

Jan. 20, 1942.

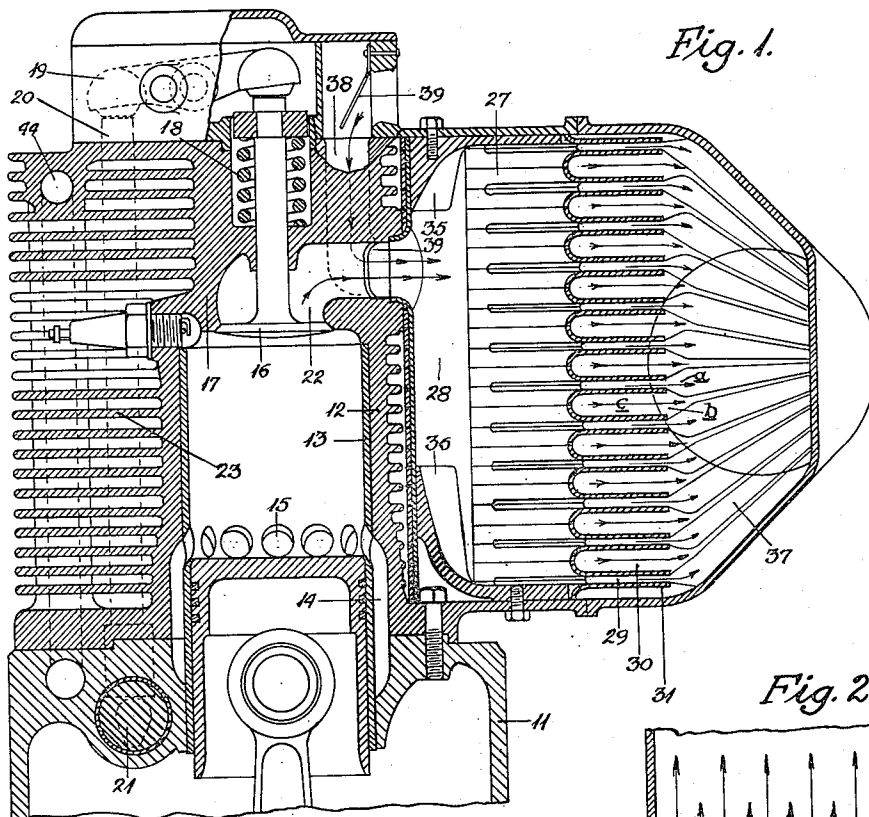
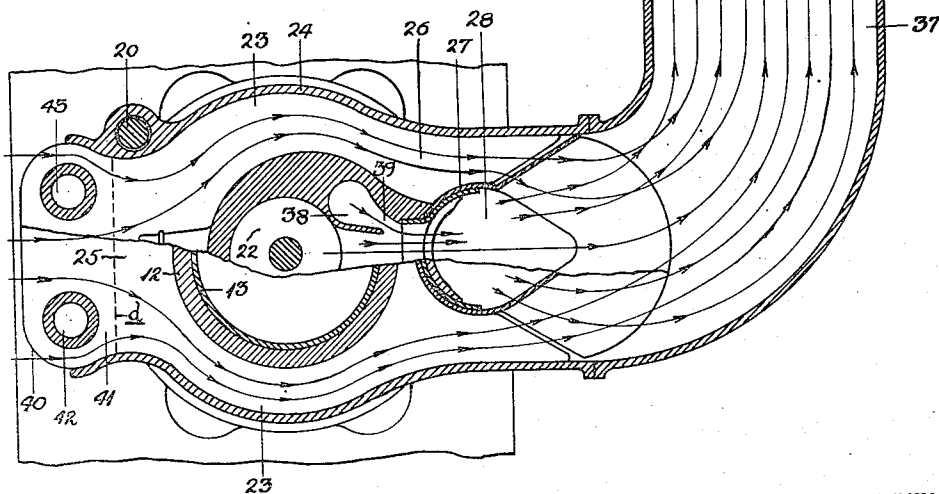
A. H. NEULAND

2,270,546

EJECTOR DEVICE

Filed Jan. 22, 1940

2 Sheets-Sheet 1



INVENTOR.

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Fig. 3.

