REST

# PATENT SPECIFICATION

738,085

Date of Application and filing Complete Specification : Aug. 12, 1952. No. 20247/52.

Application made in Germany on Aug. 27, 1951.

Complete Specification Published : Oct. 5, 1955.

Index at acceptance:—**Classes 7(2),** B2C3A(1:4), B2C3C, B2C4(A:C:E); **and 7(6),** B2P (1A3:11C2), B2Q1(C:D), B2Q2, B2Q5(A:B:D), B2Q(9:16B).

## COMPLETE SPECIFICATION

## Improvements in Air-cooled Four-stroke Internal Combustion Engines with Rotary Valve Control

We, N S U WERKE AKTIENGESELLSCHAFT of Neckarsulm, Württemberg, Germany, a German Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an air-cooled four-stroke internal combustion engine with rotary valve control, in which the rotary valve, geared down with respect to the crank shaft in the ratio 1:2, is housed in the cylinder head and the axis of rotation of the valve extends in the direction of the cylinder axis.

Many constructional forms of rotary valve engines are known. Some of these engines operate with cylindrical rotary valves which are swept through transversely to the axis of rotation, others with cylindrical rotary valves, in which the combustible mixture enters at the periphery and escapes in the axial direction. There are also conical rotary valves which rotate in the interior of the cylinder head. Other constructions employ flat valves which rotate eccentrically with respect to the centre of the cylinder and uncover the control ducts in the head.

As compared with a poppet valve-controlled engine all these constructions present the following difficulties:

1. The sealing surface of contact between the rotary valve and the cylinder head lies in a region of high pressures and high temperatures.

2. At the sealing surface there occurs an additional increase in temperature due to the sliding motion with metallic contact.

3. The sealing surface has under these unfavourable conditions to take over the transmission of heat to the stationary cooled parts of the cylinder head.

4. The sealing surface must wholly or in part transmit the occurring combustion pressures.

In the four-stroke engine according to the invention these difficulties are entirely or to a great extent avoided. The idea underlying the invention consists in this, that the rotary valve housed in the cylinder head is so fashioned as regards its shape and its cooling conditions that it is of itself capable without the other constructional parts of the engine, such as cylinder, cylinder head and so forth, of giving off the heat transmitted to it at moderate temperatures. According to the invention, in an engine of the kind described the rotary valve is of cylindrical shape at the end adjacent to the piston and is mounted on a thick shaft and thermally insulated with respect to the correspondingly formed inner surface of the cylinder head by an air gap, the ratio between the smallest diameter of the said shaft and the cylinder diameter being 0.5 and 1. The upper part of the valve may be of hemispherical form and the thickness of the air gap between the hemisphere and a corresponding hemispherical surface of the cylinder head may be regulable by means of adjustable bearings adapted to resist axial thrust. Adjustment during operation is not necessary, since there is no contact between the valve body and the cylinder head, and no correction is required. Adjustment during assembly is effected by insertion of shim rings, in the usual manner.

The combustion pressure is not taken up by way of the sealing surfaces of the rotary valve, but by way of axially loadable rolling bearings. The sealing surfaces themselves have as small a total area as possible and are preferably provided on piston ring-like annular discs engaging in recesses in the periphery of the cylindrical part of the valve and on a bush which is

loosely mounted in a port provided in the valve and has a spherically or cylindrically curved end surface adapted to make sealing contact with a correspondingly curved surface of the cylinder head.

The cross-sections of the material of the valve are so selected that the most favourable heat flow results. For increasing the dissipation of heat a ribbed hub may be used, which is preferably forced or shrunk on to the rotating shaft of the valve and may at the time constitute the blade wheel of an axial fan. The cooling ribbing of the cylinder head will then most suitably be formed as guide apparatus for this axial fan. Finally, the shaft of the rotary valve may be hollow, in which case its bore will act as suction duct for a radial fan combined with the axial blade wheel.

In the accompanying drawings the invention is illustrated by a constructional example of an engine.

Fig. 1 shows in longitudinal section the arrangement of those parts of the engine, which are of importance as regards the invention.

Fig. 2 shows in section the rotary valve of Fig. 1 of which the upper part is of hemispherical shape.

Fig. 3 is a further sectional view of the engine of Fig. 1 showing the manner in which the cooling air passes through the hollow shaft of the valve, and

Fig. 4 is a sectional view showing an alternative form of valve which is of cylindrical shape throughout.

