Nov. 28, 1967 V. GUARNASCHELLI 3,354,635

MEANS FOR BURNING THE EXHAUST GASES OF INTERNAL COMBUSTION ENGINES

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FIG. 1.

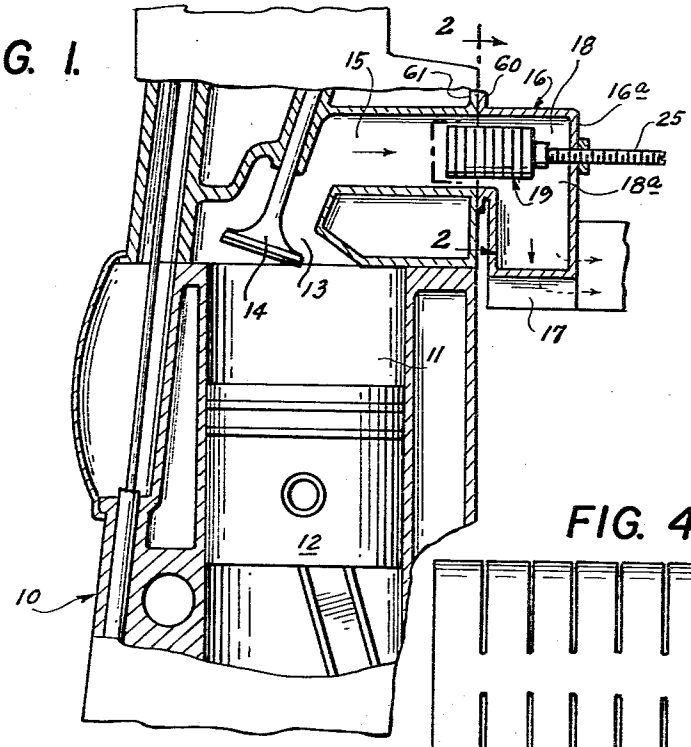
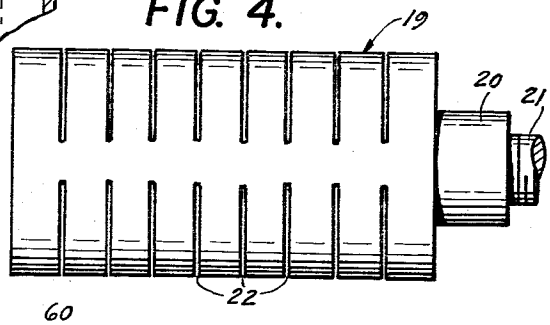


FIG. 4.



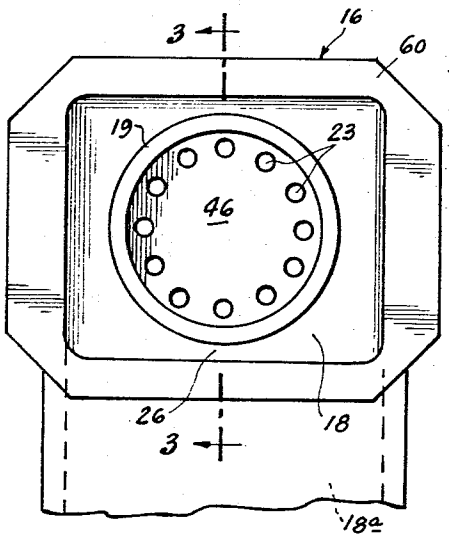


FIG. 2.

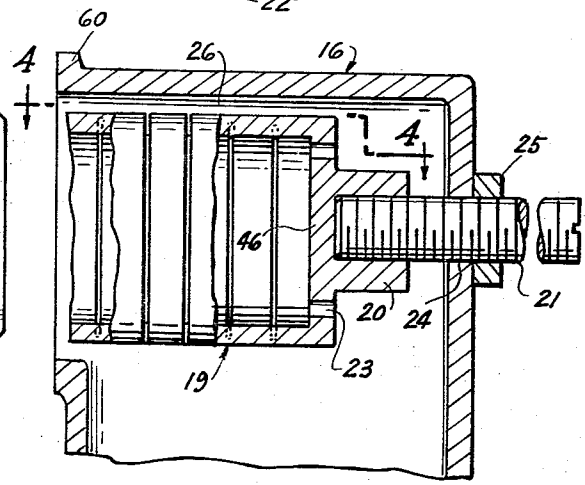


FIG. 3.

