

Aug. 15, 1967

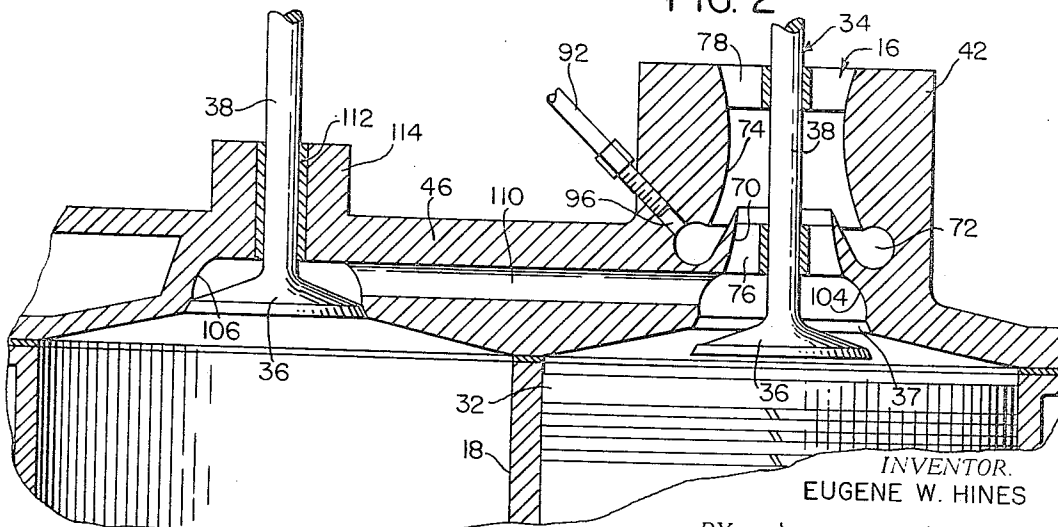
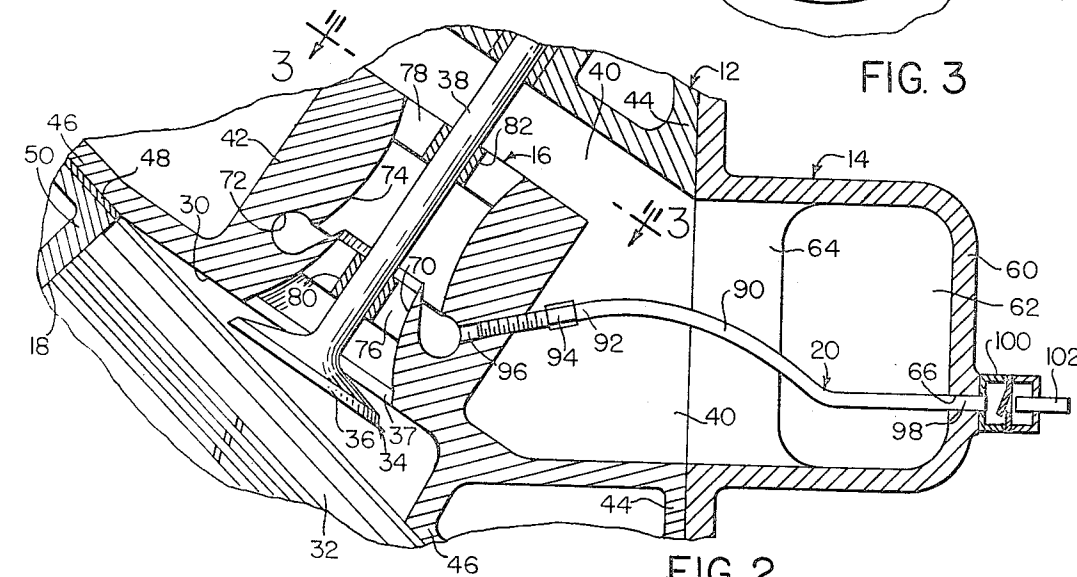
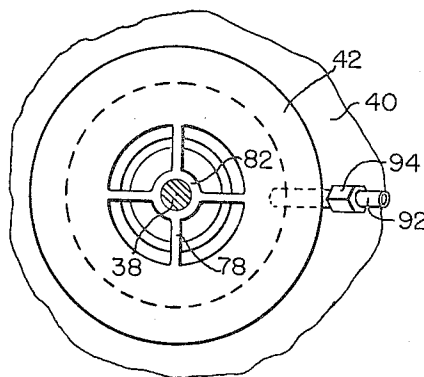
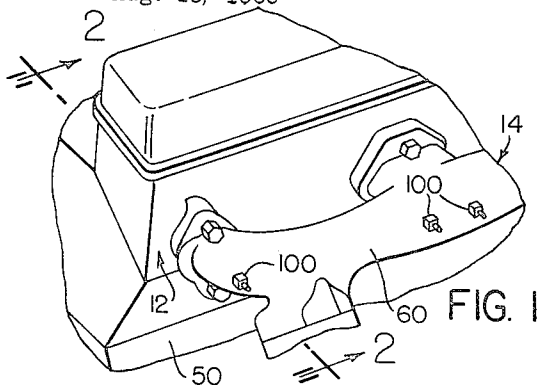
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3,335,564

