Jan. 16, 1940. H. COANDA 2,187,342

EXHAUST OF GASES FROM ENGINES

Original Filed July 17, 1936 4 Sheets-Sheet 1

FIG 1

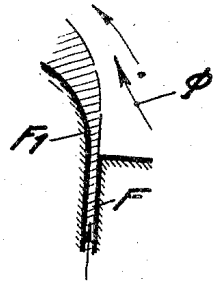

FIG 2

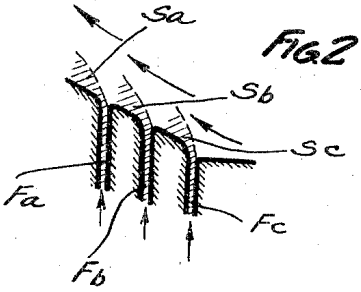

FIG. 7

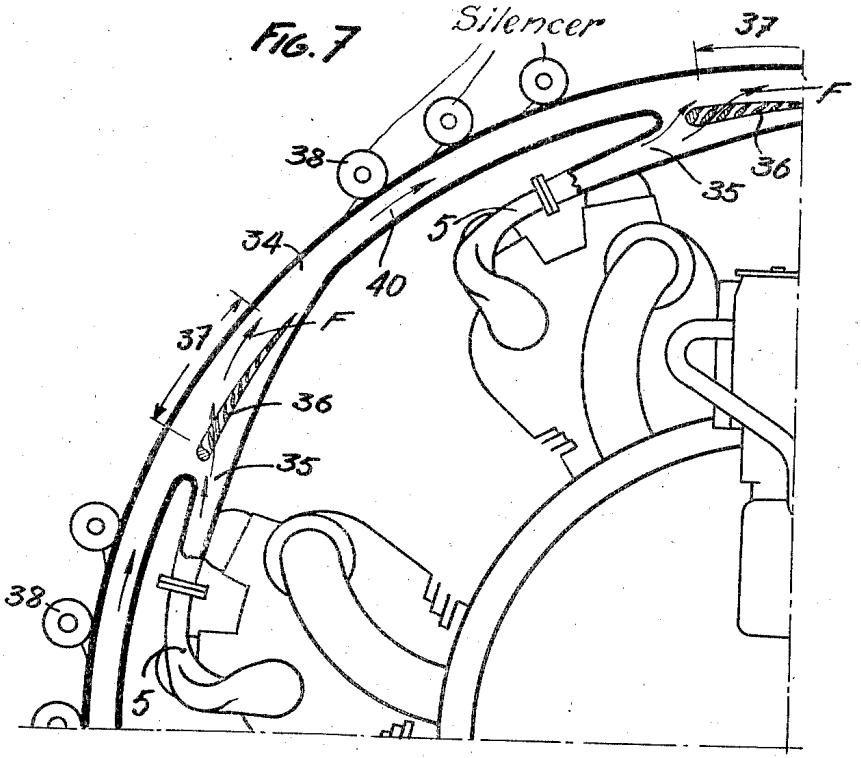