INVENTOR.
VINCENT GUARNASCHELLI
BY J. Lederman
ATTORNEY

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MEANS FOR BURNING THE EXHAUST GASES OF INTERNAL COMBUSTION ENGINES

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FIG. 5.

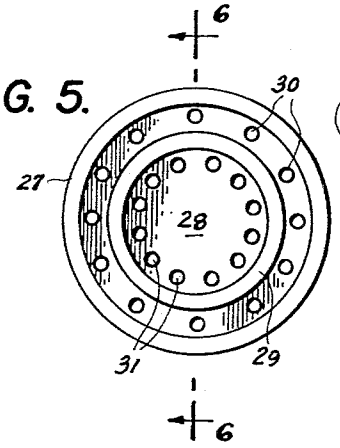


FIG. 6.

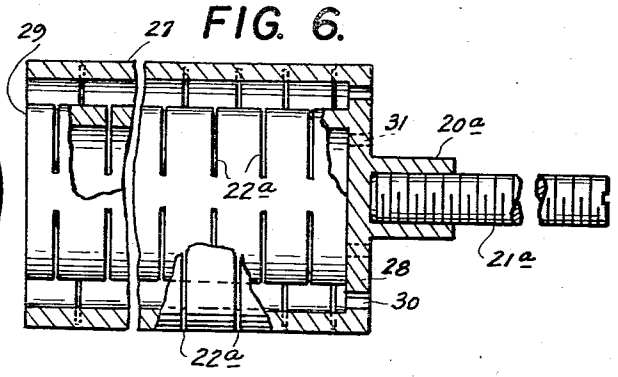


FIG. 9.

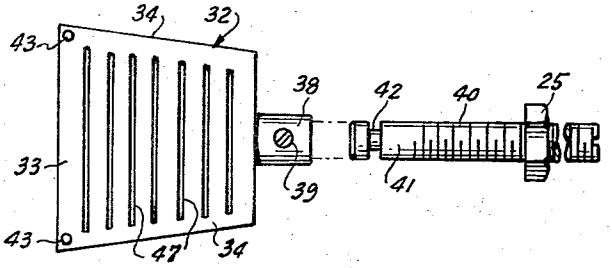
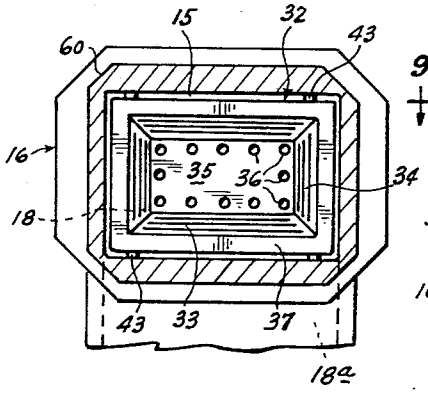


FIG. 8.



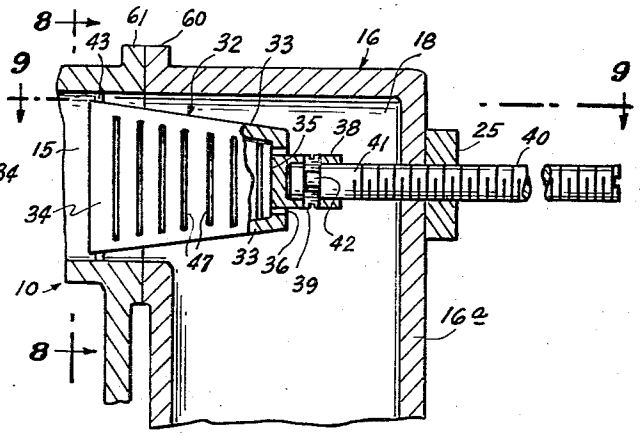


FIG. 7.