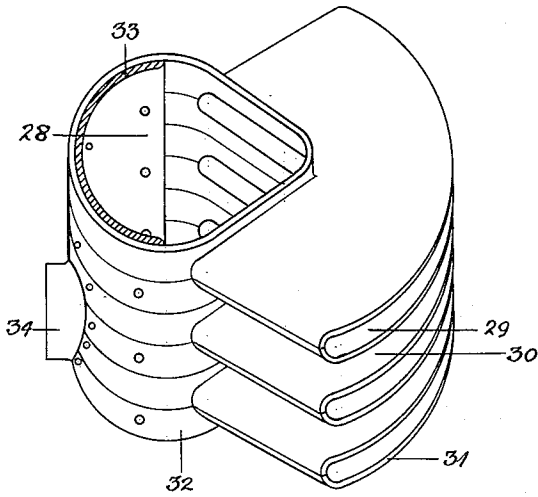


Fig. 4.

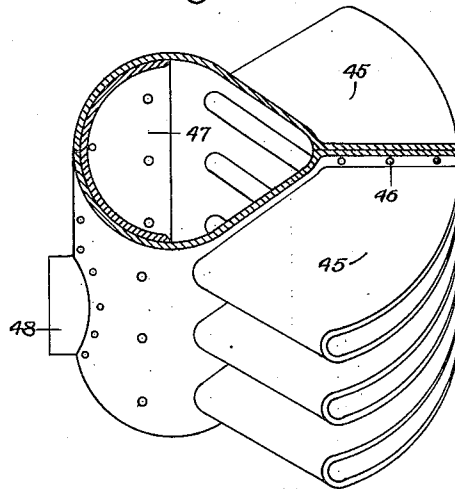
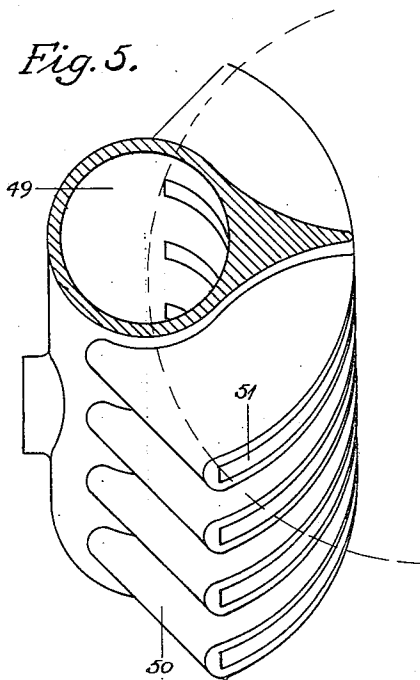


Fig. 5.



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UNITED STATES PATENT OFFICE

2,270,546

EJECTOR DEVICE

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Application January 22, 1940, Serial No. 314,977

4 Claims. (Cl. 230—95)

This invention relates to systems for cooling internal combustion engines with a stream of cooling air in which the cooling air is drawn through the engine cooling chamber or jacket by the engine exhaust gas. The present application is in part a continuation of my copending application Serial No. 181,086 which has matured into Patent No. 2,209,996.

In arrangements that have heretofore been proposed, for instance in French Patent No. 382,005 and United States Patent No. 1,025,251, the impelling effect is secured by concentrating the cooling air or exhaust gas within a constricted passage and expelling the other through the passage by means of a conduit or pipe arranged centrally within the passage for the purpose of bringing the exhaust gas and cooling air into intimate contact with each other. However with such an arrangement the vacuum developed in the cooling air conduit and the impelling effect between gas and air is small as the exhaust gas forms eddy currents between nozzle and passage which interfere with the flow of the cooling air. This condition and the resistance of the constricted passage limit the volume of air through the system and render such an arrangement deficient for use with high power engines.

The object of my invention is to overcome the deficiencies of former systems and for this purpose I provide a novel construction and cooperation between elements for coupling the exhaust gas with the cooling air which greatly reduces the formation of eddy currents, forms a strong vacuum in the engine cooling chamber and a powerful impelling effect, permits the use of a relatively large passage for the cooling air and results in a substantial increase in the flow of cooling air through the system.

The foregoing and other objects and advantages of my invention will appear in the following description and from the drawings showing a preferred embodiment of my invention and will hereafter be more fully defined in the appended claims.

