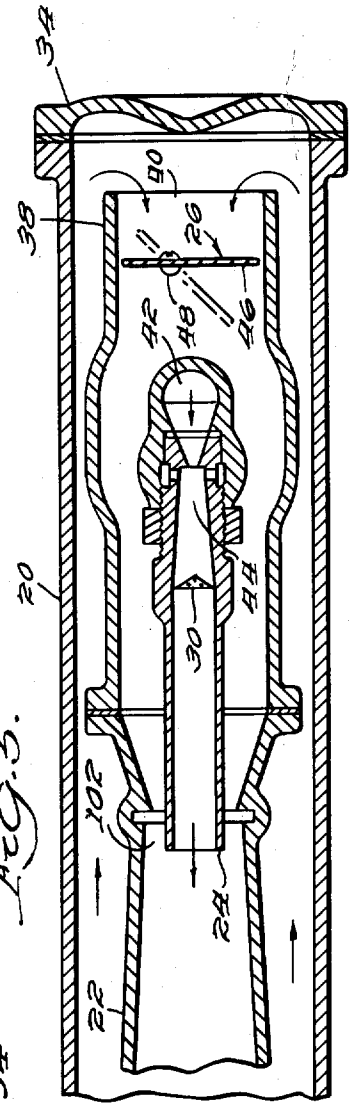


Fig. 5.

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Fig. 6.

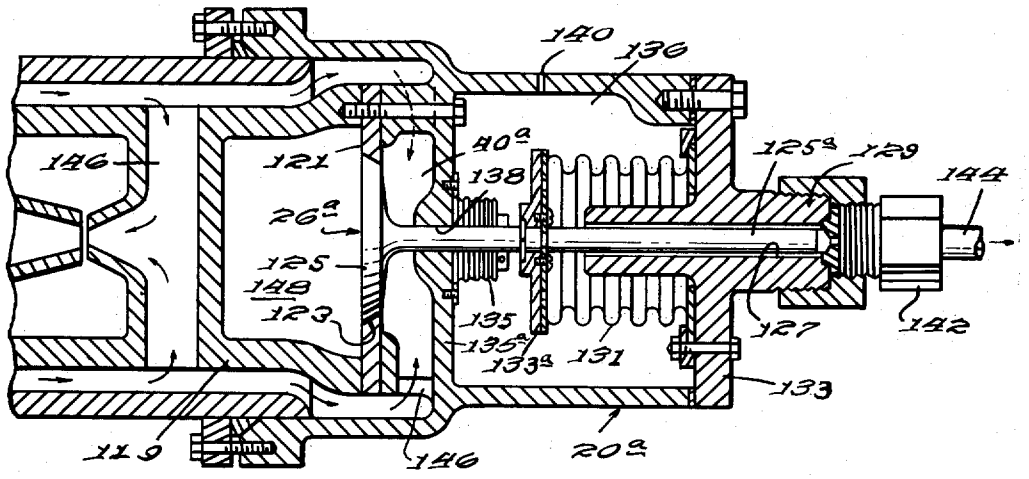
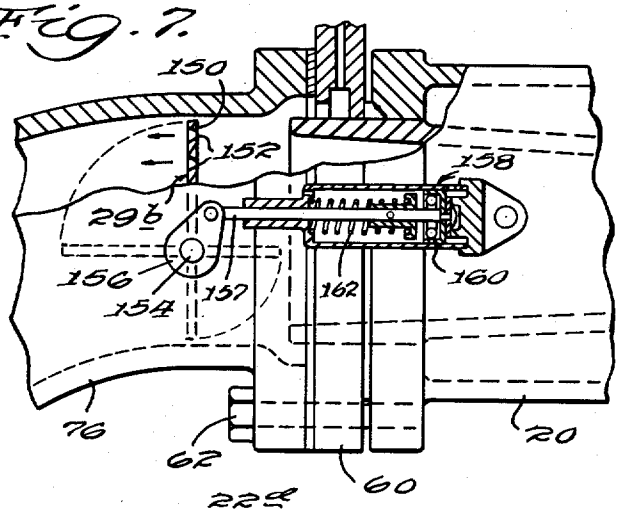


Fig. 7.



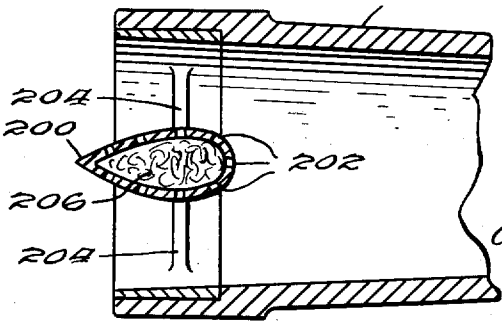


Fig. 9.