INVENTOR.
VINCENT GUARNASCHELLI

BY J. Ledermann

ATTORNEY

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MEANS FOR BURNING THE EXHAUST GASES OF INTERNAL COMBUSTION ENGINES

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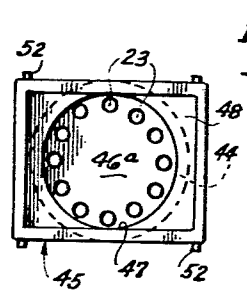

FIG. 11.

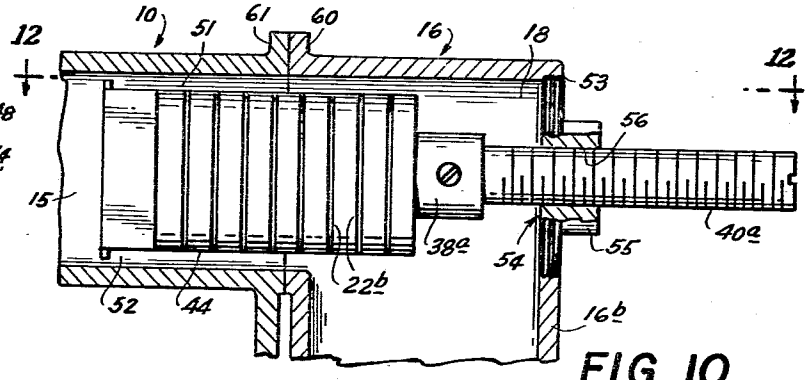

FIG. 10.

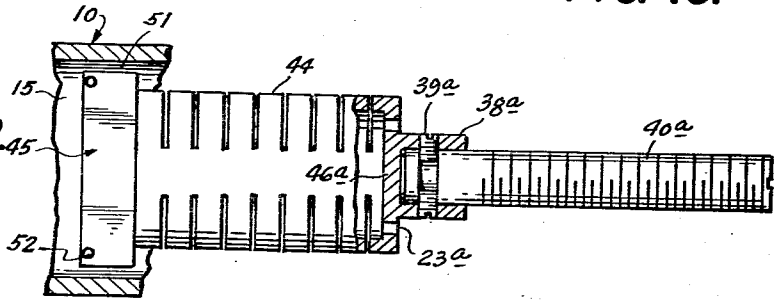

FIG. 12.

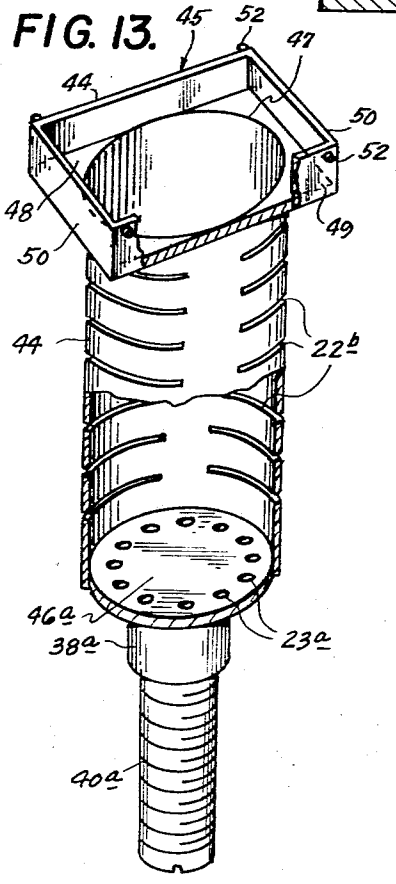

FIG. 13.

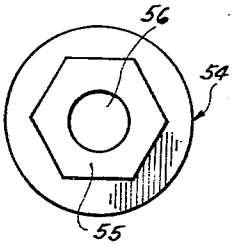

FIG. 14.

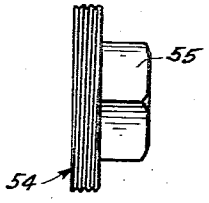

FIG. 15.

INVENTOR.
VINCENT GUARNASCHELLI
BY J. Ledermann
ATTORNEY

United States Patent Office 3,354,635 Patented Nov. 28, 1967

3,354,635

MEANS FOR BURNING THE EXHAUST GASES OF INTERNAL COMBUSTION ENGINES

Vincent Guarnaschelli, Greenlawn, N.Y., assignor, by mesne assignments, to Mutual Industries, Inc., Worcester, Mass., a corporation of Massachusetts

Filed Apr. 6, 1966, Ser. No. 540,614
18 Claims. (Cl. 60—29)

This invention relates to means or devices for burning the exhaust gases of internal combustion engines and aims to provide new and improved means for efficient combustion of the normally incompletely burned exhaust gases which are generally lumped together in the term "hydrocarbons."