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Fig. 4

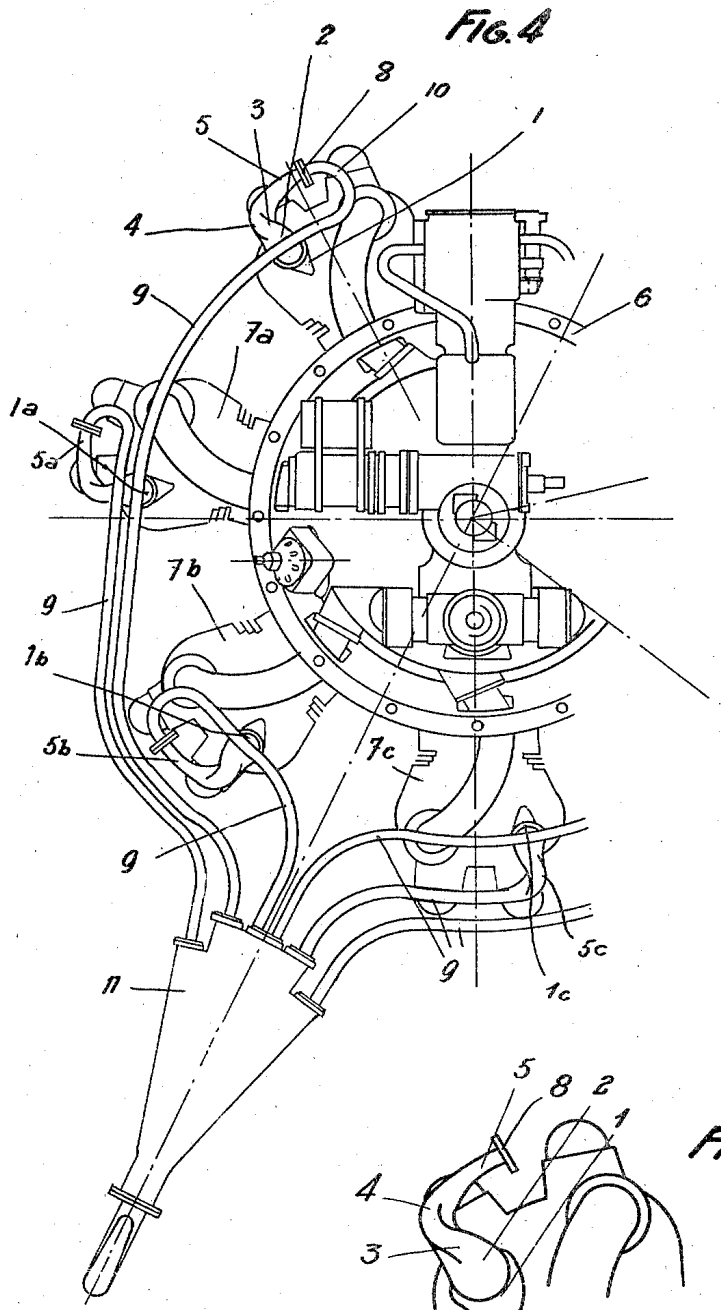

Fig. 3

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Fig. 5

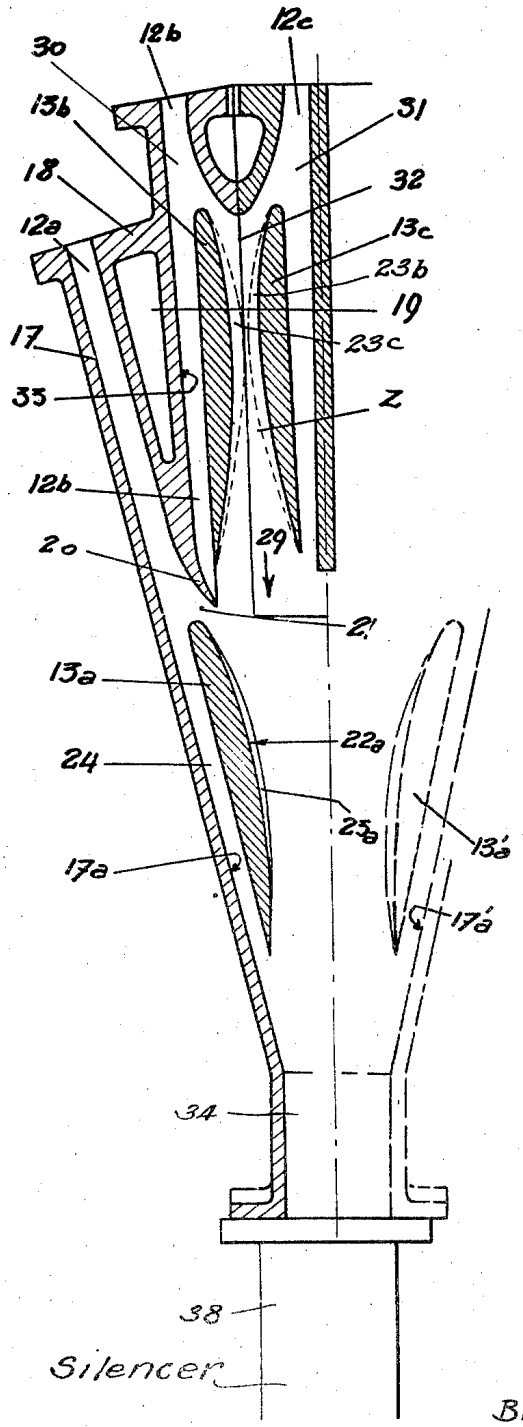
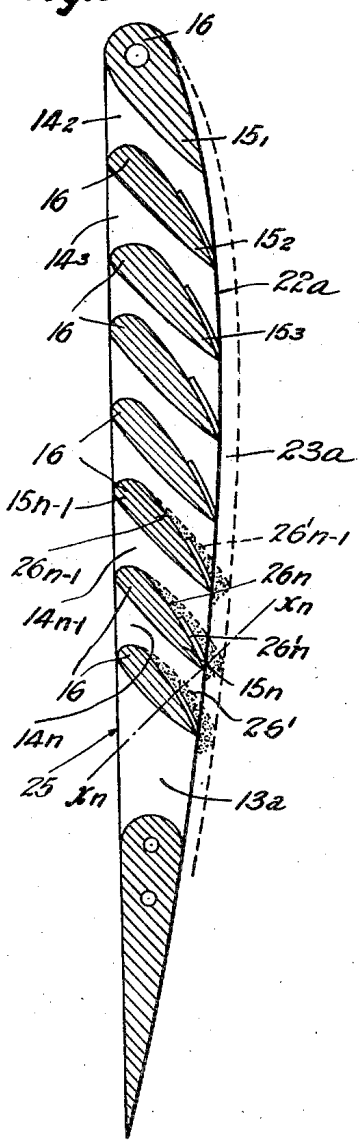


