Feb. 13, 1940. L. BIRKIGT 2,190,394

COOLING SYSTEM FOR PISTON ENGINES

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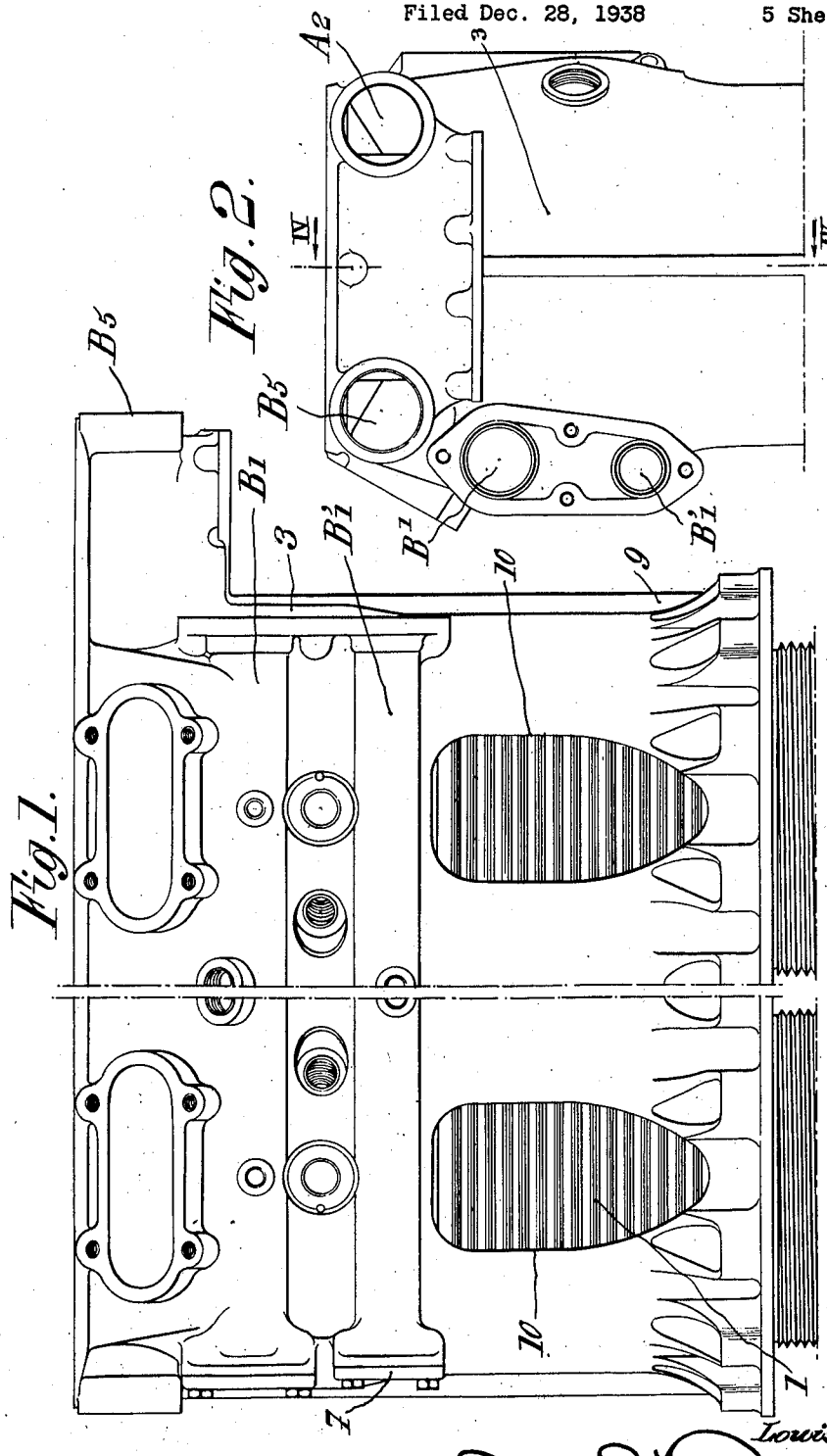


Fig. 2.

Fig. 1.

Inventor:
Louis Birkigt,
Bailey & Carson Attorneys.

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Fig. 3.