Numerous unsuccessful attempts to solve the problem of removing pollutant hydrocarbons from engine exhausts have been made in the past, which need not be discussed here. The present invention presents a new approach to the problem.

The temperature of the exhaust discharged by a cylinder is at its highest at a position immediately adjacent the exhaust valve and, as is well known, the exhaust discharged upon opening the valve is accompanied by the flames of the burning fuel mixture. In other words, the exhaust is discharged past the open valve in a flaming condition. For an efficient and practically, if not wholly, complete combustion of the hydrocarbons, a finite though brief interval of time delay is advantageous to complete the burning. Such an interval is provided in four cycle and two cycle engines between the shutting off of the exhaust valve and its next opening. However, where the passage for the exhaust gases is continuous and unobstructed, as is usually the case, for a substantial distance from the valve, such interval is not made use of. For as the hot gases pass on into the exhaust manifold and beyond, they are rapidly cooled below any possible combustion temperature; in fact, the temperature of the exhaust manifold in even a mild winter climate does not rise much above 600 degrees F. In order to further burn the discharged exhaust it is therefore advisable to provide a retarding obstruction close to the exhaust valve, which will not only be heated by the flaming exhaust to a very high combustion temperature but will also slow down the average rate of flow of the gases into the manifold and thereby take advantage of the above-mentioned interval to give the gases time for further combustion.

Another object of the present invention is therefore to provide an insert supported in the exhaust manifold union which connects the manifold with the motor block and extending into the exhaust chamber of the motor block, that is, the chamber in the motor block into which the exhaust valve opens. Such insert is made of any suitable material, for example, metal, metal alloys, a combination of metals, or a plated metal such as chrome plated copper, that is, such as are capable of withstanding very high temperatures up to, say, 1800 degrees F. or higher. Such materials of high heat conductivity and high resistance to corrosion by burning are available on the market or readily manufactured.

Still another object of the invention is the provision of such an insert having adjustable means for varying the position or degree of penetration of the insert into the said exhaust chamber.

A further object of the invention is the provision of means whereby the said insert may be readily installed or removed for examination or replacement without having to detach the exhaust manifold.

The above as well as additional objects will be clarified in the following description wherein reference numerals refer to like-numbered parts in the accompanying drawing. It is to be noted that the drawing is intended primarily

for the purpose of illustration and that it is therefore neither desired nor intended to limit the invention necessarily to any or all of the details shown or described except insofar as they may be deemed essential to the invention.

Referring briefly to the drawing, FIG. 1 is fragmentary elevational view of an internal combustion engine, with parts broken away and partly in section, showing a cylinder, its exhaust valve and exhaust chamber, the union leading from the said exhaust chamber to the exhaust manifold conduit, and showing in side view one form of the insert mounted in position.

FIG. 2 is an enlarged sectional view taken on the line 2—2 of FIG. 1.

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 2, with parts broken away.

FIG. 4 is a fragmentary view taken on the line 4—4 of FIG. 3.

FIG. 5 is a front end view of a modified form of insert, per se.

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 5, with parts broken away.

FIG. 7 is a view similar to FIG. 1 but showing another modified form of insert.

FIG. 8 is a sectional view taken on the line 8—8 of FIG. 7.

FIG. 9 is an exploded view as seen on the line 9—9, of the insert per se of FIGS. 7 and 8.

FIG. 10 is an enlarged view similar to FIG. 1 but showing a still further modified form of insert as well as a modified construction of the wall of the union in which the insert is supported.

FIG. 11 is a front view of the insert per se of FIG. 10.

FIG. 12 is a view as seen looking along the line 12—12 of FIG. 10, of the insert per se, with parts broken away and partly in section.

FIG. 13 is a perspective view, with parts broken away and partly in section, of the insert per se of FIGS. 10–12.

FIG. 14 is a plan view of a plug for removably mounting the insert of FIGS. 10–13.

