July 11, 1967 A. URLAUB 3,330,264

CYLINDER FOR AN INTERNAL COMBUSTION ENGINE

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FIG. 1

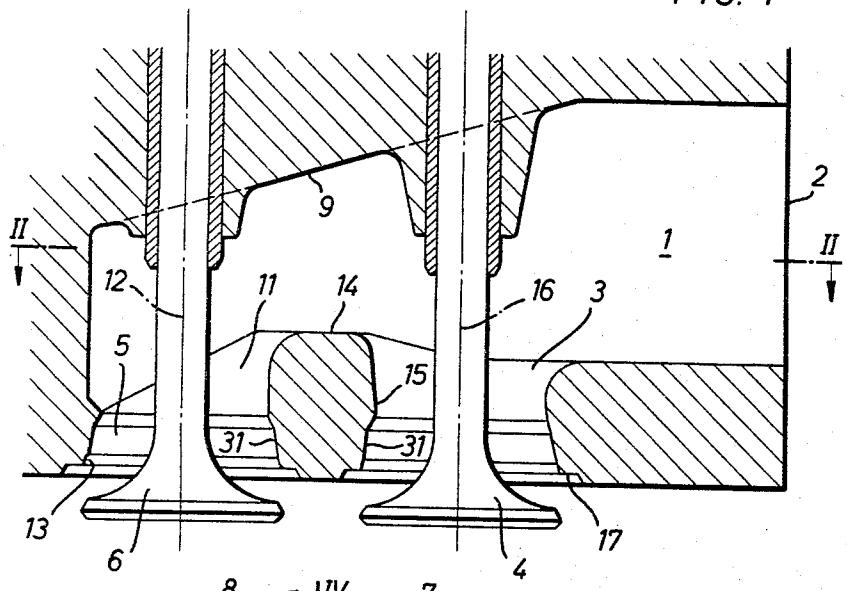
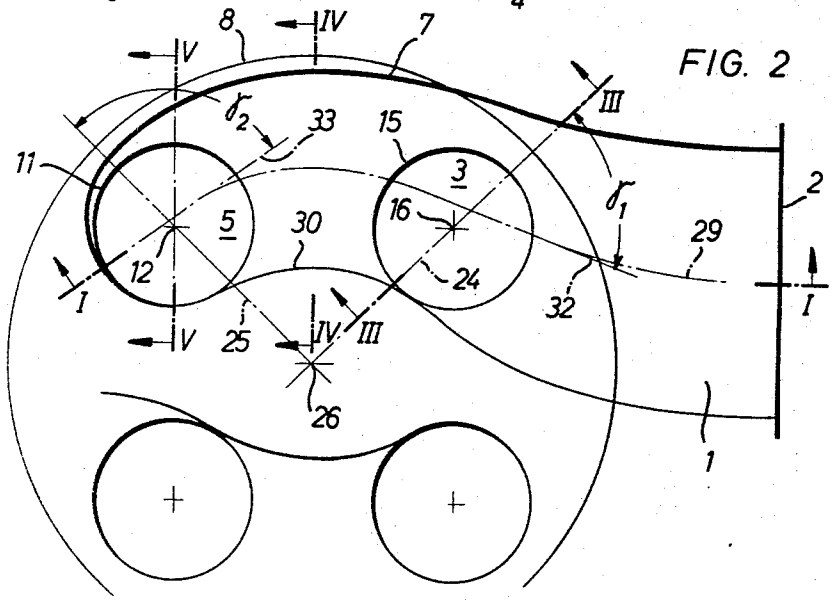


FIG. 2



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CYLINDER FOR AN INTERNAL COMBUSTION ENGINE
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FIG. 3