CYLINDER HEAD WITH EXHAUST EDUCTOR

Filed Aug. 13, 1965

4 Sheets-Sheet 1



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CYLINDER HEAD WITH EXHAUST EDUCTOR

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4 Sheets-Sheet 2

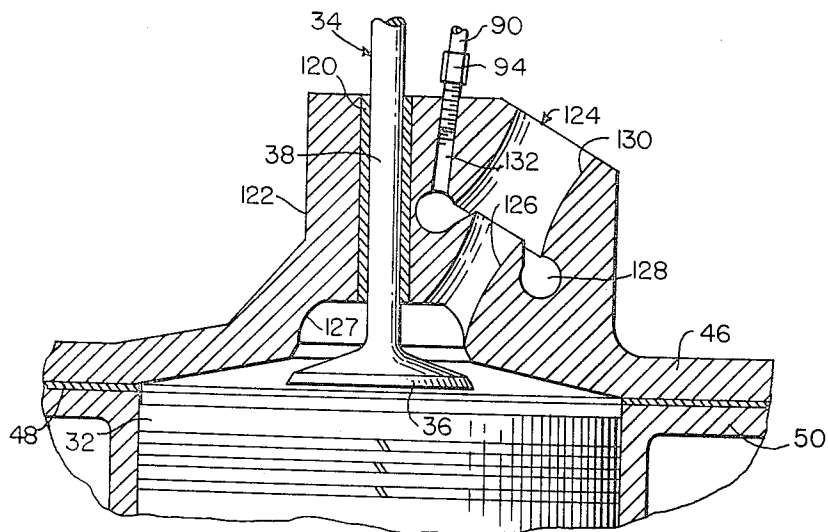


FIG. 5

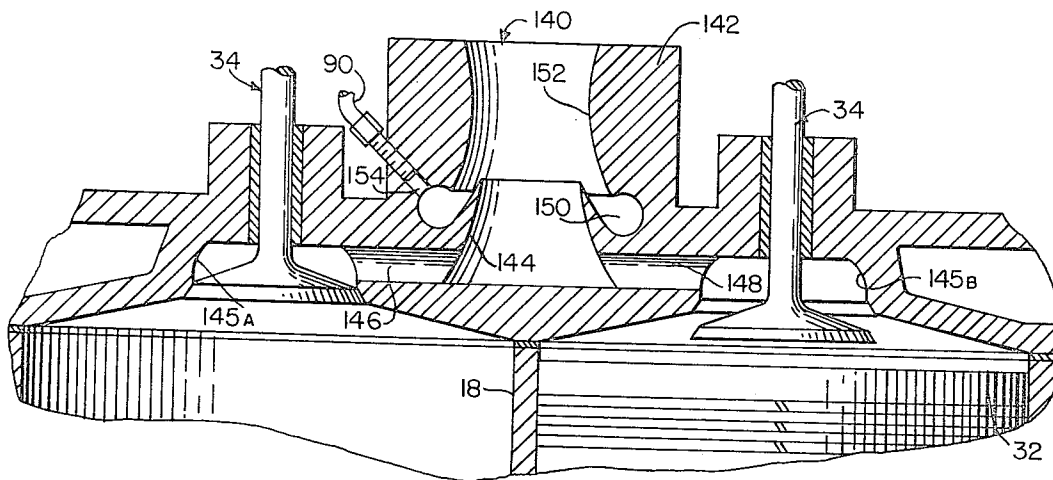


FIG. 6

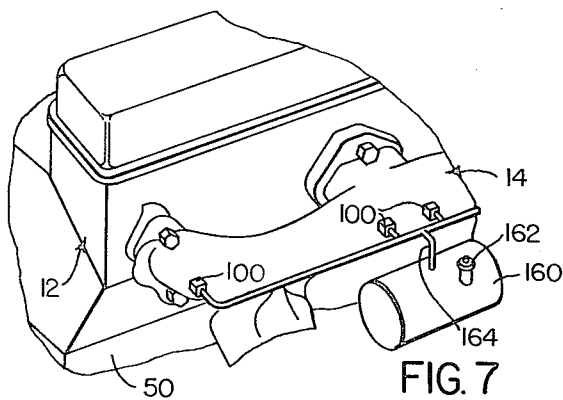


FIG. 7

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CYLINDER HEAD WITH EXHAUST EDUCTOR

