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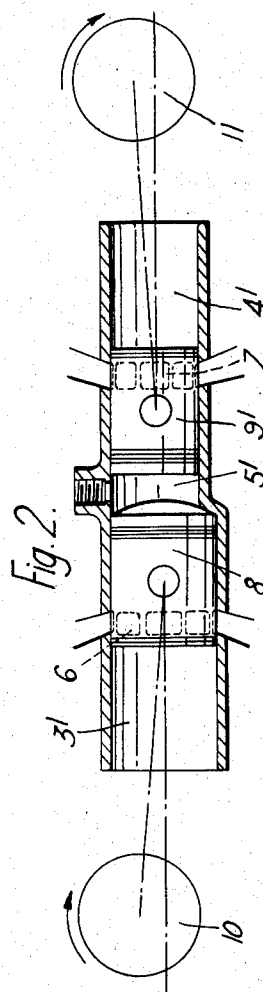
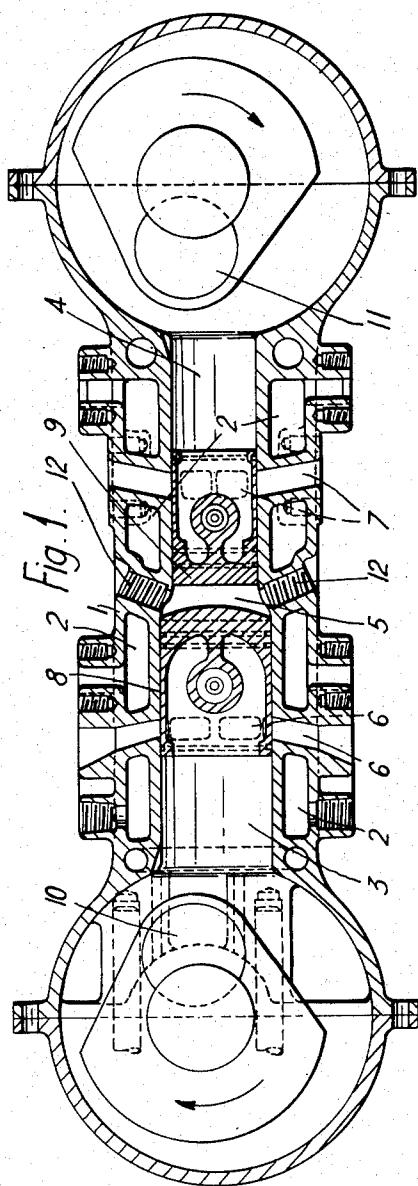
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TWO-STROKE INTERNAL COMBUSTION ENGINES

Filed Sept. 16, 1957

2 Sheets-Sheet 1



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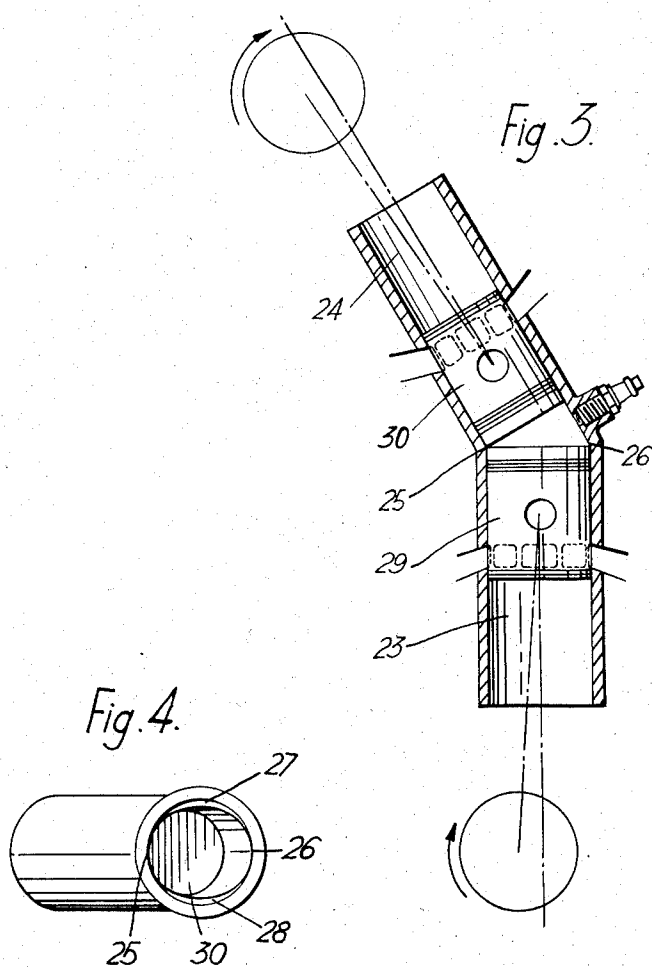
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TWO-STROKE INTERNAL COMBUSTION ENGINES