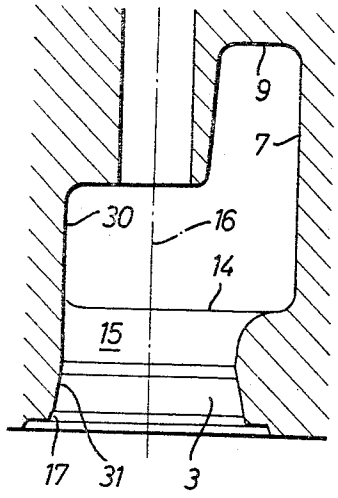


FIG. 8

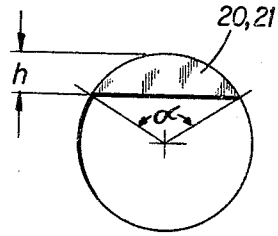


FIG. 4

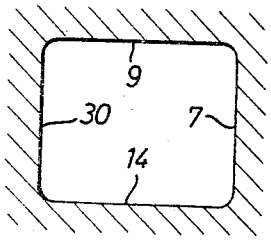


FIG. 9

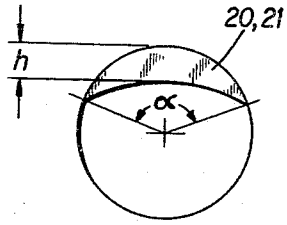


FIG. 5

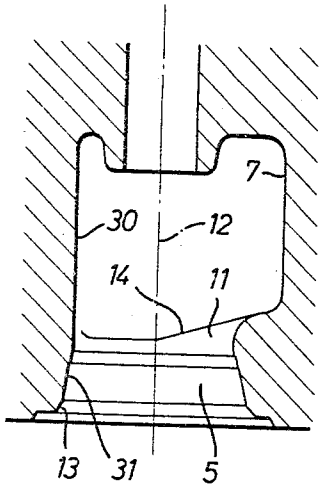
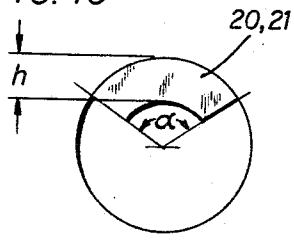


FIG. 10



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FIG. 6

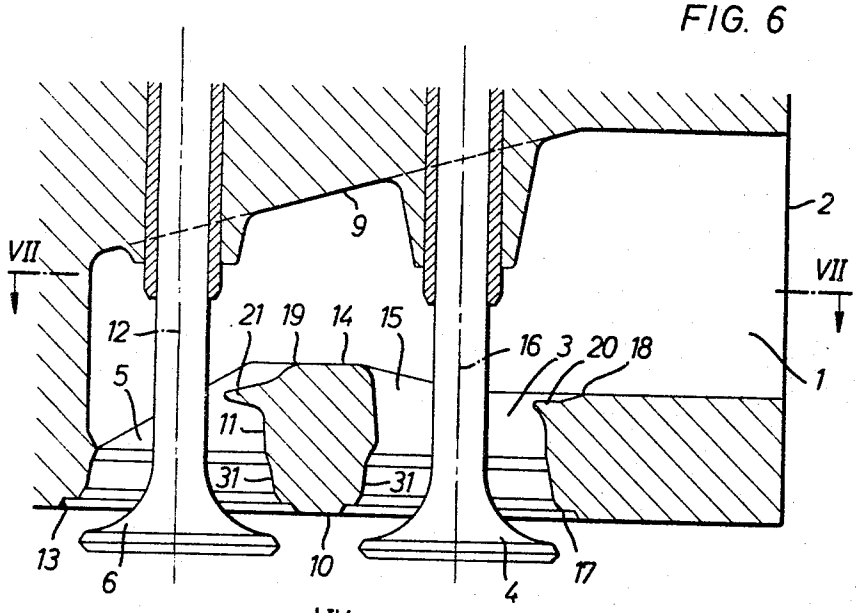
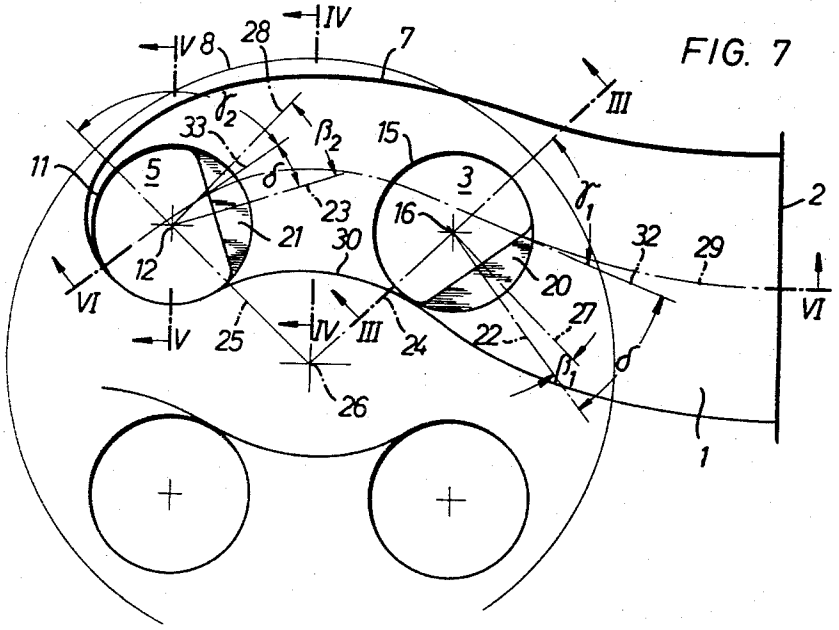