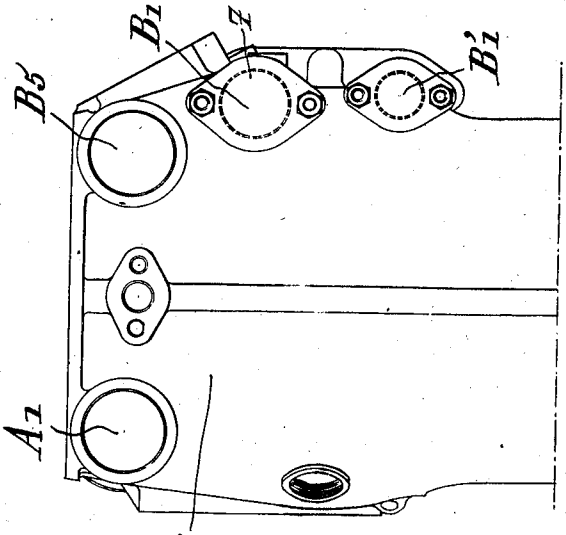
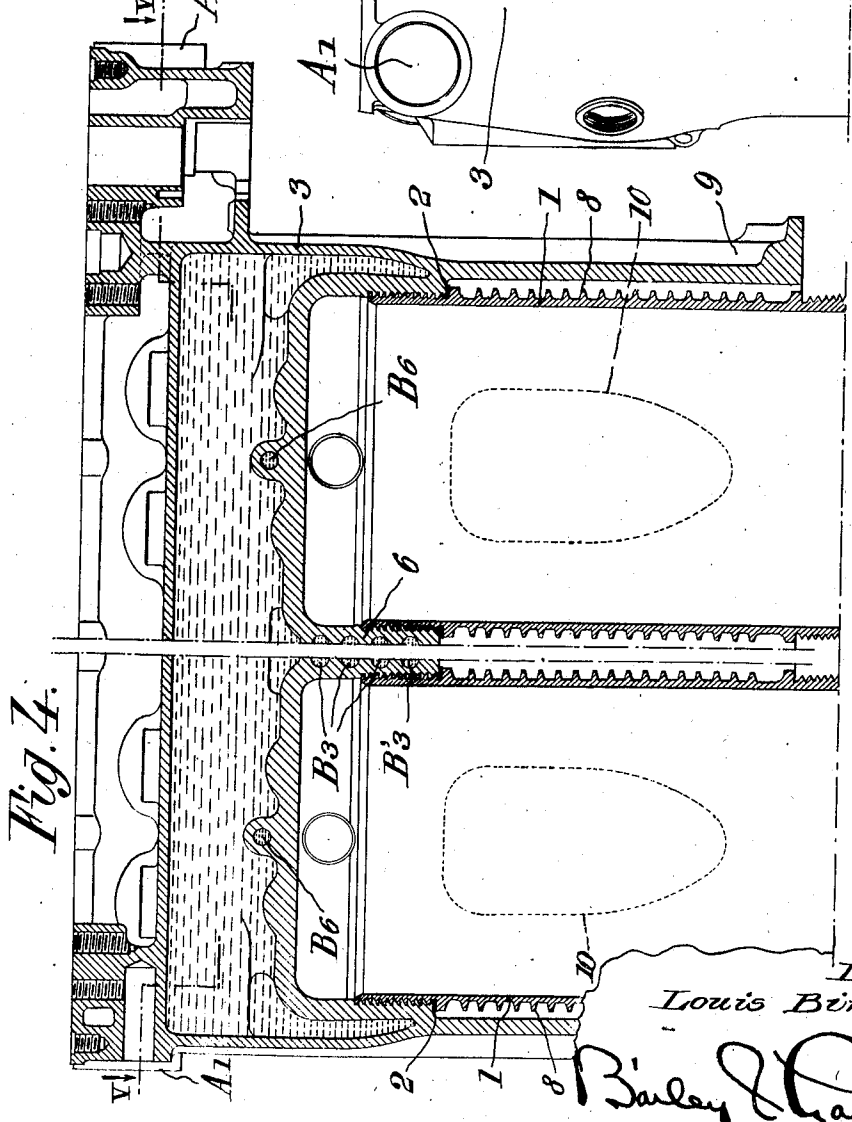


Fig. 4.