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APPARATUS FOR CONSUMING THE UNBURNED PRODUCTS OF COMBUSTION OF AN INTERNAL COMBUSTION ENGINE

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21 Claims. (Cl. 60—30)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

The present invention relates generally to the field of internal combustion engines and more particularly to a novel apparatus for consuming the unburned products of combustion exhausted from an internal combustion engine.

It is well known that the unburned products of combustion exhausted from the internal combustion engines of automotive vehicles constitute a prime source of the so-called "smog" which exists in and around the principal population centers of the country. The harmful effects of this smog upon both animate and inanimate objects are likewise very well known. Although many forms of apparatus for consuming these unburned products of combustion have been heretofore proposed, such devices have for various reasons proven to be unsatisfactory and accordingly are not now in general usage.

It is a major object of the present invention to provide an effective apparatus for consuming the unburned products of combustion exhausted from an internal combustion engine.

Another object is to provide apparatus of the aforedescribed nature that is comparatively simple in design and rugged of construction whereby it may afford a long and trouble-free service life.

A further object of the invention is to provide an apparatus of the aforedescribed nature that may be readily installed upon the engine of any conventional automotive vehicle.

It is yet another object to provide apparatus of the aforedescribed nature that is foolproof and entirely automatic in operation.

These and other objects and advantages of the present invention will become more apparent from the following detailed description, when taken in conjunction with the appended drawings wherein:

FIGURE 1 is a side elevational view of a preferred form of apparatus embodying the present invention mounted upon an internal combustion engine;

FIGURE 2 is a front view of said apparatus;

FIGURE 3 is a fragmentary enlarged bottom view of a detail of said apparatus;

FIGURE 3a is a view similar to FIGURE 3 showing a modified form of said detail;

FIGURE 4 is a central vertical sectional view of said apparatus;

FIGURE 5 is an enlarged horizontal sectional view taken along line 5—5 of FIGURE 4;

FIGURE 6 is a central vertical sectional view of an alternate type of control valve which may be utilized with said apparatus;

FIGURE 7 is a side elevation, taken partly in central vertical section, of an alternate type of flame holder which may be utilized with said apparatus;

FIGURE 8 is a central vertical sectional view of yet another type of control valve which may be utilized with said apparatus;

FIGURE 9 is a central vertical sectional view of a special igniter and flame holder which may be utilized with said apparatus; and

FIGURE 10 is a central vertical sectional view of a one-way valve that may be utilized with said apparatus.

Referring to the drawings and particularly FIGURES 1 through 5 thereof, a preferred form of apparatus A embodying the present invention is shown mounted upon one side of a conventional internal combustion engine E having an exhaust manifold M. The preferred form of apparatus A broadly comprises a cylindrical housing, generally designated **20**, that may form an integral part of the engine's exhaust manifold M. Formed within this housing **20** are a first venturi, generally designated **22**, and a second smaller venturi, generally designated **24**, the latter being coaxial with and concentric to the first venturi **22**. A control valve, generally designated **26**, is disposed forwardly of the venturis **22** and **24** and is adapted to control the flow of exhaust gas through the two venturis. A pressure dome, generally designated **27**, is disposed adjacent the outlet of the large venturi **22**. A discharge pipe, generally designated **28**, extends downwardly and rearwardly from the rear end of the housing **20**. A main flame holder, generally designated **29**, is arranged between the rear of the housing **20** and the front of the discharge pipe **28**. An auxiliary flame holder **30** is mounted in the smaller venturi **24**. An air-intake manifold, generally designated **31**, positioned below the housing **20** is adapted to introduce air into the two venturis **22** and **24**. A spark plug **32** is mounted rearwardly of the flame holder **29**.

In the operation of the preferred form of apparatus A, exhaust gases issuing from the exhaust manifold M will enter the front of the housing **20** and pass rearwardly through the venturis **22** and **24** into the discharge pipe **28**. These exhaust gases contain a certain percentage of unburned products of combustion which are adapted to be consumed in the housing **20**. Air is introduced into the housing through the air-intake manifold **31** so as to effect complete burning of these products of combustion. The spark plug **32** assists in supporting the combustion of the mixture of unburned products of combustion and air. The control valve **26** is arranged to direct all of the exhaust gases through the small venturi **24** during idling and deceleration of the engine E. During other opening conditions of the engine, however, the exhaust gases will also pass through the large venturi **22**.