FIG. 7



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FIG. 11

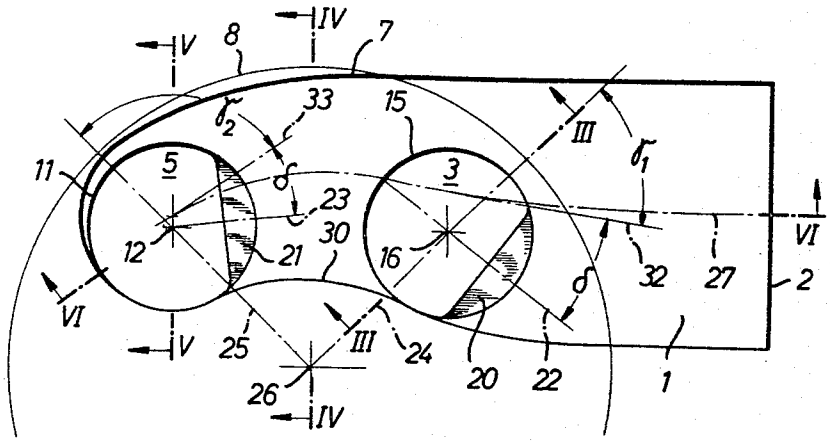
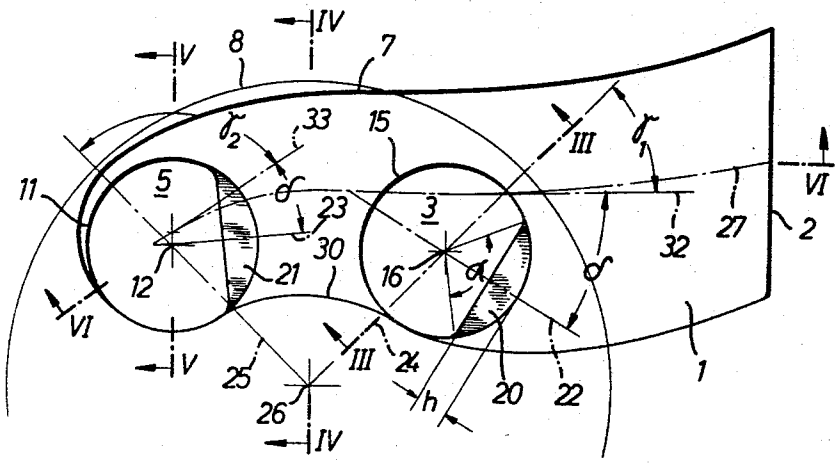


FIG. 12



United States Patent Office

3,330,264

Patented July 11, 1967

3,330,264

CYLINDER FOR AN INTERNAL COMBUSTION ENGINE

Alfred Urlaub, Griesheim, Germany, assignor to Motoren-Werke Mannheim AG., vorm. Benz Abt. Stat. Motorenbau, Mannheim, Germany, a German company

Filed Aug. 9, 1965, Ser. No. 478,046
6 Claims. (Cl. 123—193)

ABSTRACT OF THE DISCLOSURE

An internal combustion engine cylinder is provided with a cylinder head having an outwardly facing lateral surface. Two inlet valves are provided in the cylinder head and are spaced about the cylinder axis, one of the inlet valves being nearer to that lateral surface than is the other inlet valve. The inlet valves include respective inlet valve seats and respective inlet valve ports of circular cross-section encircled by the valve seats and opening into a working space of the cylinder at a bounding surface of the cylinder head bounding an end of the working space. An inlet duct extends from the lateral surface to one inlet valve port and thence to the other inlet valve port and has first and second surfaces which extend in planes transverse to the cylinder axis, a lateral, outer, third surface which is radially outer with respect to the cylinder axis, and a lateral, inner fourth surface which is radially inner with respect to the cylinder axis. As viewed in an axial direction of the cylinder, the fourth surface is tangential to the ports and the third surface lies in the region of the periphery of the working space. Moreover, as viewed in the axial direction, the area of the duct between the third surface and the fourth surface has a mean line passing radially outwardly of the axis of the one inlet valve with respect to the cylinder axis. Furthermore, also as viewed in the axial direction, a radial line from the cylinder axis through the axis of the one inlet valve and intersecting the mean line includes an angle of from 90° to 30° with a tangent to the mean line at the point of intersection of the mean line with the radial line.

This invention relates to a cylinder for an internal combustion engine.