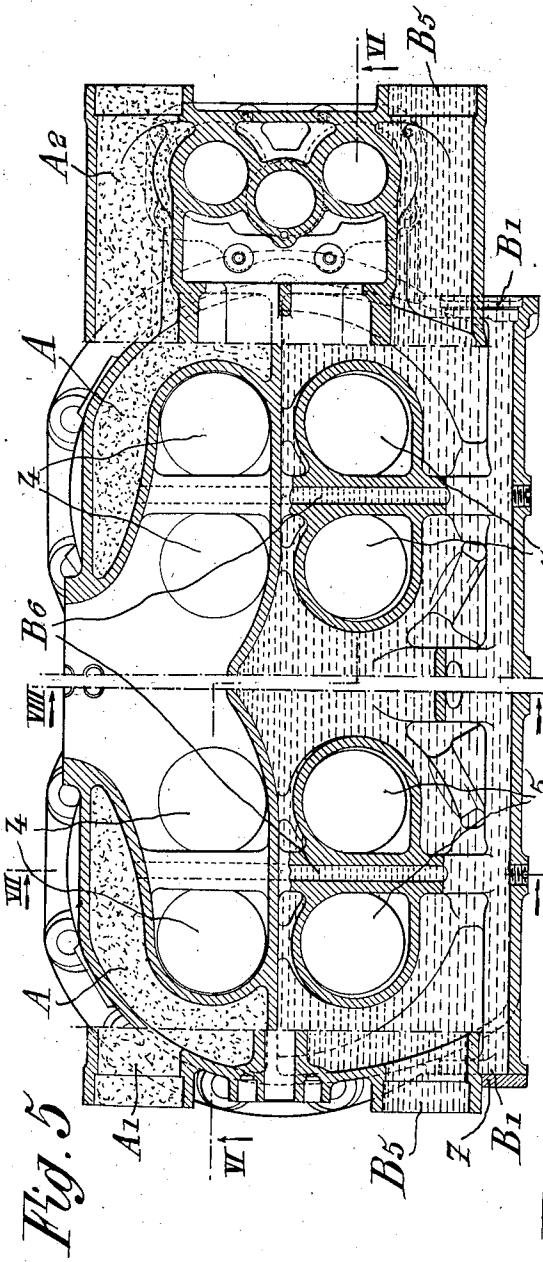


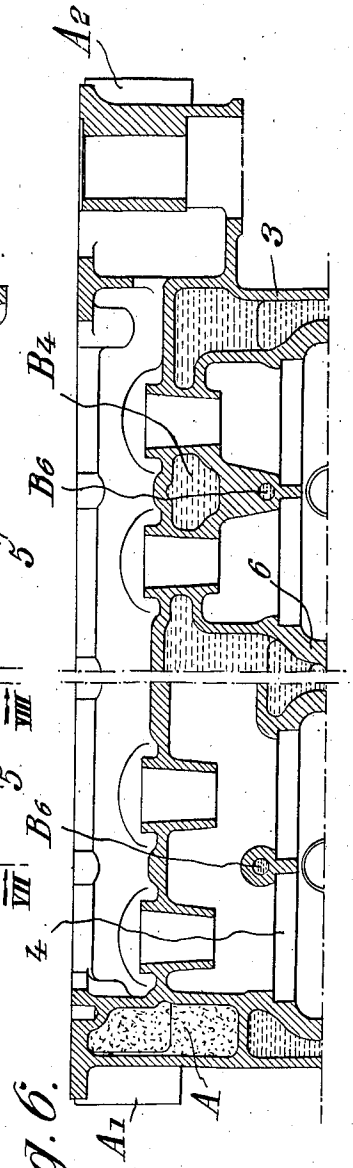
Inventor:
Louis Birkigt,
Bailey & Carson
Attorneys

Feb. 13, 1940. L. BIRKIGT 2,190,394

COOLING SYSTEM FOR PISTON ENGINES

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Inventor:
Louis Birkigt,

Bailey & Carson
Attorneys

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COOLING SYSTEM FOR PISTON ENGINES

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Fig. 8.

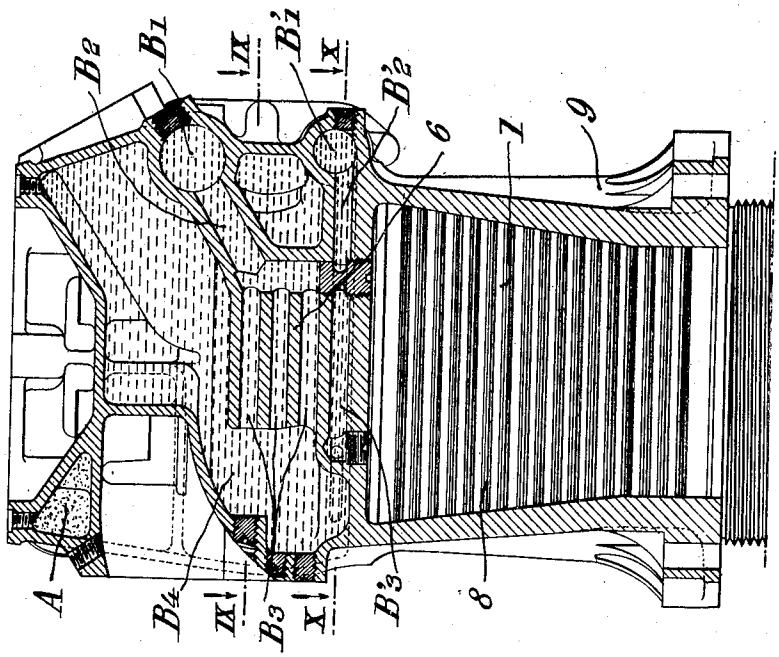
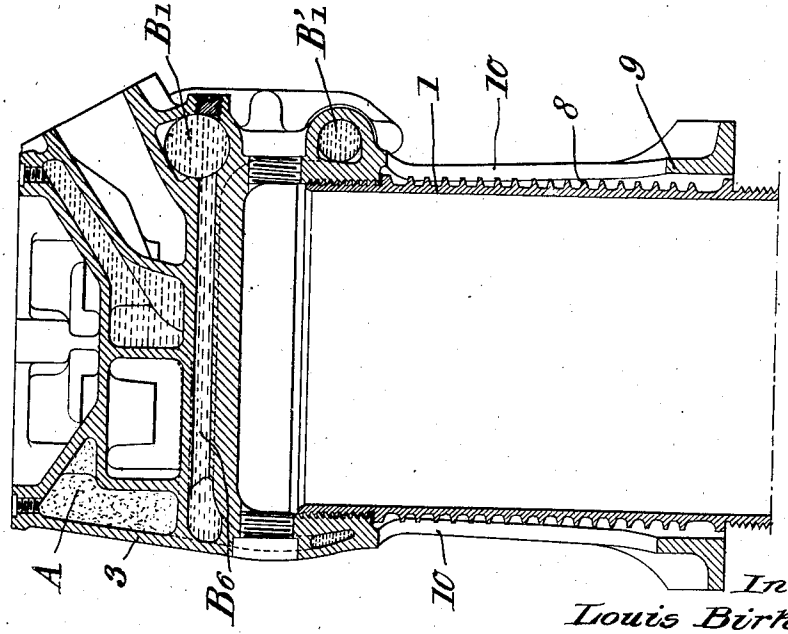