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2 Claims. (Cl. 123—51)

This invention relates to improvements in two-stroke internal combustion engines.

The invention is concerned with two-stroke internal combustion engines of the type in which two cylinders have a common combustion chamber, one cylinder having a piston-controlled inlet port or ports and the other cylinder having a piston-controlled exhaust port or ports. In prior internal combustion engines the two pistons have been coupled to a common crankshaft or to interconnected crankshafts, and the purpose of such engines has been to provide improved scavenging by introducing the fresh inlet charge at one end of the combustion space and by taking out the exhaust gases at the other end.

In prior constructions, however, the piston which controls the exhaust port or ports does not come into sufficient contact with the fresh cool charge and the crown of the piston and its ring belt and also the exhaust ports and the parts of the cylinder wall adjacent thereto may be subject to excessive heating when the engine is operating under full load and is thus likely to suffer loss of efficiency or excessive wear and overheating and/or burning of the cylinder wall and/or port bridges and the piston ring belt, and top land of the piston.

It must be appreciated that the heat absorbed by the piston crown is largely dissipated through the ring belt to the cylinder wall.

Since the area of the piston crown is related to the area of the ring belt in accordance with a square law, it would appear possible to reduce the heating of the piston crown by reducing the area of the crown of the exhaust piston, thereby improving the dissipation of heat from the piston crown through the ring belt to the cylinder wall, whilst retaining a larger inlet piston which is cooled by the inlet charge.

If, however, the bore of the exhaust cylinder is reduced too much, the area of the exhaust port openings cannot be large enough in relation to the inlet port openings and it is undesirable to compensate for this by increasing the exhaust piston stroke over that of the inlet piston, because this would introduce a loss of primary balance in the engine and sundry other undesirable factors, which would impair the efficiency and adversely affect the power to size ratio and power to weight ratio.

According to the present invention there is provided a two-stroke internal combustion engine of the type described in which the bore diameter of the exhaust cylinder is from 78% to 93% of the bore diameter of the inlet cylinder; preferably the bore of the exhaust cylinder is within the range of 83% to 88% of the bore of the inlet cylinder.

The balancing of the unequal sized pistons can be compensated for either by approximately equalising the weight of the inlet and exhaust pistons and/or by the use of suitable balance weights associated with the respective crankshafts.

The force of the explosion occurring in the combustion chamber when the charge is ignited is transmitted to both the inlet and the exhaust pistons and the power thereby

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developed is transmitted to separate crankshafts which are coupled together by gearing or by any other suitable means, or in some constructions to a single crankshaft, connected to both pistons.

The two cylinders may be preferably co-axial so as to define a symmetrical combustion space between the two opposed pistons. Other arrangements may be adopted such as having the cylinders side-by-side or in line with their axes slightly offset or with the cylinders inclined towards each other.

The preferred arrangement is where the two cylinders are co-axial and the two bores are connected together by a throat in which is accommodated the spark plug for igniting the charge and/or a fuel injector.

Another desirable arrangement is to have the axes of the two cylinders arranged at about 150° to each other so as to define a wedge-shaped space between the pistons at the top of their stroke.

The proportioning of the throat between the two cylinders is determined largely by the compression ratio required (bearing in mind scavenge or blower pressure in use) and by the combustion chamber shape and flame front required, although it will be appreciated that the compression ratio may, to a large extent, be controlled by appropriately shaping the crowns of the inlet and exhaust pistons.

The relative sizes of the inlet and exhaust pistons to give optimum performance is determined as the result of a compromise between a number of different (and sometimes conflicting) considerations.

In the type of engine under consideration both the inlet and exhaust ports may be arranged to extend in a belt around the periphery of their respective cylinders, with bridges left between the respective port apertures sufficient in width to provide sufficient cylinder wall strength and to avoid excessive wear of the rings, and to prevent the possibility of the ring ends "springing" into a port. Or the rings may be pegged in the usual way.