Fig. 6



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EXHAUST OF GASES FROM ENGINES

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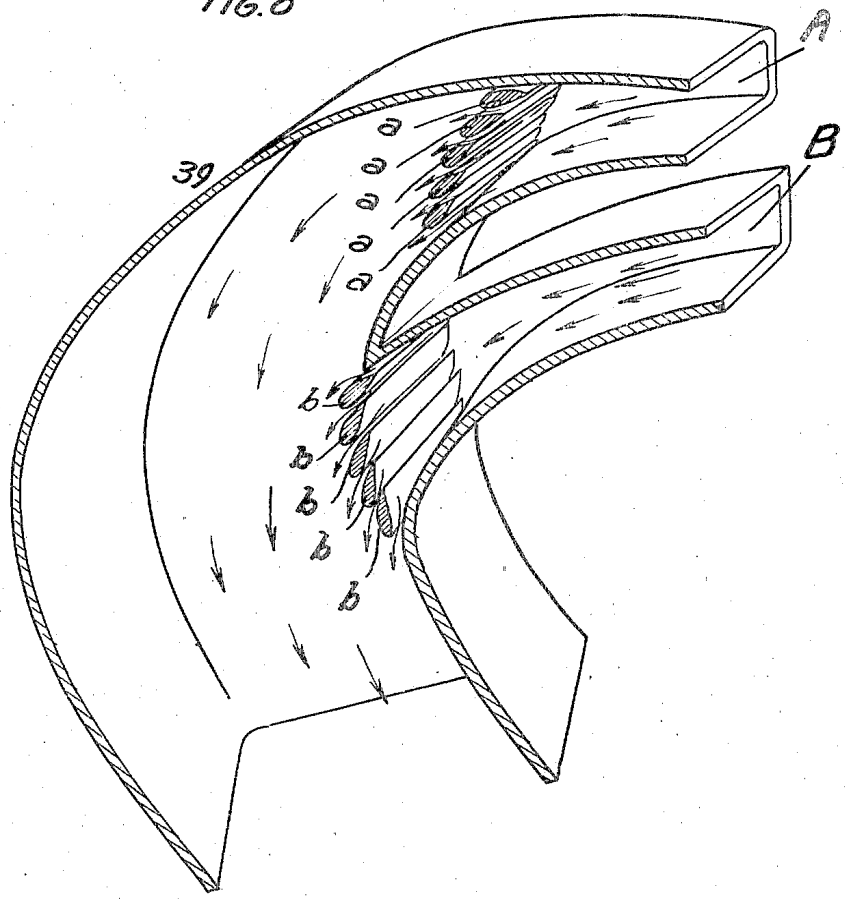
FIG. 8



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2,187,342

UNITED STATES PATENT OFFICE

2,187,342

EXHAUST OF GASES FROM ENGINES

Henri Coanda, Clichy, France

Original application July 17, 1936, Serial No. 91,062. Divided and this application July 14, 1937, Serial No. 153,500. In France July 17, 1935

8 Claims. (Cl. 60—32)

The present invention, which is a division of my copending application Ser. No. 91,062, filed July 17, 1936 relates to exhaust systems for internal combustion engines.