Fig. 7.



Inventor.
Louis Birkigt,
Bailey & Carson
Attorneys

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COOLING SYSTEM FOR PISTON ENGINES

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Fig. 9.

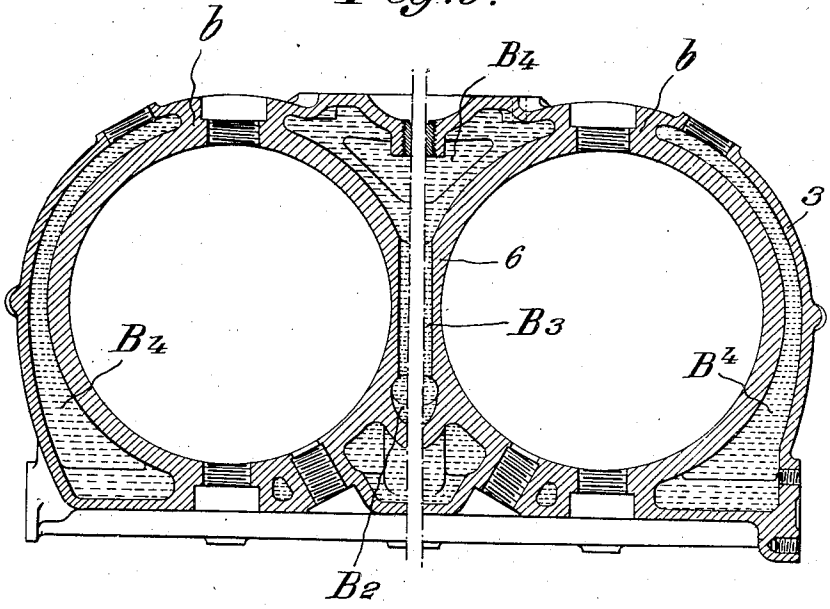
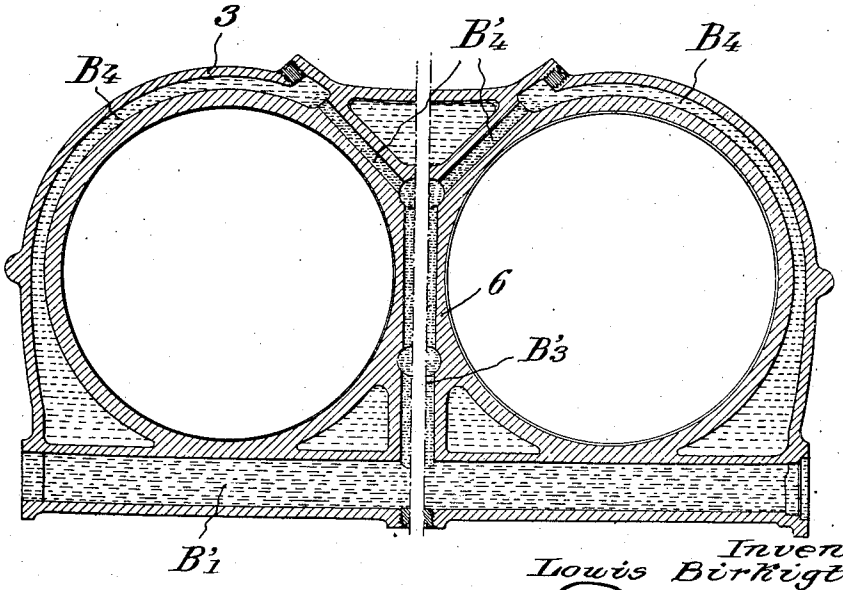


Fig. 10.



Inventor:
Lewis Birkigt,
Bailey & Carson
Attorneys

Patented Feb. 13, 1940

2,190,394

UNITED STATES PATENT OFFICE

2,190,394

COOLING SYSTEM FOR PISTON ENGINES

Louis Birkigt, Versoix, near Geneva, Switzerland

Application December 28, 1938, Serial No. 248,131
In Belgium February 11, 1938

17 Claims. (Cl. 123—173)

The present invention relates to machines of the piston type which are to be provided with cooling systems. The invention is more especially, although not exclusively, concerned with machines of this kind which constitute internal combustion engines.