It is one object of my invention to improve the flow conditions of the air whirling in the cylinder with regard to a good mixture formation. This object is to be achieved solely by the position and form of the inlet duct.

It is another object of my invention to improve the flow conditions of the air whirling in the cylinder with regard to a good mixture formation by a special arrangement of masks in the region of the inlet ports.

According to the present invention, there is provided in combination, a cylinder for an internal combustion engine, 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 which are provided in said cylinder head and spaced apart about the axis of said cylinder and of which the first inlet valve means is 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 of said first and second inlet valve means and first and second inlet valve ports of said first and second inlet valve means of substantially circular cross-section and encircled by said first and second valve seats and opening into said working space at said bounding surface, and fourth portions of said cylinder head defining an inlet duct extending from said lateral surface to the first inlet valve port and thence to the second inlet valve port, communicating with said first and second inlet valve ports, having first and second surfaces which extend in planes transverse to the cylinder axis, having a lateral, outer, third surface which is radially outer with respect to said cylinder axis, and having a lateral inner, fourth surface which is radially inner with respect to said cylinder axis, the combination having the following features:

(a) As viewed in an axial direction of said cylinder, said inner, fourth surface is substantially tangential to said ports and said outer, third surface lies in the region of the periphery of said working space,

(b) As viewed in said axial direction, the area of said duct between said third surface and said fourth surface has a mean line (i. e. a line joining the centres of those circles having said third surface and said fourth surface as envelope curves) passing radially outwardly of the axis of said first valve means with respect to said cylinder axis, and

(c) As viewed in said axial direction, a radial line from said cylinder axis through the axis of said first valve means and intersecting said mean line includes an angle of from 90° to 30° with a tangent to said mean line at the point of intersection of said mean line with said radial line.

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:

FIGURE 1 is a vertical section through a cylinder head of a diesel engine and taken along the mean line I—I of FIGURE 2, the inlet valves being displaced into the plane of the section for better illustration,

FIGURE 2 is a diagrammatic horizontal section along the line II—II of FIGURE 1, but with parts omitted,

FIGURE 3 is a section along the line III—III in FIGURE 2 or 7,

FIGURE 4 shows a section along the line IV—IV in FIGURE 2 or 7,

FIGURE 5 shows a section along the line V—V in FIGURE 2 or 7,

FIGURE 6 shows a vertical section through a modified version of the cylinder head and taken along the camber line VI—VI of FIGURE 7, the inlet valves again being displaced into the plane of the section for better illustration.

FIGURE 7 is a diagrammatic horizontal section along the line VII—VII of FIGURE 6, but again with parts omitted,

FIGURES 8, 9 and 10 are plan views of various forms of masks of the inlet valve ports,

FIGURES 11 and 12 are views similar to FIGURE 7, but showing further modified versions of the cylinder head.

Referring to the drawings, the cylinder head is formed with an inlet duct **1** which extends from an outwardly facing lateral surface **2** and with steady reduction in cross-section to a first inlet valve port **3**, which is closable by a first inlet valve closure member **4**, and thence with a reduced or constant cross-section to a second inlet valve port **5**, which is closable by a second inlet valve closure member **6**. Both valves open and close simultaneously. That lateral surface **7** of the inlet duct which is radially outer with respect to the cylinder axis **26** extends from the surface **2** to a location which is close to the circumference **8** of the cylinder working space as seen in plan and which is in the region of the first valve port **3**, and remains near the circumference **8** until in the region of the second valve port **5**. The ceiling **9** of the inlet duct **1** extends parallel to, or with a downward gradient in relation to, that surface of the cylinder head bounding the end of the working space (the surface **10** in FIGURE 6), in order to

merge in the vicinity of the second inlet valve into a short cylindrical section **11** of the port **3** which section is arranged concentrically of the valve axis **12** and leads towards the second valve seat **13**. The inlet duct floor **14** extends as far as the second valve with an upward gradient, or parallel to the surface **10** and merges at the first valve port **3** into a short cylindrical section **15** of the port **3**, which section is arranged concentrically of the valve centre **16** and leads towards the first valve seat **17**. The short sections **11** and **15** can also have the form of an obliquely sectioned cylinder or sections of a ring. From the valve seats **13** and **17**, the ports **3** and **5** can be provided with slightly conical (see FIGURE 1) or cylindrical walls **31** with conical transitions from the sections **11** and **15**.