As disclosed by my prior Patent No. 2,052,869 when a fluid under pressure, such as exhaust gases, is allowed to escape, in the form of a flat sheet through a thin slot one of the lips of which is prolonged and gradually curved away from said slot, there is produced along said lip a zone of suction into which the surrounding air flows. Therefore, it will be readily understood that, if a series of such suction zones are disposed at intervals from one another and are arranged to operate successively, the zone of suction created by the active lip of one of the slots can act upon the gases flowing out from the adjacent slot and so on.

The object of the present invention is to provide an exhaust device based upon this principle.

According to the invention, this exhaust device includes a manifold receiving the exhaust gases through flat pipes and provided, at the places where said flat pipes open thereinto, with sets of wing-like devices having, in longitudinal section, in the direction of flow of the gases, the shape of thin slotted aerofoils. Thus, when passing through said slots, the exhaust gases expand along the back faces of said wing-like devices (which constitute the prolonged lips above referred to) forming along said back faces zones of suction which draw the surrounding fluid.

Therefore, it will be readily understood that, if I dispose in a suitable manner in this manifold these wing-like devices and the outlets of the exhaust pipes, it is possible to obtain, on a set of wing-like devices corresponding to one of the exhaust pipes through which the gases are conveyed to said manifold, a suction capable of acting upon the gas stream conveyed by the adjacent exhaust pipe, and so on.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 and Fig. 2 are diagrammatic views illustrating, respectively, the production of a suction zone on the outlet side of a thin slot one of the lips of which is sufficiently prolonged, and the reaction of an elementary suction at the outlet of an exhaust slot on the flow of the gases from the adjacent slot;

Fig. 3 shows an exhaust pipe element conveying the gases to the manifold;

Fig. 4, shows a radial engine provided with exhaust pipes leading to a manifold according to the invention;

Fig. 5 is a sectional view of the manifold into which the exhaust pipes open;

Fig. 6 is a longitudinal section on an enlarged scale of a slotted wing-like surface utilized in connection with the manifold according to the invention;

Fig. 7 shows an element of a circular manifold fitted on a radial engine, partly in section;

Fig. 8 shows a modification.

Referring to Figs. 1 and 2, if a gas flowing at at high velocity is ejected through a thin slot F (of a thickness of about 1.5 mm.), the gas expands along a prolonged lip F_1 of the slot, creating thereon a zone of high suction, due to the fact that the gases expand considerably beyond their initial volume. Thus, in the hatched portion, there is produced a considerable suction due to the expansion of the fluid stream escaping at high pressure through the thin slot F and constituting a zone into which the surrounding air flows in the direction of arrows ϕ.

Consequently, it will be readily understood that if distinct gaseous streams are ejected in the same manner through adjacent orifices *Fa*, *Fb*, *Fc* (Fig. 2), at a small distance from one another, it is possible, by the production of suction zones *Sa*, *Sb*, *Sc* created at the outlet of each slot by the gas stream issuing therefrom, to increase the suction of the preceding stream, and so on.

Referring to Figs. 3 and 4, the flat exhaust tubes 5, connected to the exhaust valve chambers 1 through tubes 2, first cylindrical, then of decreasing diameter at 3 and flattened at 4, are provided at the rate of one per cylinder *7a*, *7b*, *7c*, . . . of a radial engine 6.

Each flat tube 5 is connected, through flanges 8, to a flattened tube 9, bent for instance at 10 and leading to a manifold 11.

This manifold, a portion of which is shown in section by Fig. 5, consists of a piece including a plurality of flat conduits such as *12a*, *12b*, *12c*, into which open the flattened tubes 9. Opposite these flat conduits are provided the wing-like devices *13a*, *13b*, *13c*, respectively, one of which is shown on an enlarged scale by Fig. 6.

