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1241191

DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN OR RELATING TO INTERNAL COMBUSTION ENGINES

(71) We, THE BIRMINGHAM SMALL ARMS COMPANY LIMITED, a British Company of Armoury Road, Small Heath, Birmingham 11, 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 two stroke cycle internal combustion engines, particularly to multi-cylinder in-line internal combustion engines.

One disadvantage of the piston-controlled porting of the conventional two-stroke cycle engines of the naturally aspirated type, such as for example, those used in motor cycles, is that the port timing is symmetrical. This applies particularly to the intake port where typical timings are 70° before top dead centre (BTDC) opening and 70° after top dead centre (ATDC) closing for low speed engines and up to 100° BTDC opening and 100° ATDC closing for racing motor cycle engines. It will be evident that much fuel is lost from the intake port during the crankcase compression stroke particularly with the longer timing of 200° included angle.

Various methods of providing the desirable asymmetrical timing have been proposed but the disc valve (or Zimmerman valve) is generally regarded as being the most successful. The disc valve, in most constructions, allows for symmetrical timing by having a thin steel disc, which rotates in the same plane as the flywheel, to interrupt and allow passage of the intake flow which lies in the same plane as the crankshaft. It will be obvious that it then becomes difficult to couple more than two cylinders in line together, unless a 90° bend is accepted in the intake tract. For high specific power output engines this sharp bend is undesirable. An alternative arrangement is to arrange four cylinders somewhat in the shape of a square, this being in effect two two-cylinder engines with crankshafts geared together to construct a four-cylinder engine.

One of the objects of the present invention is to provide asymmetrically intake timed, multi-cylinder in-line two-stroke cycle engines without either 90° bends in the intake tracts or the use of geared crankshafts as above referred to.

According to the invention a two stroke internal combustion engine has one or more crankcase induction passages opened and closed by a rotary valve comprising a stator having one or more passages therethrough, the or each induction passage having a stator passageway aligned therewith, and a rotor rotatable about said stator having openings and solid faces adapted to uncover and cover the or each stator passageway.

The stator is preferably in the form of a circular bar with transverse induction passages formed therein, at least one for each cylinder. The passages may conveniently be circular holes but other cross-sectional shapes may be used to give different intake characteristics. Each passage will of course be in line with each intake tract and may be so disposed as to assist in providing a desired directional flow.

The rotor is preferably in the form of a sleeve having suitable holes formed therein which when in register with the induction passages in the stator, allow the inlet mixture to pass into the engine cylinder. The size, shape and disposition of the holes in the rotor will depend on the port timing of each cylinder and the firing order of the cylinders.

The rotor may be driven from the crankshaft by any convenient means, for example, by chain, gears or rubber toothed timing belt. Preferably an extension to the crankcase is adapted to accommodate the stator-rotor assembly. The rotor is preferably mounted on anti-friction bearings and is adapted to run clear of the housing and the stator.

In the general construction of an engine according to the invention, whilst it is acceptable for the connecting rod to pass through an extension of the bore of the cylinder to the crankcase in conventional manner, it is preferred that the connecting rod pass through

a slot in the metal of the crankcase. It is also preferred that two opposed transfer ports are used together with a rear transfer port, steeply inclined towards the cylinder head.

An embodiment of the invention, by way of example, is shown in the accompanying drawings, in which:—

Figure 1 is a plan section along line X—X of figure 2 of an air coded four cylinder two-stroke cycle engine according to the invention,

Figure 2 is an elevation section along line Y—Y of figure 1, and

Figure 3 is an elevation section along line Z—Z of figure 1.

Referring firstly to figures 1 and 2, the four cylinders of a two-stroke engine 1, 2, 3, and 4 are arranged in in-line arrangement in cylinder block 5. A piston 6 is disposed within each cylinder such that the pistons within cylinders 1 and 3 are at top dead centre when the pistons within cylinders 2 and 4 are at bottom dead centre. Connecting rod 7 connects the piston 6 to crankshaft 8 in conventional manner and passes through slot 9 in the wal 10 which substantially closes the bottom of each cylinder.

Cylinder head 11 is secured to the cylinder block 5 by means of nuts 12 screwed on to studs 13 screwed into the cylinder head and forms hemispherical combustion chamber 14 at the top of each cylinder. A sparking plug 15 is screwed into the threaded aperture 16 provided at the apex of each combustion chamber.

Exhaust pipes 17 are secured to the cylinder block 5 in alignment with exhaust ports 18 to conduct away the exhaust gas in conventional manner.