FIG. 15 is a side view of the plug of FIG. 14.

Referring in detail to the drawing, the numeral 10 indicates the motor block of an internal combustion engine, showing a cylinder 11, its piston 12, and its exhaust valve 14 in open position. The cylinder upon opening of the valve discharges flaming exhaust into the exhaust chamber 15. Coupled to the chamber 15 is the usual union 16 leading downward into the exhaust manifold conduit 17 which is common to all the cylinders of the engine, or on one side of the engine. The union provides a substantially inverted-L-shaped path or passage; the upper portion of this passage which is shown at 18 is aligned with the chamber 15 while the lower portion thereof is shown at 18a. Thus the chamber 15 and the passage portion 18 may be considered a continuous passage or a combined chamber. The union 16 is coupled to the chamber 15 by fitting its rectangular flange 60 to the complementary flange 61 on the motor block, in the well known manner, and the chamber 15 and the passage portion or chamber 18 are both substantially rectangular in cross-section.

The insert illustrated in FIGS. 1–4 is shown as an elongated hollow cylinder 19 having a reduced boss 20 extending coaxially from the base 19a which closes the rear end of the cylinder. Merely for the purposes of clarity in describing the invention in reference to the drawing, the left-hand end of the insert and its associated parts are referred to as the "front" and the right hand end as the "rear"; likewise the left-hand side of the union wall 16a may be termed the front of the wall and the right-hand side the rear thereof, while the wall itself is termed the rear wall of the union. The cylinder 19 has a

plurality of openings or passages shown as longitudinally spaced slots **22** cut through its circumferential wall. An elongated threaded stem or screw **21** is screwed into or otherwise secured in the boss **20**, coaxially with the cylinder **19**. The base **46** of the cylinder is shown having a plurality of circumferentially spaced holes **23** extending through the annual portion surrounding the boss **20**. A threaded hole **24** is drilled through the outer or rear wall **16***a* of the union, on a line coinciding with the midpoint of the chamber **15**, into which the stem **21** is threaded prior to attaching the exhaust manifold to the motor block. A lock nut **25** may be used to further fix the stem against rotation after the stem has been rotated one way or the other to advance the insert farther into chamber **15** or to retract it. Such adjustability is desirable to obtain the best pre-tested position for the insert, or to alter its position as may be found desirable at different seasons of the year. In the case of the insert **19** as well as the other inserts described below, it is of course to be understood that one such insert is to be so mounted in each cylinder exhaust of the engine. A small clearance, shown at **26** in FIGS. 2 and 3, is preferably provided between the insert **19** and the opposed walls of the combined chamber **15**, **18**, that is, the opposed upper and lower, or wider, walls of the rectangle.

In operation, the flaming exhaust exiting into the chamber **15** impinges upon and in large part enters into the cylinder **19** through the open front end thereof and passes through the slots **22** and, if the holes **23** are provided, partly through these holes. Thus, not only the heat from the exhaust gases as a whole but also and particularly the flames of the explosion act upon the insert to raise it to a very high temperature. Tests conducted with a pyrometer recording at the dashboard the temperature of the insert showed that within less than one minute after starting a cold engine in winter weather the insert reached a temperature of above 800 degrees F. while the cooling water of the engine remained substantially cold, and while driving the car the temperature of the insert rose rapidly with increasing speed to about 1600 degrees F. but the temperature of the exhaust manifold conduit did not rise above 600 degrees F. Not only does the insert become very hot very quickly, but it is also retentive of high heat so that when the motor returns to idling the insert remains very hot for a considerable time and continues to burn up a large percentage of hydrocarbons which would otherwise be expelled into the atmosphere. Moreover, the high temperature of the insert converts whatever water vapor may be present to superheated steam which also contributes to efficient combustion.

The modified form of insert shown in FIGS. 5 and 6 is similar to that shown in FIGS. 1–4 to the extent that it also comprises a cylinder **27** open at the front end and closed by a base **28** at the rear end. However, a second concentric cylinder **29** of reduced diameter is formed integral with the base **28**, and sets of circumferentially spaced holes **30**, **31** may be provided through the base within the confines of the circumferential walls of each cylinder. Parts of this modification which are equivalent or similar to parts in FIGS. 1–4 bear the same reference numeral followed by the suffix "*a*." Herein exhaust gases partly enter both cylinders and a part of those entering the inner cylinder pass through its slots into the outer cylinder and thence through the latter's slots. Thus this insert provides a greater surface area to the flaming exhaust gases.