According to Fig. 1 the rotary valve axis lies in the direction of the cylinder axis. The valve *m* has a hemispherical form with a cylindrical extension *n*. The shaft *o* is made very big in diameter and is in rolling bearings *d*, *p*. The drive is by way of a vertical king shaft *q* and an intermediate wheel *r*. For the reduction to the crank shaft *s* the ratio 1 : 2 is adopted, so as to be able to operate with an inlet and outlet duct and a sparking plug. The rotary valve is secured in the axial direction by one of the rolling bearings *d*, *p*, which is preferably constructed as a shoulder bearing. Between the cylinder head *t*, with internal surface of the same shape as the valve and the rotary valve member *m* there is an insulating air gap *a* which is interrupted only by a sealing bush *f* supported loosely in a port provided in the valve. This bush has an end surface shaped as part of a sphere and is pressed by the gas pressure against the cylinder head during the compression and expansion strokes and thereby prevents the escape of combustible mixture or gases *via* the air space *a*. The thickness of the air gap *a* between the hemispherically shaped upper part of the valve *m* and the correspondingly shaped internal surface of the cylinder head *t* may be regulable by means of the bearings *d*, *p*, the latter being adapted to resist axial thrust.

In the cylindrical extension *n* of the rotary valve piston ring-like packing elements *e* are provided, which act as packing elements between cylinder head *t* and rotary valve *m*. The cross-sections of the material of the rotary valve are made such that a perfectly satisfactory flow of heat is possible by conduction into the thick-walled shaft *o*. From the shaft the absorbed heat is transmitted through a a pressed-on or shrunk-on hub *b* to cooling ribs *c* which also rotate at a speed of revolution of the valve.

For assisting the cooling effect the ribs *c* may form the blades of an axial fan and at the same time produce an air current flowing over the ribs *l* of the cylinder head to the cylinder ribs *u*. In addition there may be provided in front of the axial fan, viewed in the direction of flow, a stationary guide apparatus *v*, in which is also housed a train of wheels for driving the rotary valve and the fan.

For further increasing the dissipation of heat the shaft *o* of the rotary valve *m* is made hollow and is utilised for passing cooling air through it. The wheel *b*, *c* for the axial fan may through the provision of radial bores be used for the production of a partial vacuum and thereby for initiating an air current through the hollow shaft *o* of the rotary valve.

For non-stationary arrangements, for instance motor vehicles, the engine will be preferably so installed that the effect of the fan wheel *b*, *c* will be increased by the air current due to the motion of the vehicle.

The smallest diameter of the shaft *o* amounts to 0.5 to 1 times the cylinder diameter. The air space *a* between rotary valve and cylinder head impedes the transmission of heat by conduction. The cooling air which may be assisted by the dynamic pressure of the air current due to the motion of the vehicle enters the shaft *o* at *g*, strikes the heated surface *h* of the valve and is brought through bores or ducts *i*, *j*, and *k*. The ribs of the cylinder head act as guide blades for the fan wheel *c*. Fig. 4 shows a modified construction comprising a cylindrical rotary valve, in which the sealing bush *f* bears against the inside wall of the cylindrically bored-out head. In this case the bush must be secured against turning, which may suitably be effected by the packing rings *e* engaging in a flange of the bush *f*. In this construction the size of the insulating air gap is not adjustable, but

is fixed from the start by the dimensions of the cylinder head bore and of the valve drum and, as in Fig. 1, the smallest diameter of the shaft *o* is between 0.5 and 1 times the cylinder diameter.

What we claim is:—

1. Air cooled four stroke internal combustion engine with a rotary valve, in which the rotary valve, geared down with respect to the crank shaft in the ratio 1 : 2, is housed in the cylinder head and the axis of rotation of the valve extends in the direction of the cylinder axis, characterised by the feature, that the rotary valve is of cylindrical shape at the end adjacent to the piston and is rigid with a thick shaft and is insulated with respect to the correspondingly formed inner surface of the cylinder head by an air gap, the ratio between the smallest diameter of the said shaft and the cylinder diameter being between 0.5 and 1.

2. Engine as claimed in Claim 1, characterised by the feature that the end of the valve remote from the piston is of hemispherical shape.

3. Engine as claimed in Claim 1 or 2, characterised by the feature that the total area of the sealing surface between valve and cylinder head is kept as small as possible for preventing heat transmission.