Induction passage 19 is situated at the lower end of the cylinder and has affixed in alignment with its outer opening a conventional carburettor 20. A valve assembly, indicated at 21, is positioned in induction passage 19 and is adapted to open and close said passage.

The valve assembly 21 is disposed within cylindrical bore 22 in the cylinder block, which bore runs the entire length of the cylinder block and intersects each induction passage 19 in exactly similar manner. The valve assembly 21 comprises a circular cross-section stator 23 about which rotates a rotor 24 of cylindrical shape.

At one end of the valve assembly the stator 23 is provided with central boss 25 on which is mounted ball bearing 26 which is so arranged that the rotor 24 is held in spaced relationship with the stator 23 and the bore 22. The inner ball race 27 of ball bearing 26 is an interference fit on boss 25 and therefore remains stationary therewith and the outer ball race 28 rotates with the rotor 24. The boss 25 has a threaded end portion 29 of reduced diameter which is inserted through hole 30 in end plate 31 which is secured to the cylinder block and closes the end of bore 22. Nut 32 secures the boss 25 to the end plate 31.

At the other end of the valve assembly the rotor 24 is closed by integral end wall 33 from which projects central boss 34. Bearing 35 is assembled on boss 34 such that its inner race rotates therewith whilst its outer race is stationary and is located within counterbore 36 at the end of bore 22. Ball bearing 37 is located within recess 38 in end wall 33, its outer race rotating with the rotor and its inner race remaining stationary on boss 39 projecting from the end of stator 23. End plate 40 closes the end of bore 22 and has a hole 41 through which projects boss 34 of rotor 24.

A pulley 42 is located on the threaded end portion 43 of boss 34 and is clamped thereto by nut 44. The pulley 42, and hence the rotor 24, are driven from pulley 45 mounted on the crankshaft 8 by means of toothed belt 46. The driven/driver ratio is 2:1 such that the rotor 24 rotates one for every two revolutions of the crankshaft 8.

The use of bearings 26, 35 and 37 produces a valve assembly in which there are no rubbing parts and which operates with the minimum of frictional losses. The valve requires very little power for its operation, particularly if the rotor is made from a light material such as aluminium.

The valve operates to open and close the inlet ports of the cylinders by means of apertures in the stator and the rotor which move into and out of alignment. The apertures in the stator 23 are in the form of circular cross-section bores 47 of the same diameter, and aligned with, the induction passages 19. In this embodiment there are, therefore, four bores 47 in the stator 23.

The rotor 24 has four pairs of diametrically opposed holes 48, each pair being positioned with its axis in the same plane as the axis of one of the bores 47 in the stator 23. The axes of the pairs of holes 48 associated with cylinders 1 and 3 are co-planar and are at right angles to the axes of the pairs of holes associated with cylinders 2 and 4. By this arrangement the inlet ports of cylinders 1 and 3 are fully open, that is holes 48 are aligned with bores 47, when the inlet ports of cylinders 2 and 4 are fully closed, that is with holes 48 and bores 47 completely out of alignment.

The operation and function of the valve in relation to the two piston strokes is as follows:—

As the piston moves on the crankcase compression downstroke the valve starts to close. By virtue of the 2:1 relationship between the crankshaft and rotor speed of revolution, the 180° revolution of the crankshaft from the top dead centre position to the bottom dead centre position results in a 90° revolution of the rotor from the fully open to the fully closed position. The closure of the induction passage during the crankcase compression stroke limits loss of fuel and increases the crankcase compression ratio and thus results in

quick and efficient transference of the fuel mixture from the crankcase to the combustion chamber when the rear transfer port 49 and the side transfer ports 50 are uncovered by the piston. The wall 10 at the bottom of the cylinder also tends to keep the crankcase compression ratio at a fairly high value.

As the piston moves on the crankcase induction upstroke the valve opens until it is fully open at top dead centre and thus allows fuel mixture to be drawn from the carburettor into the crankcase.

It is apparent that the port timing of the engine according to the invention is not piston controlled and can be arranged to be asymmetric with relation to the piston movement as described in the above embodiment.

In a modification of the above described embodiment the holes in the rotor are of rectangular shape and thus open and close the stator bore more quickly for any given rotor diameter.

The firing sequence of an engine according to the invention is not limited to that described above in which the cylinders fire in pairs and indeed it would be preferable to have in a four cylinder engine one cylinder firing every 90° rotation of the crankshaft. Obviously the disposition of the holes in the rotor can be arranged to suit any required firing sequence.

Whilst the invention is particularly suited to multi-cylinder engines it is also applicable to single cylinder engines.