Figure 1 is a partial cross section through an engine embodying my invention.

Figure 2 is a transverse section, partly through the cylinder and partly through the exhaust chamber of the engine.

Figure 3 is one species of ejector construction.

Figure 4 is another species of ejector construction, and

Figure 5 is still another species of ejector construction.

Referring to the illustrated embodiment of my

invention and particularly to Figures 1 and 2, the numeral 11 designates a fragment of an engine casing with which a cylinder body 12 is associated. The cylinder 12 may be provided with a liner 13 forming the intake duct 14 for charging the cylinder through the ports 15 with a combustible mixture, or with air, in case the engine is operated with compression ignition, from any suitable source not shown. An exhaust valve 16 is provided, preferably within the cylinder head 17, is held closed by the spring 18 and opened by means of the rocker arm 19 and push rod 20, by rotation of the cam shaft 21 connected to the crank shaft of the engine in any well-known manner, not shown. The valve 16, when open, admits the exhaust gas into the exhaust gas chamber 22.

With the arrangement above described, the body of the engine cylinder 12 may be cast from aluminum in one piece to include the valve housing and exhaust chamber and may be provided with cooling fins 23 distributed along its entire length and thereby provide effective cooling for the exhaust chamber as well as the cylinder. I further provide a jacket 24 forming an air chamber around the cylinder body and fins, and a conduit for the cooling air stream having a plurality of intake openings 25 on one side of the cylinder and a plurality of outlet openings 26 on the other side of the cylinder connecting with the conduit 37 through an impeller conduit which will hereafter also be identified as the joint conduit.

Arranged within the joint conduit I provide an exhaust ejector 27 which will hereafter also be referred to as an impeller for the air stream. The impeller consists of a distributing chamber or exhaust gas conduit 28 and a series of narrow exhaust gas nozzles 29 extending therefrom edge-wise into the cooling air stream across the interior of the joint conduit as shown in Fig. 2. The nozzles are arranged flatwise side by side and spaced to form a series of air ducts 30 alternating with the intermediate nozzles 29. For use in engines of substantial size, I prefer to construct the ejector as shown in Figures 1 and 2 and shown in greater detail in Figure 3 from thin sheet metal plates 31 of suitable shape having one portion of their edges bent in one direction to form closures for the sides of the nozzles, and having another portion of their edges bent in the opposite direction to form the conduit portion 32. The plates 31 may be identical, but reversed one with respect to the other so that each pair of plates forms a nozzle and a corresponding portion of the con-

duit 32. The ejector is made up of as many pairs of plates or nozzles as the outlet opening of the air conduit will accommodate. The assembly is joined together in some suitable manner as by welding, or hard soldering, adjoining edges and may be reenforced by a strip of metal 33 provided with a nipple 34 which serves to connect the distributing chamber with the engine exhaust chamber 22. The ejector is held in place by the plugs 35, 36 secured to the air conduit 24 by screws and shaped to direct the exhaust gas stream into the nozzles. The ejector is thus readily installable and can be easily removed for inspection or replacement.

From Figures 1 and 2 it will be seen that when the valve 16 opens, the exhaust gas escapes through the exhaust chamber 22 into the distributing chamber 28 and through the narrow nozzles into the mixing chamber or exit conduit 37. The nozzles form the exhaust gas into a series of thin parallel or flatwise associated streams and distribute the streams of exhaust gas throughout the joint passage. Emerging from the nozzles the streams spread until adjacent streams substantially meet and bridge the spaces intermediate the nozzles and tend to establish a vacuum in the air ducts 30 and thereby draw a stream of air through the cooling air chamber. The ejector divides the air stream into a series of thin streams and causes both flat sides of the air streams to be acted on by the exhaust streams. This arrangement enables me to secure a substantially uniformly distributed pressure in, and a uniform velocity through the section of exit conduit 37, a long line of contact between the exhaust gas and air streams with but moderate relative velocity between adjoining layers, to transfer a considerable amount of kinetic energy therebetween and thereby to vigorously impel the air stream with the exhaust gas. Because of the flatwise alternating relationship between the gas and air streams and the cooperative association of the ejector with the conduits as shown in Figs. 1 and 2 the vacuum that forms in the air ducts of the ejector is considerable, especially during the first stage of the exhaust period when the pressure is high, and serves, at this moment, to effectively muffle the exhaust noise. From the drawings it is seen that the cooling air conduit formed by the jacket 24, the exit conduit 37 and the joint conduit connecting them are all associated in streamline relation with one another and that the nozzle edges are shaped to streamline the exhaust gas into the air streams and to conduct the streams unidirectionally into the exit conduit 37. The streamlines and arrows in Figures 1 and 2 clearly show the paths of the exhaust gas and air streams. The exhaust streams *a* emerge from the nozzles and form vacuum pockets *b* into which the air streams *c* are drawn. The streams emerge from the ejector and flow into the exit conduit 37 in alternate layers and retain the flatwise relationship for some distance after leaving the ejector and thus establish and maintain an effective linkage or coupling between exhaust and air streams. From the foregoing it will be seen that the nozzles are shaped and proportioned to absorb as little heat energy from the exhaust gas as possible in order to make the maximum amount of kinetic energy available at the nozzle openings for the production of a high vacuum in the cooling air conduit.