4. Engine as claimed in Claims 1, 2 or 3, characterised by the feature that sealing is effected by piston ring-like annular discs engaging in recesses in the periphery of the cylindrical part of the valve and by a bush loosely mounted in a port provided in the valve, said bush having an end surface shaped as part of a sphere or cylinder and adapted to make sealing contact with a correspondingly shaped internal surface of the cylinder head.

5. Engine as claimed in any of Claims 1 to 4, characterised by the feature that the cross-sections of the material of the valve are made such as to ensure the most favourable flow of heat from the combustion space to the valve shaft.

6. Engine as claimed in any of Claims 1 to 5, characterised by the feature that for increasing the dissipation of heat on the rotating shaft of the valve a ribbed hub is mounted by being forced or shrunk on to it.

7. Engine as claimed in Claim 6, characterised by the feature, that the ribbed hub at the same time constitutes the fan wheel of an axial fan.

8. Engine as claimed in Claim 7. characterised by the feature, that cooling ribs on the cylinder head constitute guide blades for the fan wheel mounted on the valve shaft.

9. Engine as claimed in Claim 7 or 8, characterised by the feature, that the valve shaft is hollow and acts as a suction duct for the fan.

10. Engine as claimed in any of Claims 7 to 9, characterised by the feature that when adopted for locomotion, for instance in the case of a motor vehicle, the engine is installed in such a manner that the cooling effect of the fan wheel is assisted by the air current due to the motion of the vehicle.

11. Air-cooled four-stroke internal combustion engines with a rotary valve substantially as hereinbefore described and as illustrated in and by the accompanying drawings.

MARKS & CLERK.

Printed for Her Majesty's Stationery Office by Wickes & Andrews, Ltd., E.C.4. 684/2.—1955.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