WHAT WE CLAIM IS:—

1. A two stroke internal combustion engine having one or more crankcase induction passages opened and closed by a rotary valve comprising a stator having one or more passageways therethrough, the or each induction passage having a stator passageway aligned therewith, and a rotor rotatable about said stator having openings and solid faces adapted to uncover and cover the or each stator passageway.

2. A two stroke internal combustion engine according to Claim 1 wherein the or each stator passageway is of the same cross-sectional shape and area as the induction passage with which it aligns.

3. A two stroke internal combustion according to Claim 1 wherein the stator is of substantially cylindrical shape.

4. A two stroke internal combustion engine according to Claim 3 wherein the rotor is a hollow cylinder arranged co-axially with, and rotatable about, the stator.

5. A two stroke internal combustion engine according to Claim 4 wherein one or more bearings are interposed between the stator and the rotor to facilitate rotation of the latter about the former and to hold each in spaced relationship with the other.

6. A two stroke internal combustion engine according to any one of the preceding claims wherein the stator and the rotor are disposed within a passageway in the cylinder block of the engine, said passageway intersecting the or each induction passage.

7. A two stroke internal combustion engine according to Claim 4 wherein the rotor has a pair of openings disposed diametrically on the rotor, the axis of said pair of openings being co-planar with the axis of a stator passage.

8. A two stroke internal combustion engine according to Claim 7 wherein the openings are of circular shape.

9. A two stroke internal combustion engine according to Claim 7 wherein the openings are of rectangular shape.

10. A two stroke internal combustion engine according to any one of the preceding claims wherein the rotor is driven by the engine crankshaft.

11. A two stroke internal combustion engine according to any one of the preceding claims wherein the rotor rotates at one half the speed of the engine crankshaft.

12. A two stroke internal combustion engine according to any one of the preceding claims wherein the engine has a plurality of cylinders disposed in in-line arrangement.

13. A two stroke internal combustion engine according to any one of claims 1 to 11 wherein the engine has a single cylinder.

14. A multi-cylinder in-line two stroke internal combustion engine constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

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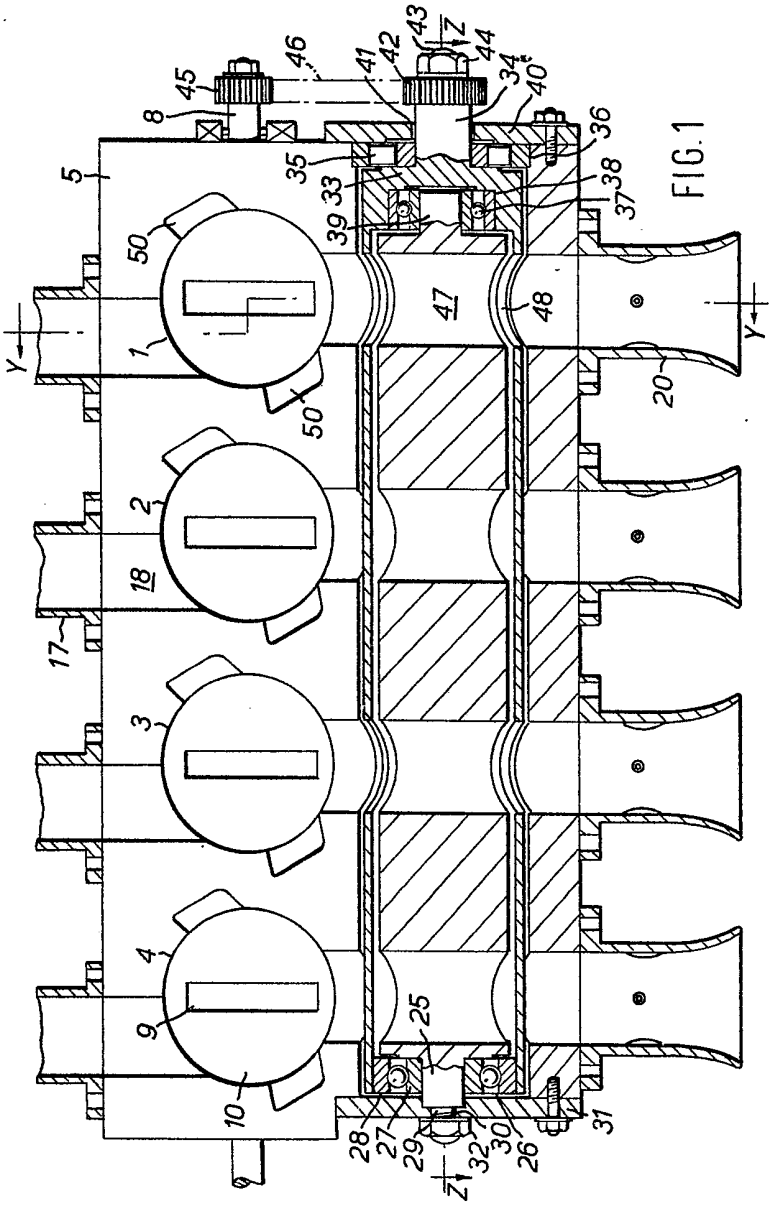
1241191 COMPLETE SPECIFICATION