In both of the modifications so far described, that is, that of FIGS. 1–4 and that of FIGS. 5–6, it is apparent that owing to the cylindrical conformation of the insert, a bypass of relatively substantial area is provided between the outer surface of the insert and the circumferential wall of the combined chamber **15**, **16**. However, such exhaust gases which take this bypass are themselves subjected to the intense heat of the insert since the greater

part thereof come in contact with it en route through the combined chamber.

A third and tapering form of insert is exemplified in FIGS. 7–9. Here the insert **32** which, as seen in the several views, is shown having the conformation of a frustum of a pyramid tapering in a rearward direction and provided with pairs of opposed walls **33**, **34**. The rear end is shown closed by the base **35** which may also be provided with a circumferential array of holes **36** therethrough. The dimensions of the open front end of the insert are such that there is a relatively small amount of clearance space **15***a* between the circumferential edge **37** of the mouth and the circumferential wall of the chamber **15**, **16**. Thus, when the insert is positioned, for example as shown in FIG. 8 with its mouth extending into the chamber **15**, nearly all of the exhaust gases are constrained to enter the insert. The walls of the tapering insert are also shown provided with openings, passages or slots **47** equivalent to the previously described openings **22**, through which (as well as through the holes **36** when provided) the thus constrained gases pass into the union **16**.

To permit of longitudinal movement of the insert **32**, the following improved structure is provided. A hollow or tubular boss **38** is shown extending from the base **35** and is provided with diametrically opposed threaded holes in which set screws **39** register. An elongated threaded stem **40**, otherwise similar to the stem **2**, has its forward end **41** smooth and provided with a circumferential groove **42** into which the screws **39** enter without being tightened down against the floor of the groove. Hence the stem **40** is rotatably connected to the insert. By turning the stem **40** in one direction the insert is advanced closer to the exhaust valve **14**, and turning it in the opposite direction retracts it, while the stem turns freely in the boss **38**. As before, the screw stem extends through the rear wall **16***a* of the union, and the lock nut serves its usual purpose.

In order to prevent the insert **32** from turning through a sufficient arc to contact its corners with the chamber walls, especially while the stem is being turned, at least two but preferably four projections, pins, nipples or the like **43** are provided projecting outward from opposed side walls of the insert at or close to the mouth end thereof, the length of which is merely equal to the clearance space **15***a* but sufficiently less than the latter to permit longitudinal movement of the insert without undue friction of the nipples against the chamber walls. The nipples thus maintain substantially constant the clearance space **15***a*.

Still another modification of the insert is illustrated in FIGS. 11–15. In this instance the insert is shown to include an elongated hollow member, shown as a cylinder **44** substantially identical to the cylinder **19** with its base **46***a* similar to the base **46** and having holes **23***a*, the cylinder being provided with similar openings or slots **22***b*. The boss **38***a* extending from the base **46***a*, however, is shown similar to the boss **38** of FIGS. 8 and 9. The stem or screw **40***a* is similar to the screw **40**, and other details **39***a* and **42***a* are similar to those of FIG. 9 bearing the same reference numerals without the suffix "*a*." Thus the stem **40***a* is also rotatably connected to this insert so that the latter may be moved longitudinally by turning the stem.

A feature by which the modified insert of FIGS. 11–15 differs from those previously described, is that it includes what may be termed a rectangular cup **45** rigid on the front end of the cylinder **44**. The floor **48** of the cup has a centered circular passage **47** of the same diameter as the internal diameter of the cylinder **44**. The opposed pairs of the walls of the cup are shown at **49** and **50**. The dimensions of the cup are such that there is a clearance space **51** between its walls and the walls of the chamber **15**, **18**, and this clearance is maintained, as in the case of the tapering insert **32** of FIGS. 7–9, by projections **52** extending from opposed walls of the cup.