As shown in FIGURES 6 and 7, at the points of transition **18** and **19** between the duct floor **14** and the short sections **11** and **15**, there are arranged covering masks **20** and **21** which project approximately as a continuation of the duct floor **14** into the short sections **11** and **15**. The masks **20** and **21** extend on both sides of centre lines **22** and **23** thereof which extend radially from the centres **12** and **16** of the inlet valves. As will be seen from FIGURE 7, each centre line **22**, **23** is situated between a radial line **24**, **25** from the axis **26** of the cylinder through the axis **12**, **16** of the associated valve, and a perpendicular **27**, **28** to the line **24**, **25**, which perpendicular intersects the axis **12**, **16** and extends from the axis **12**, **16** towards the surface **2**. The angle β between the centre line **22**, **23** and the perpendicular **27**, **28** can be smaller at the valve port **3** than at the valve port **5**. A preferred value with which the maximum dimensional components are produced over the entire cylinder cross-section is $\beta_1=0°$ and $\beta_2=30°$, β_1 being the angle at the first valve port **3** and β_2 being the angle at the second valve port **5**.

FIGURE 7 shows the mean camber line **29** of the inlet duct, i.e. the line joining the centres of those circles having the radially outer lateral surface **7** and the radially inner lateral surface **30** of the duct **1** as enveloped curves, the line **29** passing radially outwardly of the valve axes **12** and **16** in relation to the cylinder axis **26**, and in fact with a larger spacing from the valve axis **16** than from the valve axis **12**. It could instead pass radially outwardly of the valve axis **16** only. The inner lateral surface **30** is tangential to the surfaces of the short cylindrical sections **11** and **15**. The mean line **29** intersects the radial line **24** of the first inlet valve at an angle γ_1 of the 90° to 30°. The line **29** intersects the line **25** of the second inlet valve at an angle γ_2 of about 100°. As shown in FIGURES 8, 9 and 10, the masks **20**, **21** may be in the form of a crescent or segment sector. For each mask, preferred values of the maximum dimensions h radially of the associated valve, and the angle α subtended at the valve axis, are $h=0.24d$ and $\alpha=110°$ for the sector and segment and $h=0.22d$ and $\alpha=145°$ for the crescent, d being the smallest diameter of the short cylindrical section **11**, **15**. The masks can be produced by casting, the rounding of the edges and the wall thicknesses of the mask being of no great importance. Of chief importance as regards the influence of each mask on the movement of the air in the cylinder are the ratio between the mask surface area and the open cross-sectional area of the associated short cylindrical section, and the direction of the centre line of the mask. Tangents **32** and **33** to the line **29** at the points at which the radial lines **24** and **25** intersect the line **29** include, with the respective centre lines **22** and **23**, angles δ which can be between 20° and 40°. A preferred value of the angle δ, with which the maximum peripheral components are produced through the entire transverse plane of the cylinder is $\delta=30°$.

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

The fuel is injected into the cylinder, from an injection nozzle (not shown) arranged on, or close to, the axis **26**

of the cylinder, as several separate jets just before the piston reaches top dead-centre. The separate jets of fuel (not shown) are directed radially outwards from the tip of the nozzle, usually at a slight inclination away from the surface **10**. For illustrating the formation of the mixture, there is used as a basis the assumption that the air particles circulating in the cylinder must just pass through the sectors between the separate fuel jets during the injection period if a good mixture is to be formed. It is assumed that the individual fuel jet is so blown that it substantially fills the next sector downstream and finds there the air which is necessary for the combustion thereof. Whether this auxiliary assumption is actually correct cannot of course be said with certainty. However, it is established that a quite specific whirling speed with a specific injection period and number of fuel jets provides the best mixture formation. When the piston moves downwardly during the suction stroke, the contents of the cylinder, because of the described arrangement of the valve ports and masks are given a circulating motion around the cylinder axis, which is maintained during the subsequent compression stroke. This whirling effect obviously has a tendency to form a potential eddy, to which the equation $r.u$=constant is applicable, in which r is the radius on which an air particle in question circulates and u is its peripheral speed. Such a form of eddy, in which the peripheral speed of the individual air particles in the vicinity of the eddy axis is greater than at the circumference of the working space does not satisfy the requirement set forth above that the sectors between the separate fuel jets are just traversed by the circulating air particles during the injection time. This condition is in fact met by a so-called true eddy, to which the equation u/r=constant is applicable. In order to produce a true eddy, the velocity of the air particles at the circumference of the working space must be higher than in the vicinity of the eddy axis and this is achieved by the arrangement described, which causes the inflowing air to be displaced outwardly towards the cylinder circumference to such an extent as to counteract the tendency of the eddy left to itself during the compression stroke to assume the form of a potential eddy. It is also conceivable that a velocity distribution with the velocity in the vicinity of the circumference of the cylinder even higher than with a true eddy could produce a better mixture formation, because the air for combustion acts on the individual fuel jet mainly in its outer region of travel in which it is more strongly loosened and vapourised than nearer to the eddy axis. The position of the mean line, in particular the value of the angle γ_1, is decisive as regards the displacement of the inflowing air towards the cylinder circumference. Furthermore, mask positions between the angles $\beta=0°$ and $\beta=90°$ and also $\delta=20°$ and $\delta=40°$ with the indicated values for the angles γ_1 and γ_2 permit the obtaining of the most favourable conditions in every case, in which the combustion takes the desired course, which is expressed by the mean effective pressure, position of the torque vertex, exhaust smoke, specific fuel consumption, pressure curve and air exploitation, being optimum. With angle γ_1 in the region of about 45° to 55°, the displacement effect is lower than with angle γ_1 in the range from about 60° to 70° (FIGURES 6 and 7). It is quite generally applicable that, with a given diesel engine and with unmasked valve ports (FIGURES 1 and 2), the volumetric efficiency is at its best and the whirling speed of the air is at its lowest. When using masks (FIGURES 6 to 12) and with increasing surface area thereof, the volumetric efficiency decreases, while the whirling speed increases. However, it is not in any way established that the highest possible whirling speed produces the best combustion with a given internal combustion engine. Moreover, constructional aspects can be important as regards the choice of one of the constructions according to FIGURES 1 and 6. However, in all these cases, it is possible, by inter alia, altering the position of the mean line, and introducing or omitting the