More particularly, the housing **20** is provided with a front cover **34** which is secured in place by bolts **36**. Rearwardly of the front cover **34** there is mounted a guide member, generally designated **38**, which directs the exhaust gases entering the front end of the housing at **40** into the front portion of the two venturis **22** and **24**. The front portion of this guide member is of cylindrical shape and it encloses the control valve **26**. When the control valve **26** is disposed in its closed position of FIGURES 4 and 5, all of the exhaust gases will pass through a transverse passage-way **42** into the throat **44** of the smaller venturi **24**. When the control valve **26** is moved to its open position indicated by dotted outline in FIGURE 5, however, these exhaust gases will also flow into the front end of the larger venturi **22**. The control valve **26** may be of the butterfly type having a plate **46** which is secured upon a vertical shaft **48** in an off-center relationship as shown in FIGURE 5. The latter is journaled between aligned vertical bores **50** and **52** formed in the front portion of the guide member **38**. The lower portion of the shaft **48** is keyed to a cross-arm **54**, as shown in FIGURES 1, 3 and 4. The free end of this cross-arm **54** is connected to one end of a tension spring **56**. The latter has its opposite end rigidly secured to retainer **58** which depends from the underside of the housing **20**. With this arrangement, the plate **46** is normally biased to its

closed position of FIGURES 4 and 5. Since the shaft **48** is offset from the central axis of this plate, however, the exhaust gases entering the front end of the housing at **40** will tend to rotate the shaft and hence pivot the plate **46** to its dotted position of FIGURE 5. The amount of pivoting force exerted upon the plate **46** will be proportional to the pressure of the exhaust gases entering the front end of the guide member **38**.

Referring to FIGURE 3a, there is shown a modified arrangement wherein the tension spring **56** is replaced by a diaphragm type control unit **56a**. This unit includes a metallic case **57** wherein is mounted a flexible diaphragm **59**. The center of this diaphragm **59** is affixed to the rear end of a rod **61** that is pivotally connected at its front end to the free end of the cross-arm **54**. The rear surface of the diaphragm **59** is in communication with the intake manifold of the engine by means of a conduit **63**. The front of the case **57** is vented to the atmosphere by a vent hole **65**. With this arrangement, the plate **46** of the control valve **26** will be biased towards a closed position by a force that is proportionate to the value of the intake manifold vacuum of the engine.

The pressure dome **27** includes a ring-like element **60** which is rigidly affixed to the rear end of housing **20** by means of a plurality of bolt and nut combinations **62**. The upper end of this ring-like element **60** integrally merges into a cylinder **64**. The interior of the cylinder **64** is in communication with the rear end of the large venturi **22** by means of a vertical passage-way **66**. The upper wall **68** of the cylinder **64** is formed with an aperture **70**. This aperture **70** overlies a floating disc **72** which is normally supported by a retaining element **74** that depends from the upper closure **68**.

The discharge pipe **28** includes an elbow **76** having its front end rigidly connected to the rear end of the ring-like element **60** of the pressure dome **27** by the bolt and nut combinations **62**. The midportion of the elbow **76** is formed with a seat **78** for the spark plug **32**. The rear end of the elbow **76** is bolted to the upper end of a downwardly and rearwardly extending tail pipe **80** by means of bolt and nut combinations **82**. A venturi **84** is formed at the upper portion of the tail pipe **80** slightly below the latter's connection to the elbow **76**, as shown in FIGURE 4. A plurality of circumferentially spaced ports **86** are formed in the tail pipe **80** adjacent the venturi **84**.

Referring to FIGURE 4, the main flame holder **29** is of frusto-conical configuration and it is formed with a plurality of apertures **88**. The flame holder **29** is rigidly retained within the rear end portion of the large venturi **22**. The auxiliary flame holder **30** is similar in construction to the main flame holder **29** but of smaller dimensions.

The air intake manifold **31** is shown in detail in FIGURE 4. It includes a duct **90** which concentrically encompasses the tail pipe **80**, extending downwardly along its length for some distance. The upper end of this duct **90** is in communication with the throat **92** of the venturi **84** by means of the ports **86** formed in the tail pipe **80**. The upper portion of the duct is connected to a forwardly extending tube **94** which underlies the housing **20**. This tube **94** is formed with a pair of bores **96** and **98**. The front bore **98** is in communication with the throat **44** of the small venturi **24** while the rear bore **96** is in communication with the throat **102** of the large venturi **22**. The front end of the tube **94** is rigidly secured to the underside of the housing **20** by means of a valve housing **104**. The latter includes a vertically extending passageway **106** that forms a continuation of the front bore **98**. A butterfly valve **108** disposed within this passage-way **106** is manually adjustable to control the amount of air passing therethrough. The rear portion of the valve housing **104** mounts a threaded fitting **110** which is attached to a length of tubing **112**. The opposite end of the tubing **112** is in communication with the crank case of the engine E for a purpose to be set forth hereinafter. The upper

portion of the valve housing **104** includes a cylindrical cavity **114**. The latter cavity **114** encompasses an externally threaded bushing **116** that extends upwardly through an aperture **118** in the underside of housing **20** into a bore **120** formed in the lower portion of the guide member **38**.