The chief object of the invention is to provide a machine of this type which is better adapted to meet the requirements of practice.

According to an essential feature of the present invention, in order to constitute the cooling means with which the machine is to be provided, I provide, in the cylinder head of said machine, conduits (this expression designating in this case any recess through which a fluid can flow), at least one of which is for the circulation of a cooling fluid and at least one for the circulation of air. In a preferred embodiment of my invention, the last mentioned conduit (for the flow of air) is located close to the walls along which circulate the fresh gases entering said machine.

According to another feature of the present invention, I provide, for constituting the cooling means of the engine, in the walls thereof that are to be cooled and especially in the cylinder heads, at least two circulations of water or another fluid, said two circulations being distinct from each other at least over a portion of their circuit.

According to a third feature of the present invention, in order to constitute the cooling means with which the engine is to be fitted, I provide conduits for the passage of a cooling fluid in the walls to be cooled, and in particular in the partitions extending between two adjacent cylinders, and the fluid circulation is so arranged that said fluid is compelled to move in at least the conduits which are provided in said partitions.

According to still another feature of the present invention, the cooling system with which the engine is to be fitted includes a casing surrounding the intermediate and lower portions of the cylinders, said casing being provided with holes so that air can circulate therein so as to cool said cylinders. Advantageously, this casing is integral with the cylinder head.

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 is an elevational view, with parts removed, of the cylinder head of an internal combustion engine provided with a cooling system made according to an embodiment of the invention;

Fig. 2 is an end view of the same cylinder head seen from the rear;

Fig. 3 is an end view of the same cylinder head seen from the front;

Fig. 4 is a longitudinal vertical section on the line IV—IV of Fig. 2;

Fig. 5 is a horizontal section on the line V—V of Fig. 4;

Fig. 6 is a longitudinal vertical section on the line VI—VI of Fig. 5;

Fig. 7 is a transverse vertical section on the line VII—VII of Fig. 5;

Fig. 8 is a transverse vertical section on the line VIII—VIII of Fig. 5;

Fig. 9 is a horizontal section on the line IX—IX of Fig. 8;

Fig. 10 is a horizontal section on the line X—X of Fig. 8.

The following detailed description with reference to the drawings relates to the case of an internal combustion provided with a cooling system according to the invention.

Concerning first the general structure of the engine, excepting the cooling system with which it is to be provided, it can be made in any suitable conventional manner, including for instance a number n of cylinders 1 arranged in line or forming several banks, forming for example a V, a Y, a W, or any other arrangement.

By way of example, the cylinders are constituted as shown Fig. 4 by tubular elements adapted to be screwed, through their ends adjoining the combustion chamber, and with the interposition of a packing member 2, on a cylinder head 3, preferably common to all the cylinders of one bank. Preferably, as shown by the drawings, each of said cylinders is provided with two inlet valves 4 and two exhaust valves 5, housed in said cylinder head, respectively on opposite sides of the plane of symmetry of said cylinder head, said valves being operated by means of an overhead cam-shaft.

Finally, I advantageously provide, for each cylinder, two spark plugs which are carried by bosses b provided in said cylinder at the opposite ends of a diameter thereof, and located respectively near the inlet valves 4 and the exhaust valves 5.

Concerning now the cooling system which constitutes the object of the invention, it is constituted, according to a chief feature of said inven-

tion, by providing, in cylinder head 3, conduits some of which serve for the circulation of a cooling fluid, and the others for the circulation of air.

Preferably, the conduits serving for the circulation of air (and which, on the drawings, are designated by letter A, either with an index or not) are located, at least chiefly, on the same side of the longitudinal plane of symmetry of the cylinder head as the inlet valves 4, that is to say in the part of the cylinder head which is less liable to grow very hot due to the fact that the fresh gases fed to the cylinders flow along said part thereof.

As for the conduits which are to constitute the liquid cooling circuit, they are more particularly provided in the hot portions of cylinder head 3. Preferably, according to another feature of the invention, these last mentioned conduits are arranged to form at least two circulations of liquid, which are distinct over at least a portion of their circuits.

It will be readily understood that such an arrangement of the cooling conduits of the engine permits, while ensuring a thorough cooling of all the parts of the engine, of accelerating one of these circulations of liquid, so as more intensively to cool some portions of the cylinder head without having, for this reason, to accelerate the circulation of the whole of the liquid flowing through the cylinder head.

For instance I may provide, for the circulation of the cooling liquid, two circuits composed of parts B1, B2, B3, B4, B5, B6 (hereinafter designated for convenience as B) and B'1, B'2, B'3, B'4 (hereinafter designated for convenience as B') respectively, the main conduits of which are respectively located close to the exhaust valves 5 and to the cylinder tops.

Of course the cooling conduits A, B and B' may be arranged in many different manners according to the features above set forth.