masks, or changing the positions and areas of the masks, to reach a suitable compromise.

The effect of the position of the mean line **29** and of the masks can be explained as follows:

From an open poppet valve, the air flows approximately in the direction of the seating surface, i.e. obliquely downwards. If an inlet duct which is coaxial with the valve axis leads to the valve, then the velocity and direction of the air entering the cylinder are constant over the entire circumference of the valve. Such an air flow cannot cause a rotational movement in the cylinder, because, considering the velocity vectors, the components in a transverse plane perpendicular to the cylinder axis are cancelled out at the circumference of the valve, since they are of the same value and oppositely directed.

If an inlet duct of which the main direction extends transversely of the valve axis leads to an open poppet valve, the velocity distribution at the circumference of the valve is unequal and in fact the velocity of the air flowing through the valve gap is at its greatest where the air flowing from the inlet duct experiences the smallest deflection and is at its smallest where the maximum deflection is caused. The velocity vectors disposed as a continuation of the direction of flow in the inlet duct are therefore the maxima and so are also their components in the transverse plane. A vectorial addition of the velocity components in the transverse plane produce a uniform resultant, which imparts to the air in the cylinder a rotational movement when the valve is arranged in the usual way, i.e. to one side of the cylinder axis and near the cylinder circumference and when the inlet duct extends approximately tangentially of the cylinder circumference. If the transverse components of the velocity vectors of all flows in the inlet duct just before the seat are vectorially added, a resultant transverse component is obtained which extends in the direction of the mean line of the duct. The direction of this resultant transverse component agrees with the direction of the resultant of the transverse components of the velocity vectors at the valve circumference. This means that the direction of the mean line in the region just before the valve seat determines the main direction of the air flowing from the valve.

A similar effect can be produced by a mask arranged on the valve plate or near the seat. In this case, the velocity of the air at those parts of the valve circumference covered by the mask is greatly reduced by the eddy losses caused by the mask. The velocity vectors at those parts of the valve circumference which are covered, and thus their components in the transverse plane, are much smaller than at the uncovered parts of the circumference. By vectorial addition of all transverse components, there is obtained a resultant in the direction of the centre line of the mask and in fact with a direction from the axis of the valve towards the uncovered circumference. The air flowing through the valve is accordingly mainly compelled to flow in this direction.

FIGURES 11 and 12 show the effect of giving the mean line different paths from that of FIGURE 7.

I claim:

1. In combination, a cylinder for an internal combustion engine, 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 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 and first and second inlet valve ports for said first and second inlet valve means of substantially circular cross-section and encircled by said first and second valve seats and opening into said working space at said bounding surface, and fourth portions of said cylinder head defining singular inlet duct extending from said lateral surface to the first inlet valve port and thence to the second inlet valve port, communicating with said first and second inlet valve ports, having first and second surfaces which extend in planes transverse to the cylinder axis, having a lateral, outer, third surface which is radially outwards of said cylinder axis, and having a lateral inner, fourth surface which is radially inwards with respect to said third surface, the arrangement being such that:

(a) as viewed in an axial direction of said cylinder, said inner, fourth surface is substantially tangential to said ports and said outer, third surface lies in the region of the periphery of said working space,

(b) as viewed in said axial direction, the area of said singular duct between said third surface and said fourth surface has a mean line defined by joining the centers of those circles having said third surface and said fourth surface as envelope curves, passing radially outwardly of the axis of said first valve means with respect to said cylinder axis, and

(c) as viewed in said axial direction, a radial line from said cylinder axis through the axis of said first valve means and intersecting said mean line includes an an angle of from 90° to 30° with a tangent to said mean line at the point of intersection of said mean line with said radial line.