A second valve housing **122** similar to valve housing **104** is interposed between the midportion of the tube **94** and the underside of the housing **20**. This second valve housing **122** includes a vertically extending passageway **124** which forms an upward continuation of the rear bore **96**. A second butterfly type control valve **126** is mounted in this passage-way. This valve **126** is also manually adjustable so as to control the amount of air flowing through the passageway. The upper portion of this valve housing **122** defines a cylindrical cavity **128** wherein is disposed a second upwardly extending bushing **130** having its upper end threadably received within a bore **132** formed in the lower portion of the large venturi **22**. This second bushing extends through an aperture **134** formed in the underside of the housing **20** in line with aperture **118**.

In the operation of the apparatus shown in FIGURES 1 through 5, exhaust gases formed by the engine E will pass from the exhaust manifold M through the front of the housing **20** at **40**. Assuming that the engine is operating at idling speed the force of the exhaust gases entering the front portion of the guide member **38** will not be of sufficient magnitude to affect the opening of the control valve **26**. Accordingly, these exhaust gases will enter the throat **44** of the smaller venturi **24** by means of the transverse passageway **42**. The flow of the exhaust gases through the throat of the venturi **24** will serve to aspirate fresh air into the throat through the air intake manifold **31**, such fresh air entering this manifold through the open lower end (not shown) of the tube **90**. It should be observed that the incoming fresh air entering through the lower end of the tube **94** will pass upwardly and forwardly over the external surface of the tailpipe **80** in heat-transfer relationship thereto. Accordingly, this fresh air will enter the throat of the venturi **24** in a heated condition. The mixture of fresh air and exhaust gases will undergo burning within the venturi structure. It should be noted that the gases leaving the rear end of the small venturi **24** will also aspirate a certain amount of fresh air through the rear valve housing **122**.

As the rotational speed of the engine increases, the pressure of the exhaust gases entering the front of the housing **20** to **40** will increase to such a magnitude that the plate **46** of the control valve **26** will be forced open, as indicated by its dotted outline in FIGURE 5. The exhaust gases will then pass through the front of the guide member **38** into the throat **102** of the large venturi **24**. The passage of these gases through the throat of the large venturi will aspirate air through the air intake manifold **31**, such air passing upwardly through the valve housing **122**. The mixture of fresh air and exhaust gases will pass rearwardly and undergo burning adjacent the main flame holder **29**. It has been determined that such burning will normally take place at the point within the rear portion of the large venturi at which the velocity of the expanding gases equals the velocity of the gases entering the front end or sinking chamber of the venturi. This will generally be the point at which the diameter of the diffuser end portion of the venturi equals the diameter of the front end of the venturi. It has been found to be advisable to locate the main flame holder **29** at this point.

Such burning is assured by the positioning of spark plug **32** adjacent this point. The spark plug may be energized by means of an ignition coil (not shown) which is caused to spark during each power stroke of the engine's pistons. The pressure dome **27** under normal operating conditions will furnish additional fresh air to the rear end of the large venturi through its aperture **70**.

Should the force of the exhaust gases momentarily increase, the floating disc **72** will be urged upwardly so as to seal the aperture **70**. In this manner the pressure dome serves as a pressure dampener whereby the gases will flow smoothly through the apparatus despite pressure fluctuations thereof. If such flow were not comparatively smooth the flame existing within the rear portion of the large venturi could be extinguished. The existence of this pressure dome at the rear portion of the large venturi also prevents backfiring within the system.

The venturi **84** formed at the upper portion of the tailpipe **80** serves to aspirate heated fresh air into the upper end of the tailpipe. The introduction of heated fresh air at this point serves to complete any burning of the unburned products of combustion exhausted from the engine within the upper end of the tailpipe. It is desirable that no burning take place below this point. The venturi **84** likewise assists in preventing backfiring in the system. It should be noted that the tubing **112** which interconnects the crank case of the engine E with the valve housing **104** serves to scavenge oil vapors from the crank case. During deceleration of the engine E the restrictive effort of the gases flowing through the throat **44** of the small venturi **24** pressurizes these combustion chambers so as to diminish the vacuum created therein while the carburetor is operating in a closed throttle position. Accordingly, the tendency of the combustion chambers to suck oil upwardly from the crank case during deceleration will be minimized.