In a two-stroke engine it is usual to arrange for the exhaust period to be approximately 125–140° of crankshaft rotation and the inlet period to be approximately 108–120°, about crank bottom dead centre. In other words, the exhaust ports are open for about 22–28% of the exhaust piston stroke and the inlet ports are uncovered for about 16½–20% of the inlet piston stroke (given connecting rods of usual length/throw ratio).

Using pistons of the same bore and stroke and considering the top figures of the exhaust and inlet periods given above, the inlet port area available is only about 71% of maximum exhaust port area available. However, it is found that the engine will operate satisfactorily if the exhaust port area is reduced to equality with or down to 80% to 95% of the inlet port area. This bottom figure is only approximate and holds true for that area of exhaust port which is open before the inlet port opens. This permits the exhaust piston size to be reduced to the stated range of 78–93% of the inlet piston.

In the construction of an engine operating on this principle, it is found desirable that there should be an appreciable lead of the exhaust piston over the inlet piston.

Using connecting rods having a length/throw ratio of 4.5:1 and with the crankshaft axes as fully offset from the cylinder axes as is practicable, in opposite senses in relation to the direction of rotation of the crankshaft so that the exhaust piston crankshaft reaches crankshaft top dead center after piston top dead center and the inlet piston crankshaft reaches crankshaft top dead center before piston top dead center, the exhaust piston crankshaft would be arranged to lead the inlet piston crankshaft from 0–14°. Using 3.5:1 length/throw ratio rods, offsetting of crankshaft axes is undesirable and in order to obtain desirable timing, the exhaust piston

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crankshaft movement would have to be further advanced in relation to the inlet piston crankshaft movement.

The invention is hereinafter described with reference to the accompanying drawings, wherein:

Figure 1 is a section of one form of engine.

Figure 2 is a diagrammatic representation of a second form of engine.

Figure 3 is a diagrammatic representation of a third form of engine.

Figure 4 is an end view of the inlet cylinder of Figure 3.

The engine is shown in Figure 1 in diagrammatic form only and the inlet and exhaust manifolds and associated equipment are omitted. The inlet air or mixture is provided by means of a blower of known construction (not shown). The engine comprises a block 1, provided with passages 2 for coolant water.

The block 1 is bored out to provide an inlet cylinder 3 and an exhaust cylinder 4, which in this case are co-axial with each other and are connected to each other by a throat 5. The inlet cylinder 3 is provided with a belt of inlet ports 6 extending around the periphery of the cylinder and the exhaust cylinder 4 is similarly provided with a belt of exhaust ports 7. The inlet ports 6 and exhaust ports 7 are respectively controlled by an inlet piston 8 and an exhaust piston 9. The two pistons 8 and 9 are of substantially the same weight and their diameters are such that the diameter of the exhaust piston 9 lies between 78 and 93% of the diameter of the inlet piston 8.

In the construction shown it is to be observed that both the inlet piston crankshaft 10 and the exhaust piston crankshaft 11, which in this case are coupled together by suitable gearing, are of equal throw and are offset on the same side of the axis of the inlet and exhaust cylinders 3 and 4, the connecting rods being omitted for clarity in the drawing. It will be appreciated that in the position shown the exhaust piston 9 has already passed the top end of its stroke, whilst the inlet piston 8 has not yet reached it. It is also to be noted that the exhaust piston crankshaft 11 leads the inlet piston crankshaft 10 by about 10-12°.

The block 1 of the engine is provided with tapped apertures 12 entering the throat 5. These may be used for the fitting of two spark plugs or a spark plug and an injector or two injectors, depending on whether carburetion or fuel injection is employed. The engine may be arranged horizontally, as shown in the drawings, or vertically, provided the necessary modifications are made to its lubrication system. The gearing connecting the two crankshafts 10 and 11 may be constructed so as to give a direct reduction to the output shaft of the engine.