As shown in section by said Fig. 6, each of these wing-like devices consists of a plurality of solid elements 15_1, 15_2, 15_3, . . . 15_{n-1}, 15_n etc., sep-

arated from one another by passages 14_2, 14_3, 14_{n-1}, 14_n, etc., forming thin slots. Preferably, these elements 15_1, 15_2, 15_3, . . . 15_{n-1}, 15_n, etc., are themselves of aerofoil section, with a rather blunt leading edge 16. Preferably, also, the wing-like devices 13*a*, 13*b*, 13*c* are slightly inclined with respect to the axes of the corresponding conduits 12*a*, 12*b*, 12*c*.

These wing-like devices are fixed in any suitable manner to the body of the manifold in the correct position with respect to the corresponding conduits.

Among these conduits, those which extend to a greater distance inside the manifold, such as 12*a*, include, on the one hand a wall 17, coinciding with the wall of the manifold, and, on the other hand, a portion 18, for instance hollow at 19, and terminated by a slightly curved part 20, acting on the one hand as a deflector with respect to wing-like device 13*b* and, on the other hand, as a guide for the gases flowing through tube 12*a*, so as to direct them toward the back side of the wing-like device 13*a*.

The path of the gases, when travelling from the engine to the manifold, is as follows:

After having undergone a helical movement and having been flattened in conduits 3, 4, 5, the gases flow through flat tubes 9, until they enter flat conduits 12*a*, 12*b*, 12*c*.

The gases flowing through conduit 12*a* strike wing-like device 13*a* over its whole length, due to the inclined position of said wing-like device with respect to the inner face 17*a* of the wall 17 of said conduit.

These gases are divided into elementary sheets flowing through slots 14_2, 14_3, 14_{n-1}, 14_n, etc. (Fig. 6). Therefore, considering, for instance, element 15_n, there is created a zone of suction $26'_n$ along the back side 26_n of said element 15_n, this zone of suction being slightly stippled on the drawings and projecting beyond the back face 22*a* of the wing device. The same happens for element 15_{n-1}, forming a zone of suction $26'_{n-1}$ along the back face 26_{n-1} of said element, and for all the other elements.

This is due to the fact that, referring to Fig. 6, thin slot 14_n may be considered as equivalent to the slot F of Fig. 1, the heavy-lined portion of the back face 26_n of wing element 15_n which extends between the trailing edge of said wing element and line Xn—Xn being considered as equivalent to the prolonged rear lip F_1 of said slot F.

As this suction zone $26'_n$ extends slightly beyond the trailing edge of the preceding wing element 15_{n-1}, it reacts upon the surrounding fluid and, in particular, upon the gases that have flown through slot 14_{n-1} and increases the suction effect created at $26'_{n-1}$ and so on.

As these zones of suction $26'_n$, $26'_{n-1}$, etc. extend slightly beyond the rear face 22*a* of the wing device, their combined actions produce, at 23*a*, a zone of suction along said rear face 22*a* of said wing-like device.

It is this suction which draws in, through the free space 21 (Fig. 5) the gases flowing through conduit 12*a* which have not passed through slots 14_2, 14_3, . . . 14_{n-1}, 14_n, etc. The gases which thus pass through the free space 21 tend, as a consequence of the suction created at 23*a* along the back face 22*a* of wing-like device 13*a*, to run along said back face.

Therefore, in the zone existing between two symmetrical elements such as 13*a* and 13'*a*, there is produced a very strong suction due to the accumulation of the elementary suctions created by said elements 13*a* and 13'*a*. This suction draws in the gases coming in through tubes 12*b*, 12*c*, and the space 29, 32 existing between wing-like devices 13*b*, 13*c*, identical to the wing-like device 13*a* above described in detail.

It should be noted that the deflector portion 20 of piece 18 prevents any backward flow of the gases.

Also, it should be noted that the zone Z between wing-like devices 13*b* and 13*c* is a zone of suction owing to the combined actions of the elementary suction zones 23*b* and 23*c* of said respective devices.

In a modification shown by Fig. 7, the manifold is constituted by a circular flat tube 34, into which open flat tubes 35, into which open flat tubes 5 terminated by a flaring end piece in which there is mounted a wing-like device 36 similar to those above described and acting in the same way. Therefore, along each of these wing-like devices 36, there is created an intensified suction zone 37 which tends to draw in, in the direction of arrow 40, the gases contained in tube 34 ahead of this zone. The exhaust of the gases into the atmosphere may take place through silencers such as 38.