However, I have found that it is particularly advantageous to have recourse to the specific arrangement illustrated by the drawings.

According to this embodiment of my invention the liquid circuits include respectively, in the partitions 6 which extend between two adjacent combustion chambers, conduits B_3 and B'_3 through which the liquid is compelled to circulate which permits, in particular, through a suitable choice of the cross sections of said conduits, of accelerating said circulation of the liquid.

In order better to dislose the distribution and forms which have been found to be especially advantageous for the various elements of the structure, and in particular circuits A, B and B', the drawings give the relative proportions of said elements.

Furthermore, in order to simplify these drawings, I have shown, in some figures, only the front and rear parts of cylinder head 3, which are the only elements to have certain different characteristics, these parts being connected by $n-2$ intermediate parts which are similar to one another and include elements common with the end parts.

It will be readily understood that, according as the engine that is considered is provided with a tractive airscrew or a pusher airscrew, the front part of the engine that is considered separately is turned toward the front or toward the rear of the aircraft.

In the drawings, it has been assumed that the airscrew associated with the engine served to pull the aircraft, but in the embodiment of my invention which will now be described more in detail, the whole is arranged in such manner that the various inlets or outlets of fluid can be turned indifferently toward one end or the other of the engine.

Concerning first the aircircuit A, it is constituted in such manner that air penetrates into the front part of the cylinder head through a lateral inlet conduit A_1, then flows along the walls surrounding the inlet valves 4 and finally escapes through a conduit A_2 which would, on the contrary, play the part of inlet conduit in the case of an engine associated with a pusher airscrew.

Concerning now the liquid circuit B, it includes an inlet conduit B_1 (disposed laterally on the side opposed to conduit A_1 with reference to the longitudinal plane of symmetry) which runs over the whole length of the cylinder head, and the front end of which is preferably closed by a plug 7 (said end being used for the inflow of the liquid in the case of an engine associated with a pusher airscrew).

This conduit B_1 communicates, opposite the partitions existing between two adjacent cylinders, with conduits B_3 provided in said partitions, through the medium of conduits B_2 each of which communicates with the whole of the conduits B_3 corresponding to the same partition. These conduits B_3 may be of any particular arrangement and number. For instance, I provide three conduits B_3 for each partition.

Said conduits B_3 open into a jacket or chamber B_4 which partly surrounds the exhaust valves 5 and extends in the direction of the bosses *b* which carry the spark plugs provided near the inlet valves 4. This jacket B_4 may even wholly surround said bosses. Jacket B_4 is provided, near the front and rear ends of the cylinder head structure 3, with outlet conduits B_5, one of which may be closed, the outflow of the liquid then taking place through the other of said last mentioned conduits.

It will be readily understood that, with such a circuit, liquid will be compelled to circulate through conduits B_3 since said conduits are arranged in series in the cooling circuit which starts from the inlet conduit B_1 and leads to the outlet conduit B_5.

It should be noted that, advantageously, circuit B should be completed by connecting conduit B_1 to jacket B_4 through conduits B_5 passing between the valves of each cylinder. These conduits B_6 produce but a slight reduction of the circulation of liquid through conduits B_3.

I will now consider the arrangement of the other liquid circulation system, to wit B'.

This system includes an inlet conduit B'_1 provided, in a manner similar to conduit B_1, on one side of the cylinder head and, preferably, under said conduit B_1.

This conduit B'_1 is connected, through the medium of conduits B'_2, with conduits B'_3 provided in partitions 6 under conduits B_3, and located, for instance, at the level of the cylinder heads. I may, by way of example, provide one conduit B'_3 in each partition 6.

I connect the outlet end of each conduit B'_3, for instance, through the intermediate of two conduits B'_4, forming a V, with the jacket B_4 of circuit B, the evacuation of the liquid from circuit B' then taking place through conduits B_5 which, in this case, are common, same as jacket B_4, to circuits B and B'.

It is clear that, for the reasons above stated concerning conduits B_3, the liquid is compelled to circulate through the various conduits B'_3 above referred to.

Of course, I may make use of any suitable means for accelerating or controlling (either at will or automatically) the flow of the fluid which circulates through any of the circuits A, B and B'. In particular, I may feed said circuit A with air under pressure fed by the compressor of the engine, when the latter is supercharged, or again with air coming from an auxiliary blower.

In all cases, with a system embodying the above described features, I obtain an internal combustion engine the head piece of which is cooled in a methodic and particularly efficient manner, especially concerning the bosses *b* located on the side of the inlet valves, which contribute in obtaining a high efficiency of said engine.

The system above described is sufficient for considerably improving the working of an internal combustion engine, but I may further make use of other arrangements, capable of being eventually employed separately.

According to one of these features, which will be supposed, in the following description, to be applied to the engine above described, the cylinders 1 of said engine, which are advantageously provided with cooling ribs 2, are surrounded by a kind of casing 9 in the walls of which holes 10 are provided at suitable places, for instance opposite the median part of cylinders 1, so as to improve the cooling thereof.

