ABSTRACT: A compression-ignition internal combustion engine cylinder head contains an air inlet duct having two outlets encircled by the seats of two inlet valves of a cylinder. The duct extends from a lateral head surface to one outlet and thence to the other. A single covering shield shaped as a circular segment at the commencement of the one outlet has the ends of its inner edge on a line approximately radial of the cylinder as viewed axially and inclined to the axis of the associated valve, and has its inner edge, at the closest approach thereof to the latter axis, spaced from the latter axis an amount 0.25 to 0.45 times the inner diameter of the associated valve seat.
BACKGROUND OF THE INVENTION

1. Field of the Invention.

This invention relates to a cylinder head for a compression-ignition internal combustion engine with fuel injection transversely to air flow circulating about the cylinder axis. The head contains a swirl-producing inlet duct which leads from a single inlet at an outwardly facing lateral surface of the cylinder head to two curving outlets situated one after the other in the direction of flow of the entering air and encircled by respective valve seats for inlet valves mounted in the cylinder head. As viewed substantially at right angles to the cylinder axis and the longitudinal axis of the duct, the duct extends arcuately and in a narrowing fashion towards the valve seats situated in the cylinder head underside. The commencement region, nearest to the aforementioned outwardly facing lateral surface, of the first outlet leading to the first valve seat is situated nearer to that surface of the cylinder head bounding the end of the working space of the cylinder than is the commencement region, nearest to that lateral surface, of the second outlet leading to the second valve seat. Moreover, looking in an axial direction of the cylinder, the radially inner wall of the duct with respect to the cylinder axis is substantially tangential to the inner peripheries of the valve seats, the radially outer wall of the duct with respect to the cylinder axis extends past the first valve seat in the region of the periphery of the working space and is substantially tangential to the inner periphery of the second valve seat, and a single covering shield in the form of a segment of a circle at the commencement of the first outlet has the ends of its inner edge disposed on a straight line extending approximately radially of the cylinder axis.

2. Description of the Prior Art

A cylinder head with a covering shield at the commencement region, nearest the outwardly facing lateral surface, of the first outlet leading to the first valve seat is known from British Pat. No. 587,276, which differs from the head initially described by a greatly different position and shape of the covering shield and the first outlet, and by the relative position to one another of the aforesaid commencement regions. Findings on which the present invention is based have shown that these differences reduce the air throughput quantity through the first inlet valve and, owing to the position of the shield, prejudice the production of a true eddy flow in the cylinder.

A further head is known from U.S. Pat. Ser. No. 2,318,914 which differs from the construction initially described in that the inlet duct does not start from one but two inlets at the lateral surface and also in that it does not have a covering shield. These differences give a complicated construction of cylinder head and inlet manifold, and also a weak movement of air which is not suitable for the effective formation of fuel-air mixture in a high-speed internal combustion engine with fuel injection transversely to the air circulating in the cylinder.

Finally, a third head is known from U.S. Pat. Ser. No. 3,330,264 which differs from the construction initially described by the existence of covering shields at both outlets and also in that, although the inlet duct follows an arcuate course as viewed perpendicularly to the cylinder axis and its own longitudinal axis, it does not narrow towards the valve seats when so viewed. The throughflow rates of this duct leave much to be desired and also the intensity of the true eddy flow produced is dependent on relatively slight shape and position differences in the covering shields.

The invention has as an object to obviate the disadvantages of known constructions, i.e. to provide a cylinder head which has good throughflow properties, produces an intensive air turbulence in the manner of a true eddy flow adequate for mixture formation in a high-speed internal combustion engine with fuel injection transversely to the air circulating in the cylinder, and the airflow produced by which is also substantially insensitive to dimensional and position variations of the covering shield due to manufacturing tolerances.

SUMMARY OF THE INVENTION

According to the present invention, there is provided in combination, a cylinder for a compression-ignition internal combustion engine having fuel injection transversely to airflow about the cylinder axis, a cylinder head of said cylinder, first portions of said cylinder head defining an outwardly facing lateral surface thereof, first and second inlet valve means in said cylinder head and spaced-apart about the axis of said cylinder, the first inlet valve means being nearer to said lateral surface than is the second inlet valve means, second portions of said cylinder head defining a bounding surface thereof bounding an end of the working space of said cylinder, third portions of said cylinder head defining first and second inlet valve seats for said first and second inlet valve means, fourth portions of said cylinder head defining an inlet duct having a single inlet in said lateral surface and first and second outlets encircled by the respective valve seats, said inlet duct extending to the first outlet and thence immediately to the second outlet, having an outer lateral surface which is radially outer with respect to the cylinder axis, and having an inner lateral surface which is radially inner with respect to the cylinder axis, and a single covering shield in the form of a segment of a circle disposed at the commencement of the first outlet and having inner and outer edges of which the inner edge is nearer to the axis of said first inlet valve means than is the outer edge, the arrangement being such that:

a. as viewed in an axial direction of said cylinder said inner lateral surface surface is substantially tangential to the inner peripheries of said seats and said outer lateral surface extends past the first inlet valve seat in the region of the periphery of said working space and is substantially tangential to the inner periphery of the second inlet seat,