In the modification of Fig. 8, the manifold is constituted by a flaring element 39 prolonging the flat exhaust tubes A and B connected, for instance, to different engine cylinders, said element 39 being provided with streamlined partitions consisting of wing-like elements *a* and *b*, respectively, positioned with respect to one another in such manner as to constitute two wing-like devices similar to those above described in detail, the suction created by wing-like device *b* acting on the other wing-like system *a*.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the appended claims.

What I claim is:

1. An exhaust device for a fluid flowing at high velocity and under pressure into a medium at lower pressure, which comprises, in combination, a vessel opening into said medium, at least one flat tube opening into said vessel, and a slotted structure carried by said vessel opposite the outlet of said tube into said vessel, said structure consisting of a plurality of wing-like elements arranged adjacent and parallel to one another with their leading edges turned toward the direction from which the fluid is flowing, these elements being positioned close to one another, so as to leave slot-like passages between them, and in stepped relation, so that the upper side of each extends beyond the trailing edge of the element located above it and forms an outwardly curved prolonged lip to the slot existing between these two last mentioned wing-like elements, whereby the flow of fluid through each of these slots produces a suction acting on the stream flowing through the next slot above it and facilitates the flow of fluid along the back part of said slotted structure.

2. An exhaust device for a fluid flowing at high velocity and under pressure into a medium at lower pressure, which comprises, in combination, a vessel opening into said medium, at least one flat tube opening into said vessel for conveying said fluid thereto, and a wing-shaped structure

constituted by a plurality of wing-shaped elements arranged adjacent and parallel to one another with their leading edges turned toward the direction from which the fluid is flowing, these elements being positioned close to one another so as to leave slot-like passages between them and in stepped relation, so that the upper side of each extends beyond the trailing edge of the element located above it and forms an outwardly curved prolonged lip to the slot existing between these two last mentioned wing-like elements to form together a multiple-slot wing structure fixed in said vessel opposite and parallel to the outlet of said tube into said vessel so as to split the stream of gases issuing therefrom into a portion which passes around said structure and another portion which passes through the slots thereof and produces on its back face a suction which improves the flow through said tube.

3. An exhaust device for a plurality of sources of a fluid intended to flow at high velocity and under pressure into a medium at lower pressure, which comprises, in combination, a main fluid collecting vessel opening into said medium, a plurality of flat tubes connecting said sources respectively with said vessel, and at least one wing-shaped structure constituted by a plurality of wing-shaped elements arranged adjacent and parallel to one another with their leading edges turned toward the direction from which the fluid is flowing, these elements being positioned close to one another so as to leave slot-like passages between them and in stepped relation, so that the upper side of each extends beyond the trailing edge of the element located above it and forms an outwardly curved prolonged lip to the slot existing between these two last mentioned wing-like elements to form together a multiple-slot wing structure fixed in said vessel opposite and parallel to the outlet of each of said tubes into said vessel so as to split the stream of gases issuing from said last mentioned tube into a portion which passes around said structure and another portion which passes through the slots thereof and produces on its back face a suction which improves the flow through the corresponding tube, said tubes and their respective wing-shaped structures being arranged in stepped relation to one another so that the suction created by one wing-shaped structure is effective to cooperate with the other tubes.

4. An exhaust device for an internal combustion engine which comprises, in combination, a manifold, a plurality of flat tubes for conveying the exhaust gases from the cylinders of said engine to said manifold, and a wing-shaped structure constituted by a plurality of wing-shaped elements arranged adjacent and parallel to one another with their leading edges turned toward the direction from which the fluid is flowing, these elements being positioned close to one another so as to leave slot-like passages between them and in stepped relation, so that the upper side of each extends beyond the trailing edge of the element located above it and forms an outwardly curved prolonged lip to the slot existing between these two last mentioned wing-like elements to form together a multiple-slot wing structure fixed in said manifold opposite and parallel to the outlet of each of said tubes into said manifold so as to split the stream of gases issuing from said last mentioned tube into a portion which passes around said structure and another portion which passes through the slots thereof and produces on its back face a suction which improves the flow through the corresponding tube, said tubes and their respective wing-shaped structures being arranged in stepped relation to one another on said manifold so that the suction created by one wing-shaped structure is effective to cooperate with the other tubes.