Even though the nozzles are narrow, their aggregate section is considerable and permits the

rapid exhausting of the cylinder. The aggregate section of the air ducts in the ejector is also considerable and may be made to equal the aggregate section of the air ducts between the cooling fins of the cylinder. In my preferred embodiment the thickness of the air ducts in the ejector is made to exceed the thickness of the exhaust nozzle ducts in order to effectively link a relatively large volume of cooling air with a smaller volume of exhaust gas. With my arrangement, cooling of the engine varies not only with the speed of the engine, but also varies with changes in load and is approximately proportional to the fuel burned in the cylinder, and since the volume of the exhaust gas passing through the nozzles varies with the fuel burned, it is seen that the volume of the cooling air stream also varies with engine load and speed and makes it possible, by judicious proportioning of the cooling fins and ejector, to maintain an approximately constant engine temperature under all conditions of operation.

In order to still further increase the transfer of kinetic energy from the exhaust gas to the air stream and reduce heat loss to the nozzles, I provide means for converting the relatively small mass of the exhaust gas of high temperature into a relatively larger mass of lower temperature. To accomplish this object I provide means for mixing the exhaust gas with air before it reaches the nozzles of the ejector. In my preferred embodiment, air to the exhaust gas distributing chamber 28 is admitted through the duct 38 in the cylinder head which terminates in a nozzle 39 facing in the direction of the exhaust gas stream. With this arrangement air is drawn through the nozzle 39, which mingles with the exhaust gas and absorbs a portion of its heat energy. The mixture reaching the nozzles has a lower temperature and pressure but a greater mass and is more effective in impelling the air stream. Furthermore, because of the lower temperature of the mixture the ejector nozzles now absorb a smaller amount of exhaust heat, making a larger amount of kinetic energy available for impelling the air stream. After the exhaust valve 16 has closed, the air flow through the ducts 30 continues because of inertia of its mass in the chambers or conduits 24 and 37, and establishes a slight vacuum in the nozzles 29 tending to impede the flow of cooling air when the exhaust valve 16 is closed. However, the slight vacuum established in the nozzles 29 now serves to continue the flow of air through the duct 38 and nozzles 29 and prevents any serious impedance to the flow of the cooling air stream. When, during the next cycle, the exhaust valve 16 is about to open, the chamber 28 is filled with air which mixes with the exhaust gas as the valve opens and so increases the volume of the mixture passing through the nozzles. In order to prevent the escape of exhaust gas through the auxiliary air duct 38, during any moment of high pressure, I provide a reed valve 39 which permits a flow into the engine only. This feature of my invention cooperates with the vacuum drag to muffle the exhaust noise because the air that enters conduit 28 operates to cushion the peak pressure shock and to equalize the pressure before the mixture enters the nozzles.