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4 Sheets-Sheet 3

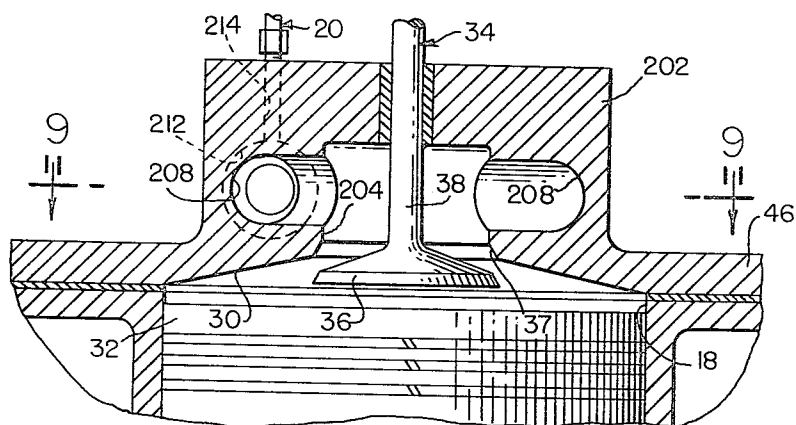


FIG. 8

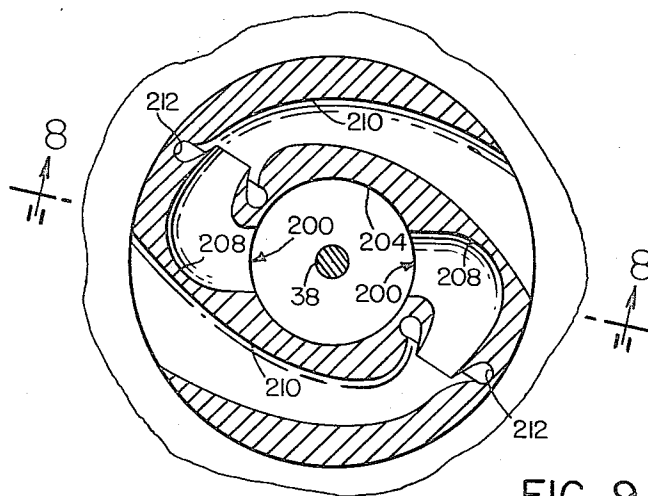


FIG. 9

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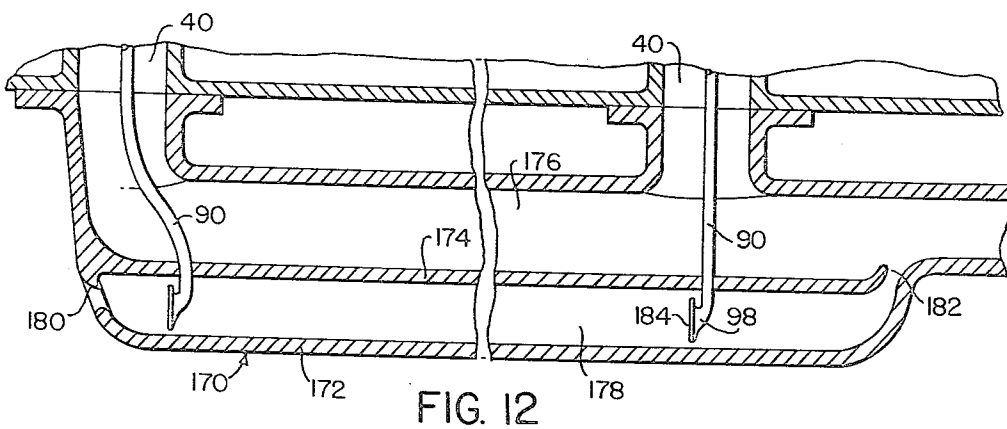
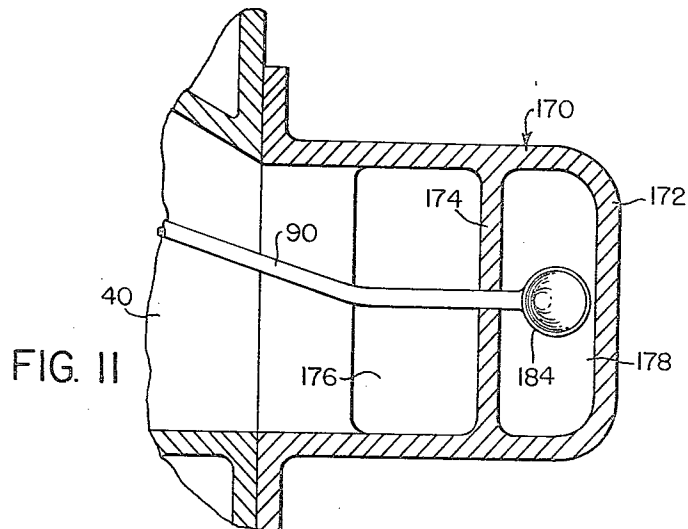
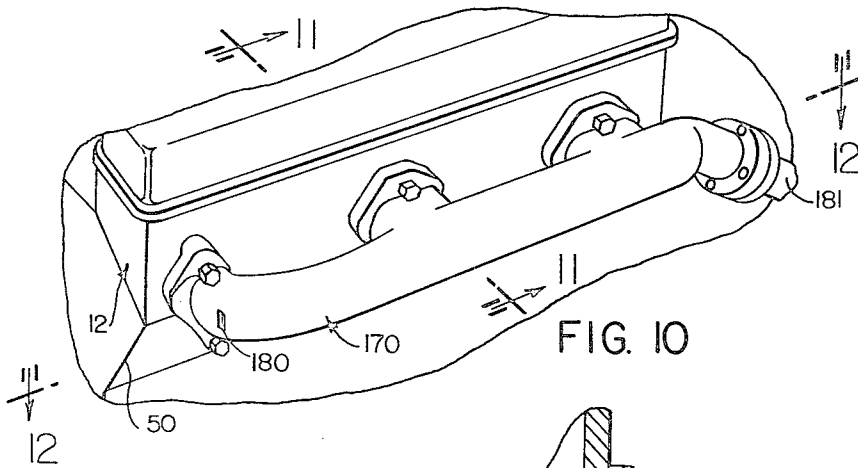
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CYLINDER HEAD WITH EXHAUST EDUCTOR

Filed Aug. 13, 1965

4 Sheets-Sheet 4



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CYLINDER HEAD WITH EXHAUST EDUCTOR
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Filed Aug. 13, 1965, Ser. No. 479,420
5 Claims. (Cl. 60—30)

This invention pertains to an engine having a venturi or eductor embodied in the cylinder head for the eduction of an oxygen-containing gas from a source of such gas into the eductor through which exhaust gases containing unburned fuel is discharged from engine cylinders to substantially complete the oxidation combustion of such fuel in the cylinder head and thus reduce to a minimum the discharge of contaminating unburned hydrocarbons.

The function of such eductor in an internal combustion engine is two-fold. First, the eductor channels the flow of exhaust gases from the exhaust valve port in the cylinder head through the head. The eductor, being designed in the form of a venturi, has an inlet portion of inwardly tapering constriction to provide a zone of increased exhaust gas pressure and reduced velocity, leading to and communicating with an outlet portion of substantially larger transverse cross-sectional area at which the exhaust gas pressure is substantially reduced and the exhaust gas velocity is substantially increased to produce a suction or negative pressure effect in the area between the inlet and the outlet portions of the eductor. In this area a passageway is provided for the admission of additional air or an oxygen-containing gas by a conduit conducting such air or gas from a point externally of the cylinder head, or conceivably from a point or an area within the cylinder head providing such air or gas, for admixing with the exhaust gases in order to complete or substantially complete the oxidation combustion of the exhaust gases discharged from the cylinder.

Under normal or usual conditions of operation, the exhaust gases discharged by the piston from a cylinder in an internal combustion engine into and through the exhaust valve port of the cylinder head are at and within the temperature range permitting of further oxidation combustion. Under such conditions, the introduction of oxygen contained in the additional air, or the introduction of a supply of oxygen or other suitable gas, initiates, supports, and/or maintains combustion of the unburned fuel in the discharged exhaust gases passing through the eductor, such air or gas supply is conducted by a conduit leading to and communicating with the eductor air passageway.