It should be particularly observed with reference to FIGURE 4 that the incoming exhaust gases flowing through the housing 20 towards the front end 34 of the latter are in heat transfer relationship with the external walls of the venturi 22. These external walls are heated to a temperature in excess of the exhaust gas temperature by the aforedescribed burning of the mixture of fresh air and exhaust gases adjacent the flame holder 29. Accordingly, the incoming exhaust gases will be raised in temperature as they flow through the housing 20. This is important to the operation of the afterburner apparatus since it increases the burning efficiency thereof during the comparatively short time available for effecting such burning as the exhaust gases pass through the afterburner. In prior afterburners the incoming exhaust gases flow directly to the burning chamber without being preheated in this manner.

When the diaphragm type control unit **56a** shown in FIGURE 3a is utilized, during cruising speed a certain amount of exhaust gas may flow through the small venturi **24** so as to cause the latter to aspirate heated air into its confines. This is true because as the intake manifold pressure decreases the diaphragm **59** will permit the cross-arm **54** to pivot the control valve **26** towards a closed position.

Referring now to FIGURE 6 there is shown another type of control valve **26a** which may be utilized with the aforedescribed apparatus. This alternate form of control valve is housed within a modified form of guide member **119**. The front wall **121** of the latter is formed with a beveled valve seat **123** for use with a poppet valve **125**. The front end of the stem **125a** of the poppet valve **125** is slidably disposed within a bore **127** formed in a guide element **129** which forms a front closure for the housing **20a**. A metallic bellows **131** is interposed between the rear surface of the front wall **133** of the guide element **129** and an annular plate **133a** which is rigidly secured to the mid-portion of the poppet valve stem **126**. A second smaller metallic bellows **135** is interposed between the poppet valve stem **125a** and a wall **135a** formed forwardly of the guide member's front wall **121**. This second bellows **135** serves to seal the chamber **136** between the guide element **129** and the wall **135a** from exhaust gases entering the housing **20a** at point **40a** from the exhaust manifold of the engine E, the rear portion of the valve stem **125a** passing through a bore **138** formed in the wall **135a**. The interior of the chamber **136** is vented to the atmosphere at **140**. The front end of the annular plate **133a** is in communication with the intake manifold vacuum of the engine E by means of a threaded fitting **142** and a length of tubing **144**.

The modified form of control valve **26a** is adapted to operate under the influence of the pressure differential between the exhaust and the intake manifolds of the engine E. At idling, the frontal area of the poppet valve **125** is exposed to the exhaust pressure entering the housing at the point **40a** through bores **146**. The interior of the bellows **131** is concurrently exposed to the pressure existing within the intake manifold of the engine E. Thus, in a typical example the exhaust pressure may be assumed as being two pounds while the intake manifold vacuum may be assumed as being ten pounds. Inasmuch as the frontal area of the poppet valve **125** and the frontal area of the annular plate **133a** are approximately equal the poppet valve would be urged forwardly to its position of FIGURE 6 so as to be seated within the valve seat **123**. Accordingly, all of the exhaust gases entering the housing **20a** at the point **40a** would enter the throat of the small venturi **24** through the transverse passage-way **146**. If the rotational speed of the engine is then increased,, the intake manifold pressure will decrease while the pressure of the exhaust gases will increase. Accordingly, the poppet valve **125** will be urged rearwardly away from the valve seat **123** into an open position and exhaust gases entering the housing **20a** at the point **40a** will flow through the passage-way **148** formed in the guide member **119** to the front of the large venturi **22**.

Referring now to FIGURE 7 there is shown an alternate type of flame holder **29b** which may be used with the aforedescribed apparatus. This flame holder **29b** is adapted to replace that shown in FIGURE 4. It includes a disc **150** formed with a plurality of apertures **152**. Each of these apertures has a frusto-conical configuration and the sum of their areas should approximate the area of the front end of the large venturi **22**. The disk **150** is supported off-center by a horizontal pivot pin **154**. The pivot pin **154** is journaled by the elbow **76** and it is keyed at one side to a cross-arm **156**. The free end of the cross-arm **156** is pivotally secured to the rear end of a rod **157**. The rod **157** is axially slidably mounted within a cylindrical dashpot member **158**. This member **158** includes a piston **160** secured to the front of the rod **157** and a helical compression spring **162** interposed between the left side of the piston and the rear end wall of the dashpot cylinder **16**. With this arrangement, during idling conditions the disc **150** will remain in its solid line position of FIGURE 7. When the rotational speed of the engine is increased, the velocity of the exhaust gases will likewise increase and the disc **150** will be pivoted towards its open position indicated by dotted lines in this figure. The point at which the burning of the gases flowing through the apparatus takes place may then move rearwardly. The dashpot **158** serves to prevent flutter of the disc **150**. The sum of the areas of the apertures **152** should approximate the area of the front end of the large venturi **22**.