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

Sheet 1



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3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

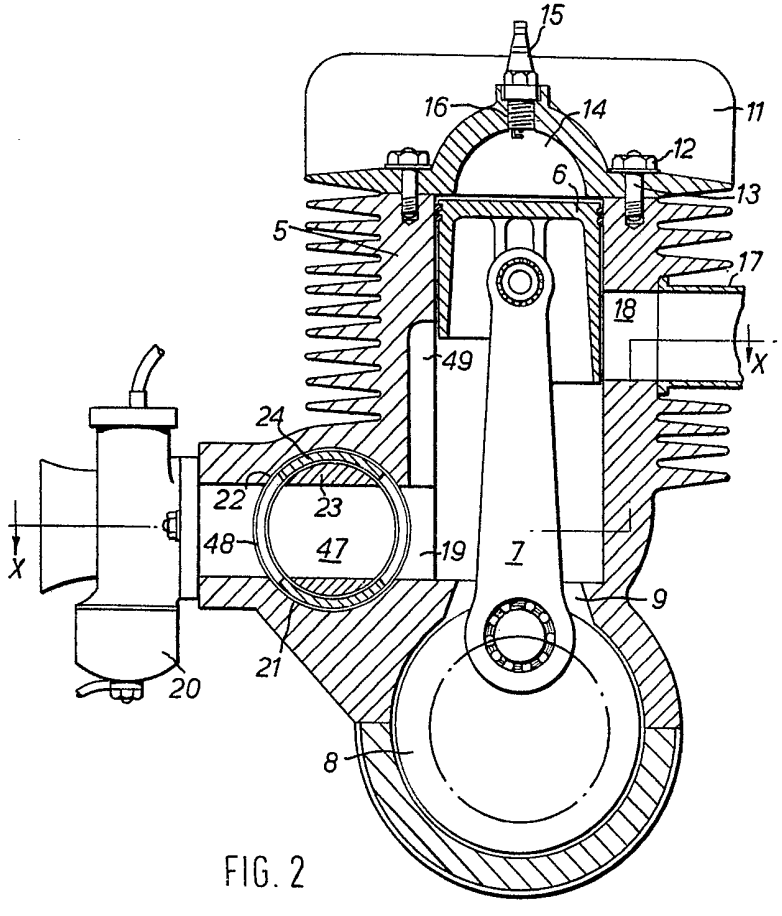

FIG. 2

1241191 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 3

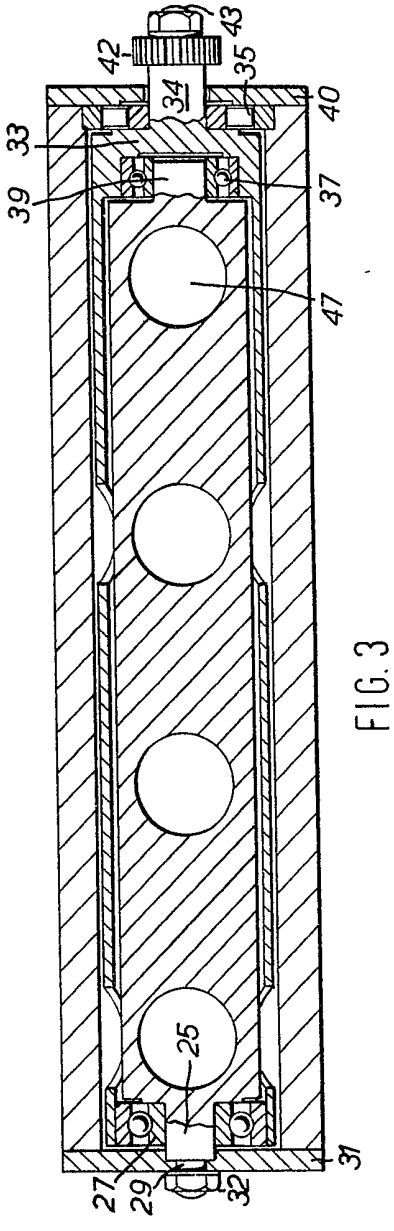

FIG. 3