The engine block, the cylinder head and the manifold operate substantially as a closed system. A certain amount of air required for combustion of the fuel ignited in the cylinder is provided by the carburetor, but such amount of air, although excellent for admixture purposes to provide a good ignition mixture and a good firing mixture, is substantially insufficient to combust all of the fuel in the cylinder at low or moderate engine speeds. When engine speeds are about 1,500 r.p.m. or higher, it appears that the air taken in at the carburetor more efficiently combusts substantially most all of the fuel in the cylinder so that a relatively small amount of the exhaust gases contain the undesired unburned hydrocarbons producing smoke and other deleterious discharge from the exhaust system of the engine. But at moderate or low speeds this is not true, and therefore a quantity of air in addition to that provided by the carburetor is required for more efficient combustion of the unburned fuel leaving the cylinder at the exhaust valve. Since this added air cannot be injected directly into the cylinder, it must be provided closely adjacent thereto after discharge of the exhaust

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gases from the cylinder, the exhaust valve area of the head being the preferred location for such after burning, since the unburned fuel in these gases is at its highest temperature in such area.

As will be later more specifically described, the air supply may be drawn from within or without the cylinder head or the gas supply furnishing the oxygen required to support or maintain combustion in the exhaust gases can be obtained from a chamber of such gas, metered or unmetered. One example of a gas containing a substantial amount of oxygen is hydrazine. Other oxygen-enriched gases may also possibly be used in connection with the invention herein disclosed.

The afterburning oxygen supply, which for purposes of simplicity will be denoted as "air," such term including ordinary atmospheric oxygen-containing gases, is drawn into the eductor from an area relatively cooler than the temperatures present in the exhaust chamber. Air can be taken from within or without the cylinder head or the manifold when suitably constructed to provide air that is relatively dry and therefore tends to ignite and combust the unburned fuel in the exhaust gases with relative ease.

If the air is taken from within the exhaust manifold or cylinder head, it will generally be at a higher temperature than if taken from without the manifold or cylinder head, and such heated air will function more efficiently in the eductor than would cooler air taken from without the manifold or cylinder head.

Because the air supply conduit leads to a point in the eductor where reduced pressure is generated by through-flow of the exhaust gases, the air supply for afterburning can be provided at atmospheric pressure and without the aid of a pump. A single eductor embodied in the cylinder head wall and communicating with the exhaust valve recess in such wall reduces the number of component parts required, the complexity of an afterburning system, and the cost of effecting more efficient combustion of the unburned fuel issuing from the engine cylinders, whose exhaust gases, now more fully consumed, are discharged from the exhaust end of the engine in a state of substantially reduced hydrocarbon contamination.

In a modification of the inventive construction, the cyclical system of firing multiple cylinders of an internal combustion engine can be utilized to permit one eductor to serve more than one cylinder by providing a passageway or conduit from the adjacent cylinder or cylinders to the eductor and arranging the firing order of these cylinders in such a manner that when the exhaust valve of one cylinder is open the exhaust valve(s) of the adjacent cylinder(s) are closed, and when one of the latter is open the former are closed, thereby placing the one eductor in substantially continuous functional operation.

It is an object of the invention to provide an internal combustion engine having an afterburning structure to effect a substantially complete and more efficient combustion of unburned fuel in the exhaust gases issuing from an engine cylinder or cylinders. Another object is to provide an eductor in the cylinder head for afterburning such unburned fuel. A further object is to provide an eductor in the cylinder head for afterburning such unburned fuel in the exhaust gases discharged from two or more cylinders. Still another object is to furnish oxygen-containing air or gas for the eductor from a position externally or alternatively internally of the exhaust manifold or cylinder head, and from the atmosphere or alternatively from a container of such oxygen-containing gas.

Yet a further object is to provide such eductor(s) at a position or positions in the cylinder head for combustion of unburned fuel in the exhaust gases when at relatively

high temperatures so as to effect further and continued oxidation combustion of such unburned fuel in the exhaust chambers of the cylinder head. A further object is to provide induction of oxygen-containing air or gas to the eductor at a position utilizing the partial vacuum created upon flow of exhaust gases through the eductor, so as to generate a reduced pressure or partial vacuum in the air supply conduit, thereby eliminating the need for an air or gas supply pump. Still another object is to provide a cylinder head and exhaust manifold combination for an internal combustion engine embodying an afterburning construction which is simple, effective and efficient, and which can be manufactured at relatively low cost.

These and other objects of the invention and features of construction will become more clearly apparent from the description given below, in which the terms employed are used for purposes of description and not of limitation. Reference is made to the drawing annexed hereto and made an integral part of this specification, in which

FIGURE 1 is a perspective view of a corner of an internal combustion engine structure embodying the invention.

FIGURE 2 is a vertical transverse sectional view taken substantially on the line 2—2 of FIGURE 1.

FIGURE 3 is a somewhat horizontal view taken substantially on the line 3—3 of FIGURE 2.