b. as viewed substantially perpendicularly to the cylinder axis and the longitudinal axis of said inlet duct, said inlet duct curves arcuately towards said seats and meanwhile narrows,

c. that commencement region of said first outlet nearest to said lateral surface is nearer to said bounding surface than is that commencement region of said second outlet nearest to said lateral surface,

d. said inner edge extends, at an obtuse inclination with respect to said axis of said first inner edge means, from said commencement region of said first outlet to said commencement region of said second outlet and, at its closest approach to said axis of said first inner edge means, is spaced a distance from this axis of between 0.25 and 0.45 times the inner diameter of said first inlet valve seat, and, as viewed in said axial direction, the two ends of said inner edge are disposed on a straight line which extends approximately radially of said cylinder axis.

Conveniently, it is possible to avoid having a very small spacing of the shield inner edge from the first inlet valve means with a given relatively large shield surface, which spacing would be unfavorable from the flow point of view, by arranging that, looking in the axial direction of the cylinder, the covering shield is crescent-shaped with the inner edge concave.

BRIEF DESCRIPTION OF THE DRAWING

In order that the invention may be clearly understood and readily carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

FIG. 1 shows a vertical section through a cylinder head of a compression-ignition internal combustion engine, the section being taken on the line I-I of FIG. 2, which contains the longitudinal axis of an air inlet duct of the cylinder head,

FIG. 2 shows a section taken on the line II-II of FIG. 1,

FIG. 3 shows a section taken on the line III-III of FIG. 2,

FIG. 4 shows a section taken on the line IV-IV of FIG. 2,
FIG. 5 shows a detail of FIG. 2, but with a differently shaped covering shield.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 to 4, the inlet duct leads from an inlet 1 in an outwardly facing lateral surface of the cylinder head to a first outlet 9 and thence, in the flow direction of the entering air, to a second outlet 11 of the duct. The inlet poppet valves 5 and 6 mounted in the cylinder head 4 cooperate with valve seats 2 and 3 enclosing the outlets 9 and 11 and situated in the undersurface 7 of the cylinder head bounding the stippled and the working space of the cylinder. As viewed in FIG. 1, the inlet duct extends arcuately towards the valve seats 2 and 3 and meanwhile narrows. That commencement region 8 of the outlet 9 nearest to the inlet 1 and the undersurface 7 is situated nearer to the cylinder head undersurface 7 than that commencement region 1 of the outlet 11 nearest the inlet 1 and the undersurface 7. As viewed in FIG. 2, that lateral surface 12 of the inlet duct which is radially inner with respect to the axis 19 is tangential to the inner peripheries 13 and 14 of the valve seats 2 and 3, while that lateral surface 15 of the inlet duct which is radially outer with respect to the axis 19 extends past the first valve seat 2 in the vicinity of the periphery 16 of the cylinder working space, and is tangential to the inner periphery 14 of the second valve seat 3. Arrangement at the commencement of the outlet 9 is a covering shield 17 which is in the form of a segment of a circle and which, as FIG. 3 shows, emerges out of the commencement region 8 and forms a portion of the cylinder head casing. As viewed in FIG. 2, the inner edge 18 of the covering shield 17 extends approximately on a radius 20 from the cylinder axis 19. The inner edge 18 is obliquely inclined to the plane of the first inlet valve 5. The covering shield 17 and its inner edge 18 extend from the commencement region 8 to the commencement region 10. At its closest approach to the axis 21, the inner edge 18 has a spacing a from the axis 21 which amounts to 0.25 to 0.45 times the internal diameter d of the first valve seat 2. The covering shield 22 shown in FIG. 5 differs from the shield 17 by being crescent-shaped as viewed in FIG. 5, the inner edge 19 being concave, and a chord 24 drawn from one to the other of the ends of the edge 23 extends approximately in the direction of the radius 20.

The operation of the arrangement described hereinbefore can be explained as follows:

The fuel is injected into the cylinder by an injection nozzle 25, arranged on, or close to, the cylinder axis 15, as several individual jets shortly before the piston reaches top dead center. The individual fuel jets (not shown) are directed radially outwards from the nozzle nose at a slight inclination away from the undersurface 7. To illustrate the formation of the fuel-air mixture, it is assumed that the air particles circulating in the cylinder must just pass through one sector between two adjacent fuel jets during the injection period of a good mixture to be formed. It is assumed that one individual fuel jet is so blown that it approximately fills the next sector downstream and finds there the air necessary for its combustion. Tests have shown that a specific whirling speed gives the best mixture formation for a specific injection duration and a specific number of fuel jets. When the piston moves downwards during the admission stroke, the cylinder contents are given, owing to the described shape and arrangement of the covering shield 17 or 22 and of the inlet duct, particularly the second outlet 11, a circulating motion about the cylinder axis 19, which is maintained during the following compression stroke. The requirement that the circulating air particles should just travel through the sectors between the individual fuel jets during the duration of injection is met by a so-called true eddy, wherein the speed of the air particles at the periphery 16 is greater than in the vicinity of the cylinder axis 19. This is achieved by the arrangement of the covering shield 17 or 22, and by the form of the inlet duct, in particular the second outlet 11, which has the result that the airflowing into the cylinder is forced outwards against the periphery 16. The optimum mixture form.