Preferably in this case, the casing in question will be made integral with head piece 3, and it will bear, through its lower part, against the casing which surrounds the crankshaft of the engine, to which casing it may be fixed, for instance, by means of assembling bolts.

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 accompanying claims.

What I claim is:

1. In an internal combustion engine including at least one cylinder and a piston movable in said cylinder, with gas inlet means in said cylinder, a head for said cylinder, at least one air cooling circuit in said head passing close to and in direct heat exchange relation with the walls of the cylinder adjacent said gas inlet means, and at least one liquid cooling circuit passing along and in direct heat exchange relation with at least the major part of the hotter portions of the cylinder walls.

2. In an internal combustion engine including a plurality of cylinders and a head for said cylinders forming partitions between two adjacent cylinders, at least two distinct cooling circuits in said head, one of said circuits being adapted for a liquid and including passages provided in said partitions and arranged in such manner that said liquid is compelled to flow therethrough.

3. In an internal combustion engine including a plurality of cylinders and a head for said cylinders forming partitions between two adjacent cylinders, at least one air cooling circuit formed in said head, and at least one liquid cooling circuit formed in said head including passages provided in said partitions and arranged in such manner that said liquid is compelled to flow therethrough and cannot remain stationary therein.

4. In an internal combustion engine including a plurality of cylinders forming at least one bank, pistons movable in said cylinders and inlet valves for said cylinders, a head common to said cylinders, at least one air cooling circuit formed in said head and including a main conduit running along said bank of cylinders on the side corresponding to said inlet valves in direct heat exchange relation with the cooler parts of the cylinder walls, and at least one liquid cooling circuit formed in said head passing along and in direct heat exchange relation with at least the major part of the hotter portions of the cylinder walls.

5. In an internal combustion engine including a plurality of cylinders forming at least one bank of cylinders, pistons movable in said cylinders respectively, and exhaust valves all located on one side of said bank of cylinders, a head common to all of said cylinders, at least one air cooling circuit formed in said head, passing along and in direct heat exchange relation with at least the major part of the cooler portions of the cylinder walls, and at least one liquid cooling circuit formed in said head and including a main conduit running longitudinally of said bank of cylinders on the side thereof corresponding to said exhaust valves in direct heat exchange relation with the hotter parts of the cylinder walls.

6. In an internal combustion engine including a plurality of cylinders forming at least one bank of cylinders, pistons movable in said cylinders respectively, inlet valves for said cylinders all located on one side of said bank of cylinders, exhaust valves for said cylinders all located on the other side of said bank of cylinders, and ignition plug supporting bosses carried by said cylinders near said inlet and exhaust valves respectively, a head common to all of said cylinders, at least one air cooling circuit formed in said head, and at least one liquid cooling circuit formed in said head and including a main conduit running longitudinally of said bank of cylinders on the side thereof corresponding to said exhaust valves and passages extending to the other side of said head so as to pass near the bosses corresponding to the inlet valves.

7. In an internal combustion engine including a plurality of cylinders forming at least one bank of cylinders, and pistons movable in said cylinders respectively, a head common to all of said cylinders, inlet valves for said cylinders located in said head all on one side of said bank of cylinders, exhaust valves for said cylinders located in said head all on one side of said bank of cylinders opposed to the side on which said inlet valves are located, ignition plug supporting bosses carried by said cylinders near said inlet and outlet valves respectively, at least one air cooling circuit formed in said head, and at least two liquid cooling circuits formed in said head and distinct from each other over at least a portion of their path, one of said liquid cooling circuits including a main conduit running longitudinally of said bank of cylinders on the side thereof corresponding to said exhaust valves and passages extending from said conduit to the other side of said head so as to pass near the bosses corresponding to the inlet valves.

8. In an internal combustion engine including

a plurality of cylinders forming at least one bank of cylinders, and pistons movable in said cylinders, respectively, a head common to all of said cylinders, inlet valves for said cylinders located in said head all on one side of the middle plane of said bank of cylinders, exhaust valves for said cylinders located in said head all on the other side of said middle plane, ignition plug supporting bosses carried by said cylinders near said inlet and outlet valves respectively, at least one air cooling circuit formed in said head, including a main passage running longitudinally of said bank of cylinders on the side of the middle plane thereof corresponding to said inlet valves, and a liquid cooling circuit formed in said head running longitudinally of said bank of cylinders on the side of the middle plane thereof corresponding to said exhaust valves, said circuit including passages extending to the other side of said plane so as to pass near the bosses corresponding to the inlet valves.

9. In an internal combustion engine including a plurality of cylinders forming at least one bank of cylinders, and pistons movable in said cylinders, respectively, a head common to all of said cylinders, inlet valves for said cylinders located in said head all on one side of the middle plane of said bank of cylinders, exhaust valves for said cylinders located in said head all on the other side of said middle plane, ignition plug supporting bosses carried by said cylinders near said inlet and exhaust valves respectively, at least one air cooling circuit formed in said head, including a main passage running longitudinally of said bank of cylinders on the side of said middle plane thereof corresponding to the inlet valves, and at least two distinct liquid cooling circuits formed in said head, including each a main conduit running longitudinally of said bank of cylinders on the side of the middle plane of said bank corresponding to the exhaust valves, at least one of the two last mentioned circuits including passages extending to the other side of said plane so as to pass near the bosses corresponding to the inlet valves.