FIGURE 4 is a vertical sectional view similar to FIGURE 2, but taken longitudinally of the cylinder head shown in FIGURE 1 and showing a modification of the embodiment illustrated in FIGURES 1—3.

FIGURE 5 is a view similar to that shown in FIGURE 2, illustrating another modification of the invention.

FIGURE 6 is a view similar to that shown in FIGURE 4, illustrating another modification of the invention.

FIGURE 7 is a perspective view illustrating a modification of the additional oxygen-containing gas supply in the form of a closed container.

FIGURE 8 is a vertical transverse sectional view similar to that shown in FIGURE 2 illustrating another modification of the invention, and taken substantially on the line 8—8 of FIGURE 9.

FIGURE 9 is a horizontal sectional view taken substantially on the line 9—9 of FIGURE 8.

FIGURE 10 is a fragmentary perspective view illustrating a modified exhaust manifold having an air intake port furnishing the air supply for the eductor(s).

FIGURE 11 is a vertical transverse sectional view taken substantially on the line 11—11 of FIGURE 10.

FIGURE 12 is a horizontal longitudinal sectional view taken substantially on the line 12—12 of FIGURE 10.

As shown in the several views of the drawings, and particularly in FIGURES 1, 2 and 3, the afterburner combustion structure 10 comprises a cylinder head 12, an exhaust manifold 14, an eductor 16 serving at least one engine cylinder 18, and an oxygen-containing air conduit 20 communicating with the eductor.

The cylinder head 12 is provided with spaced exhaust recesses 30 in register with engine block cylinders 18 containing pistons 32, exhaust valve 34 each having a valve head 36 adapted to close the valve at a valve seat 37 and an integral valve stem 38, an exhaust gas chamber 40 and an eductor boss 42 in the chamber for each valve 34 (as shown in FIGURE 2). The cylinder head is further provided with a manifold mounting wall 44, an engine block wall 46 adapted to seat upon a gasket 48 secured between the engine block 50 and the cylinder head, and the eductor 16 disposed in the boss 42 substantially concentrically about the valve stem 38 (as shown in FIGURE 2.)

The exhaust manifold 14 (FIGURES 1 and 2) is provided with an outer wall 60, a passageway 62 extending longitudinally of the manifold and communicating with manifold chambers 64 in register and commu-

nicating with exhaust chambers 40 of the cylinder head. The exhaust manifold 14 is mounted in conventional manner upon the cylinder head 12. In straight line engines, wherein the engine cylinders are aligned and parallel, a single exhaust manifold is generally used, but in V-design engines an exhaust manifold is used for each bank of cylinders and oftentimes a connecting tube or conduit is arranged between the exhaust manifolds for discharge of exhaust gases from a single exhaust pipe or conduit to the atmosphere.

In the embodiment of the invention illustrated in FIGURES 1, 2 and 3 the exhaust manifold 14 is provided with an opening 66 receiving the conduit 20 for passage from the exterior of the manifold transversely through the manifold to the eductor 16.

The eductor 16 is in effect a modified venturi having an inlet portion 70 with entry and discharge ends just downstream of the valve recess 30, an air passageway 72 adjacent and in communication with the discharge end of the inlet portion and an outlet portion 74 with entry and discharge ends, somewhat larger in transverse cross-sectional area than the inlet portion 70, and in communication with both the inlet portion and the air passageway 72. As shown particularly in FIGURES 3 and 4, the eductor is concentric with the valve stem 38 and is further provided with ribbed members 76 and 78 integrally formed respectively in the inlet portion 70 and outlet portion 74 and providing bearings 80, 82 for the valve stem.

The conduit 20 comprises an air or gas supply tube 90 which has its outlet end 92 secured to the eductor boss 42 by threaded fitting 94 and is in communication with the passage 96 leading into air passageway 72. The inlet end 98 of the tube is provided with a one-way reed valve 100 and an inlet tube 102 of generally conventional construction and which can be mounted upon or secured to the manifold wall 60 in any suitable manner.

A modification of the structure 10 is illustrated in FIGURE 4, in which the eductor 16 is in communication both with the valve port 104 upstream of its inlet portion 70 and ribbed member 76 and with the exhaust valve port 106 of an adjacent cylinder by way of a conduit or passageway 110 connecting both valve ports. The exhaust valve stem 38 of the adjacent cylinder is slidably disposed in a bearing 112 secured in a boss 114. As shown in FIGURE 4, the left valve 34 is closed while right valve 34 is open to accept the charge of exhaust gases driven through the eductor 16 by the piston 32. By arranging the firing cycle of the cylinders in predetermined sequence, the left valve 34 will open when the right valve 34 is closed and a substantially continuous flow of exhaust gases will pass through the single eductor 16 from both valve ports 104 and 106.