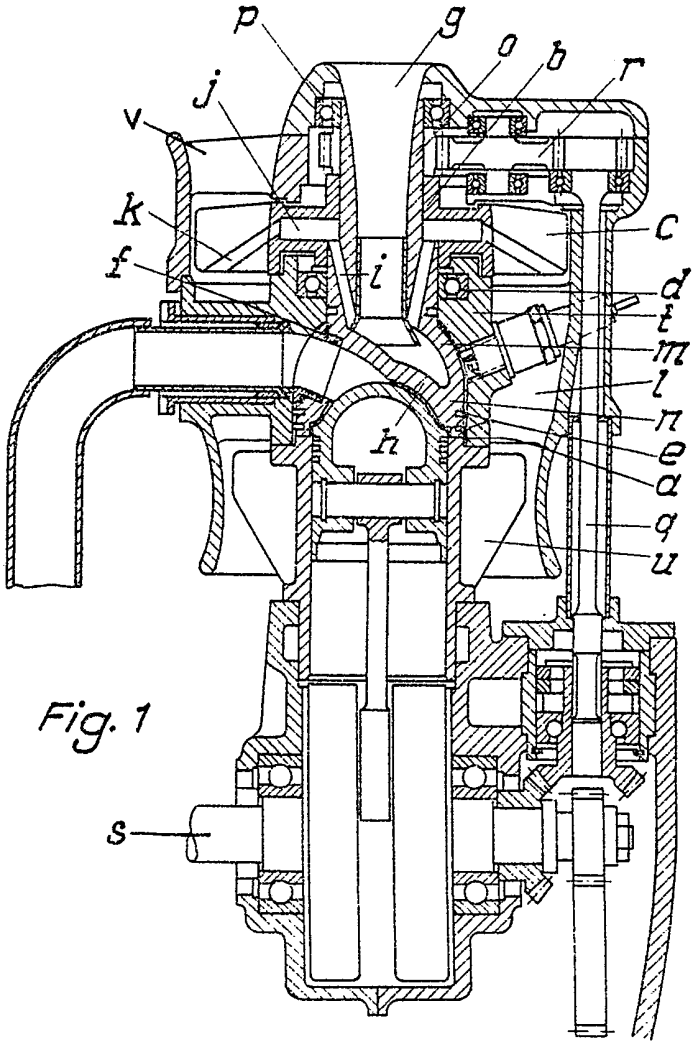


Fig. 1

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2 SHEETS

*This drawing is a reproduction of the Original on a reduced scale.*

*SHEETS 1 & 2*

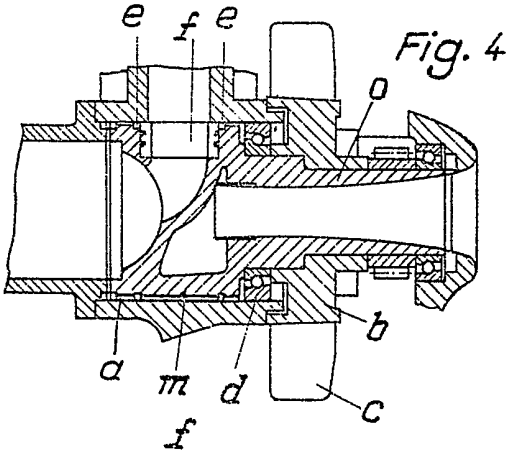


Fig. 4

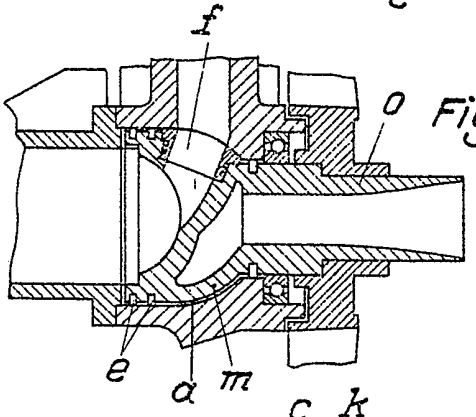


Fig. 2

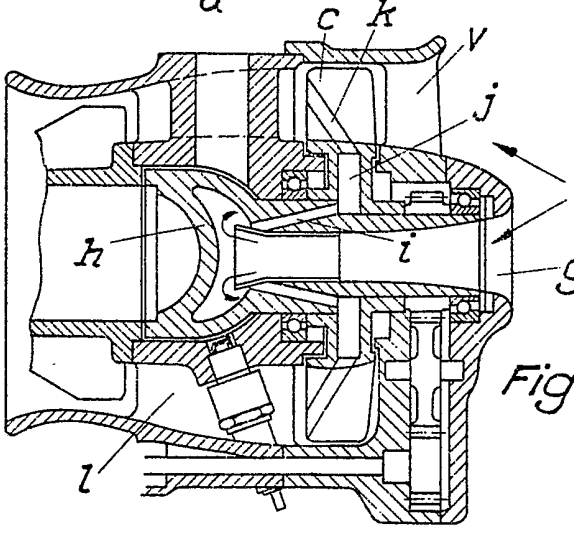


Fig. 3

738,085 COMPLETE SPECIFICATION
2 SHEETS

*This drawing is a reproduction of the Original on a reduced scale.*
*SHEETS 1 & 2*

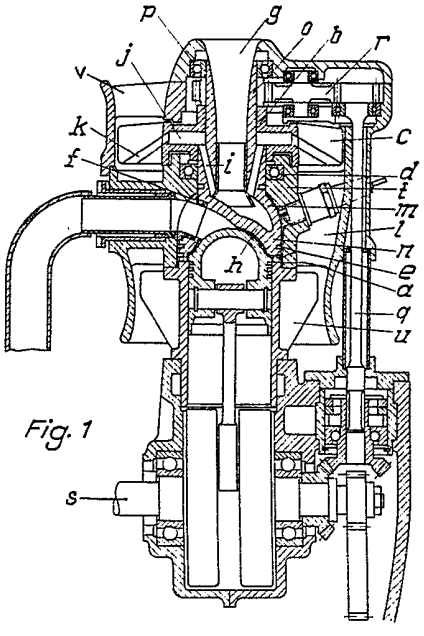


Fig. 1

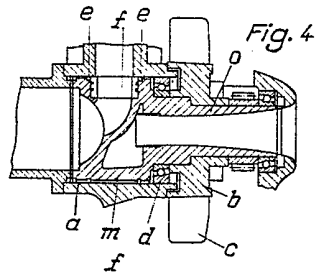


Fig. 4

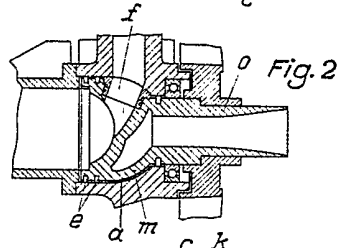


Fig. 2

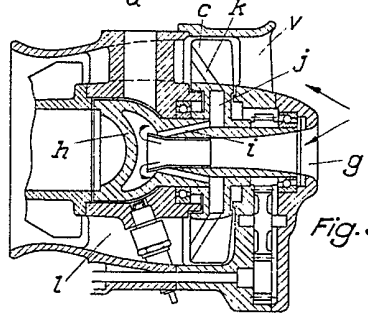


Fig. 3