5. An exhaust device for an internal combustion engine which comprises, in combination, a manifold, a plurality of flat tubes for conveying the exhaust gases from the cylinders of said engine to said manifold, and a wing-shaped slotted structure mounted in said manifold opposite each tube outlet into said manifold, with the leading edge of said structure parallel to said outlet, each of said structures consisting of a plurality of wing-like elements arranged adjacent and parallel to one another with their leading edges turned toward said tube outlet, these elements being positioned close to one another, so as to leave slot-like passages between them, and in stepped relation, so that the upper side of each extends beyond the trailing edge of the element located above it and forms an outwardly curved prolonged lip to the slot existing between these two last mentioned wing-like elements, whereby the flow of exhaust gases through each of these slots produces a suction acting on the stream flowing through the next slot above it and facilitates the flow of gases from the corresponding tube along the back face of said wing-like structure, said tubes and their respective wing-shaped structures being arranged in stepped relation to one another in said manifold so that the suction created by one wing-shaped structure is effective to cooperate with the other tubes.

6. An exhaust device for an internal combustion engine which comprises, in combination, a manifold, a plurality of flat tubes for conveying the exhaust gases from the cylinders of said engine to said manifold, and a wing-shaped slotted structure mounted in said manifold opposite each tube outlet to said manifold, with the leading edge of said structure parallel to said outlet, each of said structures consisting of a plurality of wing-like elements arranged adjacent and parallel to one another with their leading edges turned toward said tube outlet, these elements being positioned close to one another, so as to leave slot-like passages between them, and in stepped relation, so that the upper side of each extends beyond the trailing edge of the element located above it and forms an outwardly curved prolonged lip to the slot existing between these two last mentioned wing-like elements, whereby the flow of exhaust gases through each of these slots produces a suction acting on the stream flowing through the next slot above it and facilitates the flow of gases from the corresponding exhaust tube onto and along the back face of said wing-shaped structure, said tubes and their respective wing-shaped structures being arranged in stepped relation to one another in said manifold so that the suction created by one wing-shaped structure is effective to cooperate with the other tubes, and a deflector carried by said manifold between two successive wing-shaped structures so as to prevent back-flow and eddy-like movements of the exhaust gases in said manifold.

7. An exhaust device for a radial internal combustion engine which comprises, in combination, a manifold in the form of a flat circular vessel surrounding said engine, a plurality of flat tubes for conveying the exhaust gases from the cylinders of said engine to different points of the circumference of said manifold, and a wing-shaped

structure constituted by a plurality of wing-shaped elements arranged adjacent and parallel to one another with their leading edges turned toward the direction from which the fluid is flowing, these elements being positioned close to one another so as to leave slot-like passages between them and in stepped relation, so that the upper side of each extends beyond the trailing edge of the element located above it and forms an outwardly curved prolonged lip to the slot existing between these two last mentioned wing-like elements to form together a multiple-slot wing structure fixed in said manifold opposite and parallel to the outlet of each of said exhaust tubes into said manifold, so as to split the stream of gases issuing from said last mentioned tube into a portion which passes around said structure and another portion which passes through the slots thereof and produces on its back face a suction which improves the flow through the corresponding exhaust tubes, said tubes and their respective wing-shaped structures being so arranged along the circumference of said manifold that the suction created by one wing-shaped structure is effective to cooperate with the other tubes.

8. An exhaust device for an internal combustion engine which comprises, in combination, a manifold in the form of a flaring tube, a plurality of flat tubes opening into said tube at successive points of one wall thereof, and a slotted structure carried by said manifold across the outlet of each of said tubes into said first mentioned flaring tube, said structure consisting of a plurality of wing-like elements arranged adjacent and parallel to one another with their leading edges turned toward said exhaust tube, these elements being positioned close to one another, so as to leave slot-like passages between them, and in stepped relation, so that the upper side of each of them extends beyond the trailing edge of the element located above it and forms an outwardly curved prolonged lip to the slot existing between these two last mentioned wing-like elements, whereby the flow of fluid through each of these slots produces a suction acting on the stream flowing through the next slot above it and facilitates the flow of exhaust gases along the back part of said slotted structure, the arrangement of these slotted structures in succession along said wall of the flaring tube causing each slotted structure to exert a suction on the gases issuing through the preceding slotted structure.

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