The effects of the configurations of the inlet duct and the covering shield 17 or 22 can be explained as follows:

From an open poppet valve, the air flows approximately in the direction of the seat surface i.e. obliquely downwards. If an inlet duct which is coaxial with the valve axis leads to this valve, the speed and direction of the air entering the cylinder are identical over the entire circumference of the valve. Such an airflow cannot amplify or rotary movement in the cylinder, since, considering the velocity vectors of the valve circumference, the components thereof in a transverse plane at right angles to the cylinder axis cancel one another out since they are of equal magnitude and directed oppositely to one another.

If an inlet duct of which the main direction extends transversely to the valve axis is led to an open poppet valve, the speed distribution of the air issuing at the valve circumference is unequal, and in fact the speed of the airflowing through the valve gap is greatest where the airflowing from the inlet duct is subjected to the least deflection, and is smallest where it experiences the greatest deflection. Thus, in respect of the air flowing from the inlet duct, the velocity factors disposed as a continuation of the tangential flow in the inlet duct are therefore the maxima and so also are those components in the plane perpendicular to the cylinder axis. A vectorial addition of the velocity components in this plane gives a resultant which obliges the air situated in the cylinder to carry out a rotational movement when the valve is arranged, as usual, to one side of the cylinder axis and in the vicinity of the periphery of 18 of the valve seat 2. The airflowing through the outlet 9 is therefore considerably deflected in the direction of the outlet 11, and the airflowing in the cylinder axis 21 towards the noncovered circumference. The airflowing through the outlet 9 is therefore obliged to take this direction, which in the present case coincides with the line III-III as viewed in FIG. 2.

An effective airflow into the cylinder, i.e. an air inflow directed appropriately for stimulating the necessary true eddy flow and of an adequate strength, not only requires an appropriate shape and position of the inlet duct and the covering shield, but also requires an accelerated flow in the region of the outlets 9 and 11 as free from loss and detachment as possible. This requirement is met by the narrowing cross-sectional course of the outlet 11, and the arrangement of the covering shield 17, which leads the airflow into the outlet 11 without substantial turbulence formation. The flow about the covering shield to the valve seat 2 is in fact not turbulence-free, but the airflow issuing from the valve 5 would not be able to contribute to producing the necessary true eddy flow without the directing effect of the shield 17. The inclined position of the inner edge 18 and the indicated values for the spacing a, how-

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ever, have the effect that the turbulence losses are within acceptable limits having regard to the desired overall result.

I claim:

1. In combination, a cylinder for a compression-ignition internal combustion engine having fuel injection transversely to airflow about the cylinder axis, a cylinder head of said cylinder, first portions of said cylinder head defining an outwardly facing lateral surface thereof, first and second inlet valve means in said cylinder head and spaced-apart about the axis of said cylinder, the first inlet valve means being nearer to said lateral surface than is the second inlet valve means, second portions of said cylinder head defining a bounding surface thereof bounding an end of the working space of said cylinder, third portions of said cylinder head defining first and second inlet valve seats for said first and second inlet valve means, fourth portions of said cylinder head defining an inlet duct having a single inlet in said lateral surface and first and second outlets encircled by the respective valve seats, said inlet duct extending to the first outlet and thence immediately to the second outlet, having an outer lateral surface which is radially outer with respect to the cylinder axis, and having an inner lateral surface which is radially inner with respect to the cylinder axis, and a single covering shield for said cylinder head in the form of a segment of a circle disposed at the commencement of the first outlet and having inner and outer edges of which the inner edge is nearer to the axis of said first inlet valve means than is the outer edge, the arrangement being such that:

a. as viewed in an axial direction of said cylinder, said inner lateral surface is substantially tangential to the inner peripheries of said seats and said outer lateral surface extends past the first inlet valve seat in the region of the periphery of said working space and is substantially tangential to the inner periphery of the second inlet valve seat,
b. as viewed substantially perpendicularly to the cylinder axis and the longitudinal axis of said inlet duct, said inlet duct curves accurately towards said seats and meanwhile narrows,
c. that commencement region of said first outlet nearest to said lateral surface is nearer to said bounding surface than is that commencement region of said second outlet nearest to said lateral surface,
d. said inner edge extends, at an oblique inclination with respect to said axis of said first inlet valve means, from said commencement region of said first outlet to said commencement region of said second outlet, and, at its closest approach to said axis of said first inlet valve means, is spaced a distance from this axis of between 0.25 and 0.45 times the inner diameter of said first inlet valve seat, and, as viewed in said axial direction, the two ends of said inner edge are disposed on a straight line which extends approximately radially of said cylinder axis.

2. A combination according to claim 1, wherein, as viewed in said axial direction, said covering shield is crescent-shaped, said inner edge being concavely curved.