In addition to the distinguishing feature just mentioned by which the insert of FIGS. 11–15 differs from the other modifications illustrated, a modification in the construction of the rear wall **16***b* of the union **16** is illustrated in FIGS. 10, 14 and 15. The latter modification is applicable to all of the forms of inserts discussed herein as well as other forms, not shown, and it is therefore believed unnecessary to illustrate it except in FIGS. 10, 14 and 15. In the various inserts of FIGS. 1–4, FIGS. 5–6, and FIGS. 7–10, it is obviously necessary to screw the stem into the hole **24** of the rear wall **16***a* before attaching the union to the motor block. A disadvantage of this is that to examine or replace the insert the exhaust manifold must be detached. In order to overcome this disadvantage the following means is provided, which also permits installation of the insert after the exhaust manifold has been secured to the motor block. The rear wall **16***b*, FIG. 10, is provided with a relatively large threaded hole **53** receptive of a threaded plug **54**. The plug is shown having a nut **55** integral therewith, and an axial passage **56** extends through both the nut and the plug; this passage is threaded to receive the screw **40***a*. The thus removable plug forms a part of the wall **16***b*. The diameter of the hole **53** is at least as large as the maximum transverse dimension of the insert, that is, in the case of the insert of FIGS. 10–13, the maximum transverse dimension of the cup **45** with its nipples **52**. With the screw **40***a* registering in the hole **56** of the plug prior to screwing the plug into the hole **53**, for example approximately in the relative positions shown in FIG. 10, the insert may be passed through the hole **53** with the cup entering the chamber **15**, after which the plug is registered in the hole **53**. A lock nut, not shown, may of course be screwed down upon the nut **55**, and in all the modifications discussed a washer may be interposed under the lock nut in the well known manner.

It is to be noted and it is obvious, that exhaust manifolds at present manufactured as well as those already attached to engines, can readily be altered to permit of insertion of an insert into the combined chamber **15**, **18** in the manner just described. This is done by drilling a hole such as the hole **53** in the rear wall of the union **16** and providing a plug similar or equivalent to the plug **54** to be screwed into the drilled hole.

From all of the foregoing it is obvious that the heat from the flaming exhaust in the chamber **15** is transferred to the insert, and this heat increases proportionally to the degree the insert is advanced toward the exhaust valve. By thus positioning the insert to receive the heat of the flames rather than only the cooler gases such as are present in the exhaust manifold conduit **17**, FIG. 1, or even more distant from the chamber **15**, the insert is heated to a much higher temperature than could otherwise be obtained. The substantial reduction in hydrocarbons present in the exhaust gases discharged into the atmosphere with the present invention installed as described, is obtained at all times subsequent to the very short period required to raise the insert to a high temperature, whether during idling of the engine, during driving at varying speeds, or during deceleration of the engine.

While the invention has been described with particular reference to the constructions shown in the drawing such is not to be construed as a limitation upon the invention which is best defined in the accompanying claims.

What is claimed is as follows:

1. In combination with the exhaust chamber of a cylinder in the motor block of an internal combustion engine which chamber extends outward through the block from the exhaust valve of the cylinder, and the inverted-L-shaped union which connects the common exhaust manifold conduit of the engine to the outer end of said chamber wherein said union has a rear wall spaced outward from the motor block and said union provides at the upper end thereof a passage aligned with said exhaust

chamber thereby forming together with said exhaust chamber a combined chamber, the cross-sectional area through said combined chamber being substantially rectangular, said rear wall having a hole therein aligned with the center line of said combined chamber, a high heat conducting insert having a stem extending from the rear end thereof in alignment with the center line of the insert, said insert being mounted in said combined chamber with said stem registering in said hole, and means for securing said stem in said hole.

2. A combination according to claim **1**, said means comprising screw threads in the circumferential wall of said rear wall and complementary screw threads on said stem.

3. A combination according to claim **2**, said stem having a length sufficient to extend a distance through said hole beyond the outer surface of said rear wall when said insert is positioned relatively remote from said exhaust valve whereby the insert may be moved to a position closer to said valve by turning said stem in one direction and retracted from said closer position to a position more distant from said valve.

4. A combination according to claim **3**, having means partly on said stem and partly on said rear end of said insert for rotatably connecting said stem to said insert.