Another modification of the inventive structure is illustrated in the embodiment shown in FIGURE 5 in which the exhaust valve 34 has its stem 38 slidably mounted in bearing 120 secured in the boss 122, and an eductor 124 offset with respect to the valve 34 has an inlet portion 126 in communication with valve port 127, an air passageway 128 adjacent and in communication with the inlet portion, and an outlet portion 130 somewhat larger in transverse cross-sectional area than the inlet portion 126 and in communication with both the inlet portion 126 and the air passageway 128. An air or gas conduit 90 is secured to the boss 122 by its threaded fitting 94, as before, in passage 132 leading to the air passageway 128.

A further modification is that illustrated in FIGURE 6, in which the eductor 140 is disposed in a boss 142 of the cylinder head and has its inlet portion 144 in communication with adjacent valve ports 145a and 145b by way of conduits or passages 146 and 148 respectively. The eductor 140 is provided, as before, with a communicating inlet portion 144, an air passageway 150 and an outlet portion 152, air passage 154 leading from conduit 90 to air passageway 150. Although only two valves 34 and cylinders 18 are illustrated, it will be understood that

three, four or more valves and cylinders can be accommodated by the eductor 140 upon a suitable arrangement of conduits leading from respective valve ports to the inlet portion 144. The firing cycle of the cylinders can be so arranged that a sequential or simultaneous opening of exhaust valves will be accommodated by the eductor.

Although the additional supply of oxygen-containing gas can be provided by air externally of the manifold, as described above and illustrated in FIGURES 1 and 2, other suitable oxygen-containing gases stored in a chamber can also be utilized. FIGURE 7 illustrates an arrangement in which a storage chamber 160 containing such oxygen-containing gas is mounted upon the engine structure at the manifold for communication with conduits 90 to conduct such gas to the eductors as required. The chamber 160 is provided with a capped inlet 162 for admission of the gas and with a conduit 164 for communication with the conduits 90 leading to the eductors. The conduit 164 may be valved or metered as desired or required.

Still a further modification of the invention can be made, as illustrated in FIGURES 8 and 9. In this embodiment, one or more eductors 200 are disposed in boss 202 integrally formed on the cylinder head wall 46. The eductor 200 is in communication with the valve recess 30 by a well 204 disposed behind the valve seat 37 into which the exhaust gases are charged by the piston 32.

The eductor 200 comprises an inlet portion 208 communicating with the well 204 and tapering in a constricting manner to its discharge end and communicating with the entry end of an outlet portion 210 terminating at one side of the boss 202. The transverse cross-sectional area of the outlet portion 210 is substantially larger than that of the inlet portion 208 in order to effect the reduced pressure or partial vacuum at the air passageway 212 which is disposed in communication with the inlet portion 208 and the outlet portion 210 and is served by conduit 20 through a communicating passage 214.

In some instances, it may be desirable to use heated air in the eductors. FIGURES 8, 9 and 10 illustrate a manifold construction whereby additional air for the eductors can be heated in the exhaust manifold. The manifold 170 is provided with an outer wall 172 and an intermediate wall 174 defining an inner exhaust gas passageway 176 and an outer air supply chamber 178 extending from the forward end of the manifold to a point adjacent the rearward end of the manifold but spaced therefrom. In the outer wall 172 of the air supply chamber 178, an air inlet port or slot 180 is provided for admission of external atmospheric air into the chamber 178. Exhaust gases from the eductor(s) are discharged through the passageway 176 to the exhaust pipe 181 and in their flow past the manifold orifice 182, defined by the walls 172 and 174 at the rearward end of the manifold, a reduced pressure or partial vacuum is established in the chamber 178 causing air to be sucked into the chamber through port 180.

The conduit(s) 90 are provided with air scoops 184 at their inlet ends 98 which terminate in the air supply chamber 178. Upon operation of the engine, the discharged exhaust gases heat the cylinder head 12 and the manifold 170, whereby the incoming air is heated by radiation and convection in the air supply chamber 178 to provide air for the eductors at relatively elevated temperatures.