2. In combination, a cylinder for an internal combustion engine, 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 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 and first and second inlet valve ports for said first and second inlet valve means of substantially circular cross-section and encircled by said first and second valve seats and opening into said working space at said bounding surface, fourth portions of said cylinder head defining a singular inlet duct extending from said lateral surface to the first inlet valve port and thence to the second inlet valve port, communicating with said first and second inlet valve ports, having first and second surfaces which extend in planes transverse to the cylinder axis and of which the first surface is nearer to said bounding surface than is said second surface, having a lateral, outer, third surface which is radially outwards of said cylinder axis, and having a lateral, inner, fourth surface which is radially inwards with respect to said third surface, first and second masks situated at locations of transition from said first surface to the walls of the first and second ports, and extending into said ports in a general direction of extension of said first surface, the arrangement being such that:

(a) as viewed in an axial direction of said cylinder, said inner, fourth surface is substantially tangential to said ports and said outer, third surface lies in the region of the periphery of said working space,

(b) as viewed in said axial direction, the area of said singular duct between said third surface and said fourth surface has a mean line defined by joining the centers of those circles having said third surface and said fourth surface as envelope curves, passing radially outwardly of the axis of said first valve means with respect to said cylinder axis,

(c) as viewed in said axial direction, a radial line from said cylinder axis through the axis of said first valve means and intersecting said mean line includes an an angle of from 90° to 30° with a tangent to said mean line at the point of intersection of said mean line with said radial line, and

(d) as viewed in said axial direction, each mask has a center line which extends substantially radially from the axis of the associated valve means and lies between the radial line from the cylinder axis through the axis of the associated valve means and another line extending from the latter axis perpendicularly to the latter radial line towards said lateral surface.

3. In combination, a cylinder for an internal combustion engine, 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 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 and first and second inlet valve ports for said first and second inlet valve means of substantially circular cross-section and encircled by said first and second valve seats and opening into said working space at said bounding surface, fourth portions of said cylinder head defining a singular inlet duct extending from said lateral surface to the first inlet valve port and thence to the second inlet valve port, communicating with said first and second inlet valve ports, having first and second surfaces which extend in planes transverse to the cylinder axis and of which the first surface is nearer to said bounding surface than is said second surface, having a lateral, outer, third surface which is radially outwards of said cylinder axis, and having a lateral, inner, fourth surface which is radially inwards with respect to said third surface, first and second masks situated at locations of transition from said first surface to the walls of the first and second ports, and extending into said ports in a general direction of extension of said surface, the arrangement being such that:

(a) as viewed in an axial direction of said cylinder, said inner, fourth surface is substantially tangential to said ports and said outer, third surface lies in the region of the periphery of said working space,

(b) as viewed in said axial direction, the area of said singular duct between said third surface and said fourth surface has a mean line, defined joining the centres of those circles having said third surface and said fourth surface as envelope curves, passing radially outwardly of the axis of said first valve means with respect to said cylinder axis,

(c) as viewed in said axial direction, a radial line from said cylinder axis through the axis of said first valve means and intersecting said mean line includes an angle of from 90° to 30° with a tangent to said mean line at the point of intersection of said mean line with said radial line,

(d) as viewed in said axial direction, each mask has a center line which extends substantially radially from the axis of the associated valve means and lies between a radial line from the cylinder axis to the axis of the associated valve means and another line extending from the latter axis perpendicularly to the latter radial line towards said lateral surface, and

(e) as viewed in said axial direction, the center line of each mask includes an angle of from 20° to 40° with a tangent to said mean line at a point of intersection of said mean line with a radial line from the cylinder axis through the axis of the associated valve means.