Referring now to FIGURE 8, there is shown yet another type of control valve **26c** which may be utilized with the aforedescribed apparatus. This control valve **26c** is similar to that shown in FIGURE 6 in that its poppet valve **161** is adapted to operate under the influence of the differential between the intake manifold pressure of the engine and the exhaust manifold pressure. To this end, a modified guide member **163** is provided having a wall **164** formed with a valve seat **166**. The housing **20c** mounts a front closure **168** which cooperates with the front end of this housing in defining a cylindrical chamber **170**. A guide element **172** interposed between the housing **20c** and the front closure **168** includes an annular plate **174** and an integral boss **176**. The latter is formed with a bore **178** that supports the stem **180** of

the poppet valve **161** for axial sliding movement. A first metallic bellows **182** is interposed between the front end of the valve stem **180** and the front of the plate **174**, while a second similar bellows **184** is interposed between the rear of the plate **174** and an annular heat deflector **186**. The latter is rigidly affixed to the rear portion of the valve stem **180** and is slidable within the housing **20c**. The interior of the front bellows **182** is in communication with the intake manifold of the engine E through a passage **188**, a threaded fitting **190** and a length of tubing **192**. The interior of the rear bellows **184** is connected to the atmosphere by a vent passage **194**. The annular spacing surrounding the front bellows **182** is connected to the atmosphere by a vent hole **196**. The annular space surrounding the rear bellows **184** is connected to the exhaust pressure by virtue of the loose fit of the heat deflector **186** with the walls of the housing **20c**.

Under idling conditions of the engine E, the comparatively high intake manifold pressure will cause the poppet valve **161** to be urged rearwardly against the valve seat **166**. All the exhaust gases will then flow through the passage-way **195** into the throat of the small venturi **24**. As the rotational speed of the engine increases the increased pressure of the exhaust gases entering the front of the housing **20c** at **40c** through bores **197** will urge the heat deflector **186** forwardly so as to unseat the valve **161**. The exhaust gases will then be free to flow through the passage-way **198** into the front of the large venturi **22**. It should be noted that flutter of the poppet valve **161** is prevented by the provision of the rear bellows **184**, the balancing of the exhaust gas pressures against the atmospheric pressure serving to approximate a more constant pressure control.

Referring now to FIGURE 9, there is shown alternate means for effecting the ignition of the gases flowing through the apparatus in place of the spark plug **32**. This means includes a streamlined holder **200** formed with apertures **202** and rigidly supported within the rear portion of the large venturi **22d** by fingers **204**. This holder **200** is filled with a suitable gauze **206** which will serve as a catalyst in the presence of the hydrocarbons flowing through the apparatus for effecting the oxidation thereof. In practice, a platinum gauze has been found suitable. The holder **200** will also serve as a flame holder for preventing the burning of the exhaust gases too far rearwardly of the large venturi **22d**.

The apparatus of FIGURE 9 provides most complete consumption of the unburned products of combustion of the internal combustion engine E. In this regard, it is known that the oxides of nitrogen are not removed in a flame-type burning chamber. In practice it has been found where air is introduced rearwardly of the catalyst through the aperture 70 of the pressure dome 27 the oxides of nitrogen will be effectively removed from the effluent flowing out of the burning chamber. Additionally, with this arrangement more complete removal of the hydrocarbons can be effected.

Referring now to FIGURE 10, there is shown a special one-way valve **220** for preventing inadvertent reverse flow into the fresh air manifold **31**. This one-way valve **220** may be mounted at the upper end of both of the valve housings **104** and **122**. It includes a disc **222** which is constantly biased downwardly by a helical compression spring **224** against the upper end of the vertical passage-way **106e**. This disc **222** will be unseated upwardly under the influence of the fresh air aspirated through the tube **94** by the venturi **24**. With this arrangement, reverse flow of the exhaust gases downwardly into the tube **94** or into the engine's crankcase through tubing **112** will be prevented.

It should be particularly observed that the aforedescribed apparatus when utilized in conjunction with the engine of an automotive vehicle reduces the sound level of the exhaust gases to such an extent that the conventional muffler may be eliminated. This apparatus also permits the exhaust gas impulses to be tuned so as to provide a reduction of turbulent flow and thereby aid engine efficiency. It should additionally be noted that the entire apparatus may freely contract and expand during temperature changes without damage.