5. A combination according to claim **4**, said insert having at least the front portion thereof rectangular in outline and complementary to the walls of said combined chamber but spaced substantially equidistantly from said chamber walls to provide a clearance space between said front portion of the insert and said chamber walls, and means for maintaining said clearance space substantially constant while the insert is being moved closer to or more distant from said valve.

6. A combination according to claim **2**, said rear wall of said union having a second threaded hole therein which is concentric with said first-named hole and has a diameter at least equal to the maximum transverse dimension of said insert, a threaded plug registering in said second hole thereby forming a part of said rear wall, said plug having said first-named hole therein.

7. A combination according to claim **1**, said insert comprising a hollow member open at its front end and closed at said rear end thereof, and a plurality of openings in the circumferential wall of said member.

8. A combination according to claim **7**, said stem being reduced with respect to said rear end of the insert, said member having an additional plurality of openings through said rear end thereof between said stem and said hollow member.

9. A combination according to claim **7**, said member comprising a cylinder.

10. A combination according to claim **4**, said insert comprising a hollow member tapering from a maximum transverse area at the front end thereof to a minimum transverse area at said rear end thereof and having a plurality of openings in the circumferential wall thereof.

11. A combination according to claim **1**, said insert comprising two axially spaced mutually concentric cylinders open at their front ends, said rear end of said member comprising a base common to both said cylinders, both of said cylinders having a plurality of openings in the circumferential walls thereof.

12. A combination according to claim **4**, said insert comprising an elongated hollow member closed at the rear end thereof and a rectangular cup rigid on the front end thereof, said cup including a floor and forwardly extending walls complementary to the corresponding walls of said combined chamber but spaced therefrom to provide a circumferential clearance space between said cup and said chamber walls, said floor having an opening therethrough communicating with said hollow member, said hollow member having a plurality of spaced openings in the circumferential wall thereof.

13. A combination according to claim 12, said hollow member comprising a cylinder.

14. A combination according to claim 12, said rear wall of said union having a second threaded hole therein concentric with said first-named hole and having a diameter at least equal to the maximum transverse dimension of said insert, a threaded plug registering in said second threaded hole and having said first-named hole therein, said plug being part of said rear wall of the union.

15. A combination according to claim 12, said insert having means thereon constraining the insert against rotational movement to maintain said clearance space substantially constant.

16. A combination according to claim 15, said last-named means comprising outward projections on opposed sides of said cup.

17. In combination with the exhaust chamber of a cylinder in the motor block of an internal combustion engine which chamber extends outward through the block from the exhaust valve of the cylinder, and the substantially inverted-L-shaped union which connects the common exhaust manifold conduit of the engine to the outer end of said exhaust chamber wherein said union has a rear wall spaced outward from the motor block and said union provides in the upper portion thereof a passage aligned with said exhaust chamber thereby forming a combined chamber together with said exhaust chamber, a high heat conducting insert mounted in said combined chamber in a position spaced from the circumferential walls of the combined chamber, and an adjustable support extending from said insert through an opening in said rear wall for supporting said insert in said position and for moving said insert longitudinally in said combined chamber, and means for releasably locking said support in a selected longitudinal position of said insert.

18. In combination with the exhaust chamber of a cylinder in the motor block of an internal combustion engine which chamber extends outward through the block from the exhaust valve of the cylinder, and the substantially inverted-L-shaped union which connects the common exhaust manifold conduit of the engine to the outer end of said exhaust chamber wherein said union has a rear wall spaced outward from the motor block and said union provides in the upper portion thereof a passage aligned with said exhaust chamber thereby forming together with said exhaust chamber a combined chamber, said rear wall having a relatively large threaded hole therein concentric with the longitudinal center line of said combined chamber, a threaded plug registering in said relatively large threaded hole and having a relatively small axial hole therein, a threaded stem registering in said relatively small threaded hole, an insert positioned within said combined chamber and spaced from the circumferential walls thereof at least sufficiently to be freely movable longitudinally of said combined chamber, said insert having the rear end thereof secured to the front end of said stem with the longitudinal center line of the insert aligned with the axis of the stem, said relatively large hole having a diameter at least equal to the maximum transverse dimension of said insert.

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RALPH D. BLAKESLEE, *Primary Examiner.*