I further provide means for cooling the engine oil with an exhaust gas impelled stream of cooling air. It consists of a heat exchanger or radiator 40 arranged on the intake side of the air stream. The oil radiator may be arranged with-

in the air stream but separate from the engine as shown by the dotted line *d* in Figure 2, but for the sake of a compact arrangement, I have shown the oil radiator as an extension 41 of the cylinder fins which, with the inlet conduit 42, outlet conduit 43, and connecting duct 44 at the top, forms the oil radiator. The inlet conduit 42 is connected with a conventional oil pump and the outlet 43 with the engine bearings in an obvious manner, not shown. With this arrangement the cooling of the engine lubricant varies with changes in engine speed as well as with changes of load on the bearings as heretofore already described.

In Figure 4 I have shown a modified species of ejector suitable for engines of moderate size. Each half 45 of the ejector is drawn to form the outer edges and flat sides of the nozzles and one side of the conduit, all in one piece, and the two halves are riveted or spot welded along the center edge at the point 46. A curved plate 47 provided with a nipple 48 may be added to reenforce and tie the two halves together.

In Figure 5 I have shown still another species of ejector suitable for small engines. This ejector may be cast from light metal in one piece, cored out to form a chamber or conduit portion 49 and provided with the closely spaced plates 50 extending outwardly and so that two of their edges form a substantial angle. The nozzles 51 are cut flatwise into the plates with a thin saw so as to extend into the conduit and substantially span the distance between the outer edges of the plates, as shown by the dotted line.

It should be noted that various changes may be made in the details of construction of my ejector and its combination with an impelling or cooling system and that one or more of the features disclosed herein may be used in the present or other embodiments without departing from the spirit of my invention, and I desire to cover by my claims such changes and other embodiments which may reasonably be included within the scope thereof.

I claim as my invention:

1. In a suction device utilizing the waste energy of explosion gas from a source to suck air from a point of utilization, the combination of a conduit element and a stream forming impeller element arranged within said conduit element, one of said elements being adapted to suck air from said point of utilization and the other element being adapted to be connected with said source, said impeller element including a series of narrow flatwise adjacent nozzles extending edgewise substantially across the interior of the conduit element and distributed flatwise throughout substantially the entire section thereof, said nozzles being spaced one from another and shaped to form the gas and substantially all the air within the conduit into a series of layer like and substantially unidirectional streams and to join the streams of gas and air with one another in flatwise alternating relationship.

2. In a suction device utilizing the waste energy of explosion gas from a source to suck air from

a point of utilization, the combination of a conduit element and a stream forming impeller element arranged within said conduit element, one of said elements being adapted to suck air from said point of utilization and the other element being adapted to be connected with said source, said impeller element including a series of narrow flatwise adjacent nozzles extending edgewise substantially across the interior of the conduit element and distributed flatwise throughout substantially the entire section thereof, said nozzles being spaced one from another and shaped to form substantially all the air within the conduit into a series of layer like and substantially unidirectional streams and also to form the gas into a series of layer like but substantially thinner unidirectional streams and to join the streams of air and gas with one another in flatwise alternating relationship.

3. In a suction device utilizing the waste energy of explosion gas from a source to suck air from a point of utilization, the combination of a conduit element and a stream forming impeller element arranged within said conduit element, one of said elements being adapted to suck air from said point of utilization and the other element being adapted to be connected with said source, said impeller element including a series of narrow flatwise adjacent nozzles extending edgewise substantially across the interior of the conduit element and distributed flatwise throughout substantially the entire section thereof, said nozzles being spaced one from another and shaped to form the gas and substantially all the air within the conduit into a series of layer like and substantially unidirectional streams and to join the streams of gas and air with one another in flatwise alternating relationship; and means located between the nozzles and said source for mixing the gas with air before the gas reaches the nozzles.

4. In a suction device utilizing the waste energy of explosion gas from a source to suck air from a point of utilization, the combination of a conduit element and a stream forming impeller element arranged within said conduit element, one of said elements being adapted to suck air from said point of utilization and the other element being adapted to be connected with said source, said impeller element including a series of narrow flatwise adjacent nozzles extending edgewise substantially across the interior of the conduit element and distributed flatwise throughout substantially the entire section thereof, said nozzles being spaced one from another and shaped to form the gas and substantially all the air within the conduit into a series of layer like and substantially unidirectional streams and to join the streams of gas and air with one another in flatwise alternating relationship; and an exit conduit in substantially streamline relationship with said conduit element extending beyond the nozzles for substantially maintaining said flatwise alternating relationship of the streams beyond the nozzles.

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