Various modifications and changes may be made with respect to the aforedescribed detailed description without departing from the spirit of the invention or the scope of the following claims.

I claim:

[1. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine, comprising: a first venturi having communication with said exhaust manifold; a second venturi having communication with said exhaust manifold; means connecting said venturis with the atmosphere; and, means for directing the effluence of said exhaust manifold solely through said second venturi during idling and deceleration of said engine and dividedly through both of said venturis during other operating conditions of said engine.]

[2. Apparatus as set forth in claim 1 where said first venturi is larger than said second venturi.]

[3. Apparatus as set forth in claim 1 which includes ignition means disposed in the path of said effluence.]

4. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine, comprising: a first venturi having communication with said exhaust manifold; a second venturi disposed within said first venturi and having communication with said exhaust manifold; control valve means for directing the effluence of said exhaust manifold solely through said second venturi during idling and deceleration of said engine and dividedly through both of said venturis during other operating conditions of said engine; an air-intake manifold connecting the throats of said venturis with the atmosphere; and ignition means disposed adjacent the rear portion of said first venturi.

5. Apparatus as set forth in claim 4 where flame-holding means are located in the rear portion of said venturis.

6. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine, comprising: a housing connected at its front end to said exhaust manifold; a first venturi formed in said housing; a second smaller venturi formed in said housing; normally-closed control valve means in said housing that during idling and deceleration of said engine admits all of the effluence of said exhause manifold into said second venturi; means for opening said control valve means during other operating conditions of said engine whereby part of said effluence will pass through said first venturi; and, an air-intake manifold connecting the throats of said venturis with the atmosphere whereby air will be drawn thereinto in quantities that are proportional to the quantity of said effluence concurrently passing therethrough.

7. Apparatus as set forth in claim 6 where said housing contains ignition means disposed in the path of said effluence.

8. Apparatus as set forth in claim 6 where said control valve means is constantly biased towards a closed position and is moved towards an open position under the influence of the exhaust gases issuing through said exhaust manifold.

9. Apparatus as set forth in claim 6 where said control valve is urged towards a closed position under the influence of the intake manifold pressure of said engine and towards an open position under the influence of the exhaust manifold pressure thereof.

10. Apparatus as set forth in claim 6 where the rear portion of said venturi is in communication with a pressure dampening chamber.

11. Apparatus as set forth in claim 6 where flame

holding means are disposed within the rear portion of said first venturi at the point where the velocity of gases passing therethrough equals the velocity of gases entering the front end thereof.

12. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine, comprising: a housing connected at its front end to said exhaust manifold; a first venturi formed in said housing; a second smaller venturi formed in said housing; normally-closed control valve means in said housing that during idling and deceleration of said engine admits all of the effluence of said exhaust manifold into said second venturi, said control valve means opening during other operating conditions of said engine permitting part of said effluence to pass through said first venturi; a tail pipe forming a continuation of the rear end of said housing; a duct encompassing said tail pipe and having communication therewith by means of ports, said duct being open to the atmosphere; venturi means formed within said tail pipe adjacent said ports; an air-intake manifold connecting said duct with the throats of said venturis whereby during operation of said engine heated air will be drawn thereinto in quantities that are proportional to the quantity of said effluence concurrently passing therethrough.

13. Apparatus as set forth in claim 12 where said air-intake manifold is in communication with the crankcase of said engine.

14. Apparatus as set forth in claim 12 where said control valve means is constantly biased towards a closed position and is moved towards an open position under the influence of the exhaust gases issuing through said exhaust manifold.

15. Apparatus as set forth in claim 12 where said control valve is urged towards a closed position under the influence of the intake manifold pressure of said engine and towards an open position under the influence of the exhaust manifold pressure thereof.

16. Apparatus as set forth in claim 12 where flame holding means are disposed within the rear portion of said first venturi at the point where the velocity of gases passing therethrough equals the velocity of gases entering the front end thereof.

17. Apparatus as set forth in claim 12 where a flame holder is mounted adjacent the rear end of said first venturi, said flame holder including an apertured disc disposed in the path of the gases issuing through said first venturi and normally biased towards a closed position, said disc moving towards an open position when the rotational speed of said engine exceeds a predetermined value.

18. Apparatus as set forth in claim 12 where the rear portion of said first venturi is in communication with a pressure dampening chamber.