10. In an internal combustion engine including a plurality of cylinders forming at least one bank of cylinders, and pistons movable in said cylinders, respectively, a head common to all of said cylinders, partitions between said cylinders carried by said head, inlet valves for said cylinders located in said head all on one side of the middle plane of said bank of cylinders, exhaust valves for said cylinders located in said head all on the other side of said middle plane, ignition plug supporting bosses carried by said cylinders near said inlet and exhaust valves respectively at least one air cooling circuit formed in said head, including a main passage running longitudinally of said bank of cylinders on the side of said middle plane thereof corresponding to the inlet valves, and at least one liquid cooling circuit in said head including a main conduit running longitudinally of said bank of cylinders on the side of the middle plane of said bank corresponding to the exhaust valves, at least one conduit in series with said liquid circuit provided in each of said partitions, said last mentioned circuit including passages extending to the other side of said plane so as to pass near the bosses corresponding to the inlet valves.

11. In an internal combustion engine including a plurality of cylinders forming at least one bank of cylinders, and pistons movable in said cylinders, respectively, a head common to all of said cylinders, inlet valves for said cylinders located in said head all on one side of the middle plane of said bank of cylinders, exhaust valves for said cylinders located in said head all on the other side of said middle plane, at least one air cooling circuit formed in said head, including a main passage running longitudinally of said bank of cylinders on the side of the middle plane thereof corresponding to the inlet valves, and at least one liquid cooling circuit in said head including a main passage running longitudinally of said bank of cylinders on the side of the middle plane of said bank corresponding to the exhaust valves, said two longitudinal passages being adapted to be closed at will at either of their ends.

12. In an internal combustion engine including a plurality of cylinders forming at least one bank of cylinders, and pistons movable in said cylinders, respectively, a head common to all of said cylinders, inlet valves for said cylinders located in said head all on one side of the middle plane of said bank of cylinders, two exhaust valves for each of said cylinders, all of said exhaust valves being located on the other side of said middle plane of the bank of cylinders, at least one air cooling circuit formed in said head especially adapted to cool said inlet valves, and at least one liquid cooling circuit formed in said head arranged especially to cool said exhaust valves, including conduits passing between the two exhaust valves of each cylinder.

13. In an internal combustion engine including a plurality of cylinders forming at least one bank of cylinders, and pistons movable in said cylinders, respectively, a head common to all of said cylinders, inlet valves for said cylinders located in said head, outlet valves for said cylinders located in said head, at least one air cooling circuit formed in said head especially adapted to cool said inlet valves, two liquid cooling circuits formed in said head adapted especially to cool said exhaust valves, and a common return passage for both of said liquid cooling circuits formed in said head.

14. In an internal combustion engine including a plurality of cylinders, pistons movable in said cylinders, respectively, the combination of a head common to all of said cylinders forming partitions between two adjacent cylinders, inlet valves for said cylinders located in said head, exhaust valves for said cylinders located in said head, at least one air cooling circuit formed in said head especially adapted to cool said inlet valves, and at least one liquid cooling circuit formed in said head arranged especially to cool said exhaust valves, including in series conduits provided in said partitions.

15. In an internal combustion engine including a plurality of cylinders, pistons movable in said cylinders, respectively, the combination, of a head common to all of said cylinders forming partitions between two adjacent cylinders, inlet valves for said cylinders located in said head, exhaust valves for said cylinders located in said head, at least one air cooling circuit formed in said head especially adapted to cool said inlet valves, two liquid cooling circuits formed in said head especially adapted to cool said exhaust valves, at least one of said liquid cooling circuits including in series conduits provided in said partitions, and a common return passage for both of said liquid cooling circuits.

16. In an internal combustion engine including a plurality of cylinders, pistons movable in said cylinders, respectively, the combination of a head

common to all of said cylinders, inlet valves for said cylinders located in said head, exhaust valves for said cylinders located in said head, at least one air cooling circuit in said head and one liquid cooling circuit in said head, and one casing supported by said head surrounding said cylinders, provided with holes for the passage of air therethrough.

17. In an internal combustion engine including a plurality of cylinders forming at least one bank, pistons movable in said cylinders and inlet and exhaust valves for said cylinders, a head common to said cylinders, at least one air cooling circuit formed in said head and including a main conduit running along said bank of cylinders on the side corresponding to said inlet valves in direct heat exchange relation with the cooler parts of the cylinder walls, and at least one liquid cooling circuit formed in said head and including a main conduit running longitudinally of said bank of cylinders on the side thereof corresponding to said exhaust valves and in direct heat exchange relation with the hotter parts of the cylinder walls.

LOUIS BIRKIGT.