In operation, each of the eductors 16, 124, 140 and 200 perform in substantially the same way. Exhaust gases of burning gasoline or other hydrocarbon fuels, containing some portion of unburned fuel resulting from relatively inefficient engine combustion, are discharged to the exhaust valve entry areas by the ejecting movement of pistons 32 in cylinders 18. The exhaust gases, upon opening of the valves 34, are forced into the inlet portion of the eductor where they are relatively constricted to a state of slightly increased pressure and reduced velocity. As the gases pass out of the constricted inlet portion into

and through the larger outlet portion of the eductor, they sweep past the air passageway communicating with the air or gas supply conduit 90 and generate a reduced pressure in such air passageway to effect a suction of oxygen-containing air or gas into the eductor. Upon admixing of such air or gas with the unburned fuel of the exhaust gases, which is then at very high temperatures in the oxidation combustion range of the fuel, substantially complete combustion is effected in the outlet portion of the eductor and/or in the exhaust chamber 40 of the cylinder head.

Since cyclical firing can be arranged in many and various series or sequences for multiple cylinders of an internal combustion engine, the use of one eductor for more than a single cylinder appears to be feasible, practical and advantageous. However, it is considered desirable to locate the eductor(s) at positions relatively close to the exhaust valve entry areas inasmuch as the temperature gradient of the exhaust gases drops off sharply upon leaving the valve opening at the valve seat.

To assist in reducing excessive exhaust gas pressures in the eductor, the inlet area should preferably be substantially equal to the exhaust gas inlet opening area at the valve seat 37. Although a slight restriction of exhaust gas flow into and through the eductor inlet portion will be advantageous in maintaining the gases at temperatures within the combustible range, the dimensional specifications and the configuration of the inlet and outlet portions of the eductor should be predicated upon the determinable physical and thermal characteristics of the exhaust gases taken with the surrounding metal portions of the cylinder head.

Although the eductor 140 is described as formed in the cylinder head boss 142 as an integral part of such head, such eductor can also conceivably be fabricated as a separate member that can be secured directly to the cylinder wall and in communication with the passages or conduits leading to the valve entry areas of the cylinder head, in any suitable manner within the skill of persons knowledgeable in the art to which the invention pertains.

Having described the invention in its simplest terms, it is to be understood that the features of construction may be changed and varied in greater or lesser degree without departing from the essence of the invention defined in the appended claims.

I claim:

1. In an internal combustion engine having a cylinder block and a cylinder head for said block,

said cylinder head having exhaust gas ports and valves in register with and to open and close said ports, an eductor through a wall of said cylinder head downstream of and in communication with an exhaust gas port and offset from the valve for said port, said eductor conducting exhaust gases discharged from one or more cylinders of said engine to an exhaust gas discharge area having a volumetric capacity within the perimeter of said cylinder head substantially greater than the volumetric capacity of said eductor,

said eductor having

an inlet portion and an outlet portion in communication with each other,

said inlet portion comprising an inlet end, an outlet end and a communicating passage therebetween, the cross-sectional area of said inlet end being greater than the cross-sectional area of said outlet end of said inlet portion,

said outlet portion having an inlet end, an outlet end and a communicating passage therebetween, the cross-sectional area of said inlet end of said outlet portion being greater than the cross-sectional area of said outlet end of said inlet portion, said outlet end of said inlet portion lying fully within said outlet portion,

and a fluid passageway in communication with said

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inlet portion and said outlet portion disposed intermediate the inlet and outlet ends of said inlet portion and closely adjacent but rearwardly of the outlet end of said inlet portion, and a conduit conducting oxygen-containing fluid to said eductor passageway, whereby said oxygen-containing fluid drawn into said outlet portion of said eductor adjacent the outlet end of said inlet portion intermixes with said exhaust gases as they pass through said eductor to said exhaust gas discharge area.

2. The internal combustion engine of claim 1 wherein the eductor inlet portion is symmetrical about a central axis, said central axis is inclined with respect to the valve port, and the oxygen contained fluid constitutes air.

3. The internal combustion engine of claim 1 wherein the exhaust gas port is disposed concentrically about a portion of the stem of the exhaust gas valve and the eductor inlet and outlet portions are arranged in a plane which extends normally to the exhaust valve axis and generally spirally thereabout.

4. In an internal combustion engine having a cylinder block and a cylinder head for said block, said cylinder head having at least two exhaust gas ports and a valve in each port, each port communicating with a cylinder in said block, an eductor in said cylinder head disposed laterally offset from and in communication with said ports and in a plane substantially transverse to the stem of said valves,

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said eductor conducting exhaust gases discharged from said cylinders of said engine to an exhaust gas discharge area having a volumetric capacity within the perimeter of said cylinder head substantially greater than the volumetric capacity of said eductor, and a conduit conducting oxygen-containing fluid to said eductor passageway,

whereby said oxygen-containing fluid intermixes with said exhaust gases as they pass through said eductor to said exhaust gas discharge area.

5. The internal combustion engine of claim 4 wherein the eductor is disposed equidistantly from two exhaust gas ports.

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