19. Apparatus as set forth in claim 18 where flame holding means are disposed within the rear portion of said first venturi at the point where the velocity of gases passing therethrough equals the velocity of gases entering the front end thereof, said pressure dampening chamber being located rearwardly of said flame holding means, and a spark plug is disposed rearwardly of said pressure dampening chamber.

[20. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine, comprising: first venturi means having communication with said exhaust manifold; second venturi means having communication with said exhaust manifold; means connecting said venturi means with the atmosphere; and means for directing the effluence of said exhaust manifold either dividedly through both of said venturi means or alternately through solely said second venturi means depending upon the pressure of said effluence.]

[21. Apparatus as set forth in claim 20 where said first venturi means is larger than said second venturi means.]

22. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine into a discharge pipe, comprising: a housing interposed between said exhaust manifold and said discharge pipe so as to transfer the effluence from said exhaust pipe to said discharge pipe for subsequent release into the atmosphere, said housing being formed with a burning chamber through which said effluence passes; ignition means disposed in said burning chamber; first air supply means operatively connected with said housing to direct air into said burning chamber; second air supply means operatively connected with said housing to direct air into said burning chamber; and control means operatively connected to said first and second air supply means and responsive to the load condition of said engine to automatically actuate said first air supply means to admit the major proportion of air to said burning chamber during engine operations other than idling and deceleration, said control means automatically actuating said second air supply means to admit the major proportion of air to said burning chamber during idling and deceleration of said engine.

23. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine into a discharge pipe, comprising: a housing interposed between said exhaust manifold and said discharge pipe so as to transfer the effluence from said exhaust pipe to said discharge pipe for subsequent release into the atmosphere, said housing being formed with a burning chamber through which said effluence passes; ignition means disposed in said burnng chamber; first air supply means operatively connected with said housing to direct air into said burning chamber; second air supply means operatively connected with said housing to direct air into said burning chamber; and control means operatively connected to said first and second air supply means and responsive to the pressure of said effluence to automatically actuate said first air supply means to admit the major proportion of air to said burning chamber when the pressure of said effluence exceeds a predetermined value, said control means automatically actuating said second air supply means to admit the major proportion of air to said burning chamber when the pressure of said effluence falls below said predetermined value.

24. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine into a discharge pipe, comprising: a housing that receives said unburned products of combustion; a flame type burning chamber in said housing that initially receives said products of combustion; passage means connecting said burning chamber with the atmosphere to provide the fresh air required to effect burning of said products of combustion within said burning chamber; a catalyst disposed in said housing in the path of the effluent flowing out of said burning chamber; and second passage means operatively connected with said housing and connecting said housing directly with the atmosphere on the side of said catalyst downstream of said catalyst so as to introduce additional fresh air at this point.

25. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine into a discharge pipe, comprising a housing that receives said unburned products of combustion; wall means disposed within said housing and defining a flame type burning chamber; means connecting the interior of said housing with said burning chamber whereby said unburned products of combustion received by said housing will flow through said housing in heat-transfer relationship with said wall means before entering said burning chamber; passage means connecting said burning chamber with the atmosphere to provide the fresh air required to effect burning of said products of combustion within said burning chamber; a catalyst

disposed in said housing in the path of the effluent flowing out of said burning chamber; and second passage means operatively connected with said housing and connecting said housing directly with the atmosphere on the side of said catalyst downstream of said catalyst so as to introduce additional fresh air at this point.

26. Apparatus for consuming the unburned products of combustion issuing from the exhaust manifold of an internal combustion engine into a discharge pipe, comprising: a housing that receives said unburned products of combustion; wall means disposed within said housing and defining a flame type burning chamber; means connecting the interior of said housing with said burning chamber whereby said unburned products of combustion received by said housing will flow through said housing in heat-transfer relationship with said wall means before entering said burning chamber; passage means connecting said burning chamber with the atmosphere to provide the fresh air required to effect burning of said products of combustion within said burning chamber; and second passage means operatively connected with said housing and connecting said housing directly with the atmosphere downstream of said burning chamber so as to introduce additional fresh air downstream of said burning chamber.

References Cited in the file of this patent or the original patent

UNITED STATES PATENTS

1,468,895	Allen	Sept. 25, 1923
1,605,484	Thompson et al.	Nov. 2, 1926
1,789,812	Frazer	Jan. 20, 1931
1,848,990	Boyd et al.	Mar. 8, 1932
1,875,024	Kryzanowsky	Aug. 30, 1932
2,065,681	Fogas	Dec. 29, 1936
2,308,059	Decker	Jan. 12, 1943
2,679,724	Pomykala	June 1, 1954

FOREIGN PATENTS

631,736	France	Sept. 20, 1927
60,247	Netherlands	Nov. 15, 1947