4. In combination, a cylinder for an internal combustion engine, 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 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 and first and second inlet valve ports for said first and second inlet valve means of substantially circular cross-section and encircled by said first and second valve seats and opening into said working space at said bounding surface, and fourth portions of said cylinder head defining a singular inlet duct extending from said lateral surface to the first inlet valve port and thence to the second inlet valve port, communicating with said first and second inlet valve ports, having first and second surfaces which extend in planes transverse to the cylinder axis, having a lateral, outer, third surface which is radially outwards of said cylinder axis, and having a lateral, inner fourth surface which is radially inwards with respect to said third surface, the arrangement being such that:

(a) as viewed in an axial direction of said cylinder, said inner, fourth surface is substantially tangential to said ports and said outer, third surface lies in the region of the periphery of said working space,

(b) as viewed in said axial direction, the area of said singular duct between said third surface and said fourth surface has a mean line defined by joining the centers of those circles having said third surface and said fourth surface as envelope curves passing radially outwardly of the respective axes of said first and second inlet valve means with respect to said cylinder axis, and

(c) as viewed in said axial direction, a radial line from said cylinder axis through the axis of said first valve means and intersecting said mean line includes an angle of from 90° to 30° with a tangent to said mean line at the point of intersection of said mean line with said radial line.

5. In combination, a cylinder for an internal combustion engine, 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 and of which the first inlet valve means is 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 and first and second inlet valve ports for said first and second inlet valve means of substantially circular cross-section and encircled by said first and second valve seats and opening into said working space at said bounding surface, and fourth portions of said cylinder head defining a singular inlet duct extending from said lateral surface to the first inlet valve port and thence to the second inlet valve port, communicating with said first and second inlet valve ports, having first and second surfaces which extend in planes transverse to the cylinder axis, having a lateral, outer, third surface which is radially outwards of said cylinder axis, and having a lateral, inner, fourth surface which is radially inwards with respect to said third surface, the arrangement being such that:

(a) as viewed in an axial direction of said cylinder, said inner, fourth surface is substantially tangential to said ports and said outer, third surface lies in the region of the periphery of said working space,

(b) as viewed in said axial direction, the area of said singular duct between said third surface and said fourth surface has a mean line, defined by joining the centers of those circles having said third surface and said fourth surface as envelope curves, passing radially outwardly of the respective axes of said first and second inlet valve means with respect to said cylinder axis, but passing at a greater perpendicular distance from the axis of the first inlet valve means

than from the axis of the second inlet valve means, and

(c) as viewed in said axial direction, a radial line from said cylinder axis through the axis of said first valve means and intersecting said mean line includes an angle of from 90° to 30° with a tangent to said mean line at the point of intersection of said mean line with said radial line.

6. In combination, a cylinder for an internal combustion engine, 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 and, the first inlet valve means being nearer to said lateral surface than 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 and first and second inlet valve ports for said first and second inlet valve means of substantially circular cross-section and encircled by said first and second valve seats and opening into said working space at said bounding surface, fourth portions of said cylinder head defining a singular inlet duct extending from said lateral surface to the first inlet valve port and thence to the second inlet valve port, communicating with said first and second inlet valve ports, having first and second surfaces which extend in planes transverse to the cylinder axis and of which the first surface is nearer to said bounding surface than is said second surface, having a lateral, outer, third surface which is radially outwards of said cylinder axis, and having a lateral, inner, fourth surface which is radially inwards with respect to said third surface, first and second masks situated at locations of transition from said first surface to the walls of the first and second ports, and extending into said ports in a general direction of extension of said first surface, the arrangement being such that:

(a) as viewed in an axial direction of said cylinder,

said inner, fourth surface is substantially tangential to said ports and said outer, third surface lies in the region of the periphery of said working space,

(b) as viewed in said axial direction, the area of said singular duct between said third surface and said fourth surface has a mean line, defined by joining the centers of those circles having said third surface and said fourth surface as envelope curves, passing radially outwardly of the axis of said first valve means with respect to said cylinder axis,

(c) as viewed in said axial direction, a radial line from said cylinder axis through the axis of said first valve means and intersecting said mean line includes an angle of from 90° to 30° with a tangent to said mean line at the point of intersection of said mean line with said radial line,

(d) as viewed in said axial direction, each mask has a center line which extends substantially radially from the axis of the associated valve means and lies between a radial line from the cylinder axis to the axis of the associated valve means and another line extending from the latter axis perpendicularly to the latter radial line towards said lateral surface, and

(e) as viewed in said axial direction, the angle included by the center line and that other line at the first inlet valve means is smaller than the corresponding angle at the second inlet valve means.

References Cited

UNITED STATES PATENTS

2,318,914	5/1943	Anderson et al.	123—30.2
2,647,499	8/1953	Pielstick	123—30.2
3,020,896	2/1962	Meurer et al.	123—30.2
3,154,059	10/1964	Witzky et al.	123—188

FOREIGN PATENTS

136,762	3/1950	Australia.

MARK NEWMAN, *Primary Examiner.*

WENDELL BURNS, *Examiner.*