A modified construction of engine is shown in Figure 2 in diagrammatic form. This engine differs from the construction of Figure 1 in that the inlet and exhaust cylinders 3' and 4' are in line with each other, but are not co-axial. By reason of the re-positioning of the inlet and exhaust cylinders, the shape of the space 5' between the pistons is quite different and the shape of the combustion space is further altered by using a flat-crowned exhaust piston 9'. Other parts are given the same reference numerals as in Figure 1. The modified construction of engine is designed to have a considerable lead, for example, 9-12°, of the exhaust crankshaft 11 over the inlet crankshaft 10. Thus, in one example, the exhaust ports by reason of this lead and the offsetting of the crankshaft axes from the cylinder axes open at 83° before engine bottom dead centre and close at 56° after B.D.C. whilst the inlet ports open at 52° before B.D.C. and close at 61° after B.D.C., thus permitting a moderate amount of supercharging to be applied.

A further modified construction is shown in Figures 3 and 4, again in diagrammatic form. In this construction the axes of the inlet cylinder 23 and of the exhaust cylinder 24 are arranged at an angle of 150° to each other

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and the ratio of the exhaust cylinder bore to the inlet cylinder bore is cosine 30°, so that the exhaust cylinder wall meets the inlet cylinder wall at the points 25 and 26 as shown in the drawings.

It will be apparent that at the top end of the inlet cylinder there will be two shoulders 27 and 28 where the inlet cylinder and exhaust cylinder meet (see Figure 4).

Considering the engine as using flat topped inlet and exhaust pistons 29 and 30, it will be seen that a wedge-shaped combustion space 31 is defined between the two pistons, so that when the mixture in the combustion space is ignited by means of a spark plug 32, a flame front of diminishing vertical height will spread across the combustion space 31 in the direction of the point 25. The shoulders 27 and 28 impart other desirable characteristics to the combustion space in that these, in combination with the flat-topped piston 29, produce "squish" and/or "quench" areas at the sides of the flame front. The inlet piston crown could be spherically "topped" and shoulders formed at the entry to the exhaust cylinder could be shaped to conform to give the same "squish" and/or "quench" results. Such shaping would greatly improve the gas flow through the combustion space from the inlet cylinder to the exhaust cylinder.

I claim:

1. A two-stroke internal combustion engine comprising in combination a block, said block having a pair of intercommunicating cylinders therein, pistons slidable in said cylinders defining between them a common combustion chamber, one of said cylinders constituting an inlet cylinder and having only an inlet port means the opening and closing of which is controlled by its piston, the other of said cylinders, constituting an exhaust cylinder and having only exhaust port means the opening and closing of which is controlled by its piston, the bore diameter of the exhaust cylinder being from 83 to 88% of the bore diameter of the inlet cylinder, connecting rod means connected to the pistons in said cylinders, and a pair of spaced crankshafts of equal throw to which the connecting rod means are respectively connected, the weight of the piston in said exhaust cylinder being balanced against the weight of the piston in said inlet cylinder and the axes of the crankshafts being offset in relation to the axes of the pistons to which the said crankshafts are respectively connected by the said connecting rod means, the exhaust piston crankshaft leading the inlet piston crankshaft by up to 14° and the offsetting of the axes of said crankshaft being in opposite senses in relation to their direction of rotation in such manner that the exhaust piston crankshaft reaches crankshaft top dead center after piston top dead center and the inlet piston crankshaft reaches crankshaft top dead center before piston top dead center.

2. A two-stroke internal combustion engine comprising in combination a block, said block having a pair of intercommunicating cylinders therein, pistons slidable in said cylinders defining between them a common combustion chamber, one of said cylinders constituting an inlet cylinder and having only an inlet port means the opening and closing of which is controlled by its piston, the other of said cylinders constituting an exhaust cylinder and having only exhaust port means the opening and closing of which is controlled by its piston, the bore diameter of the exhaust cylinder being from 83 to 88% of the bore diameter of the inlet cylinder, the pistons in said cylinders being flat crowned, connecting rod means connected to said pistons a pair of spaced crankshafts to which said connecting rod means are respectively connected, the weight of the piston in said exhaust cylinder being balanced against the weight of the piston in said inlet cylinder, the axes of said inlet cylinder and said exhaust cylinder being inclined relative to each other and said cylinder defining a wedge-shaped combustion zone at the intersection of said cylinders, the angle of inclination between said axes having a cosine substantially equal to the ratio of the bore diameter of said exhaust cylinder to the bore diameter of said inlet

cylinder, whereby crescent-shaped shoulders are formed at the junction of the two cylinders cooperating with the pistons.

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