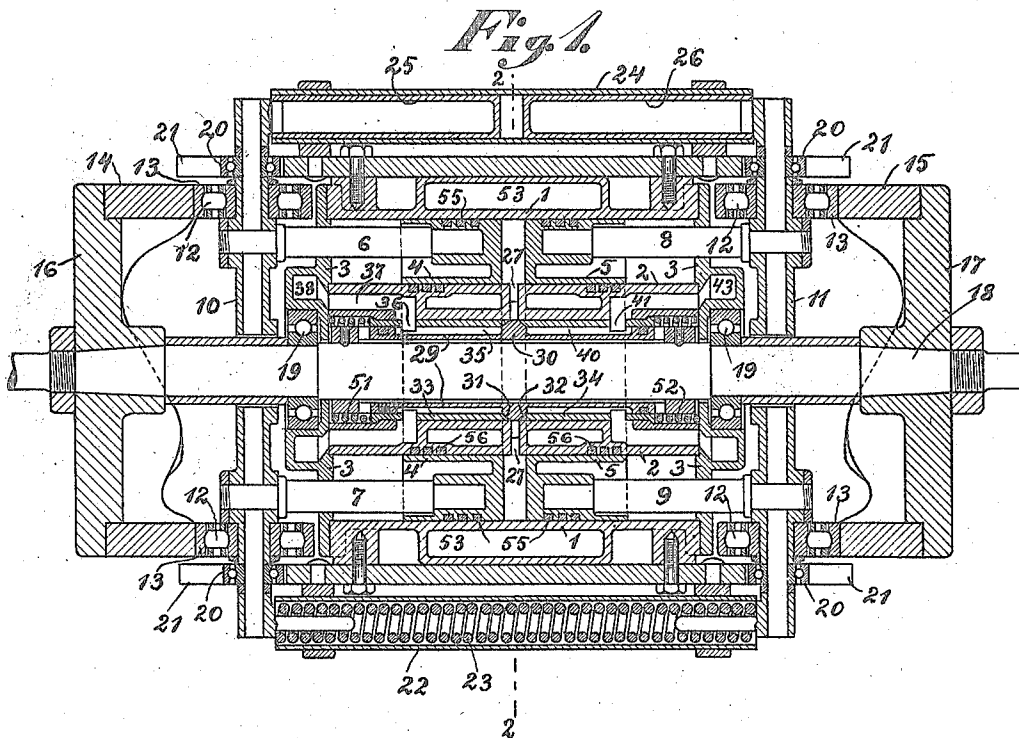


Feb. 20, 1923.

1,445,686.

C. A. HULT.
INTERNAL COMBUSTION ENGINE.
FILED AUG. 7, 1920.

3 SHEETS—SHEET 1.



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3 SHEETS—SHEET 2.

Fig. 2.

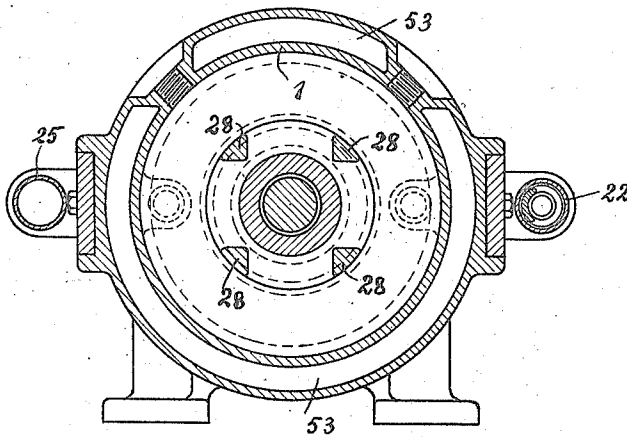
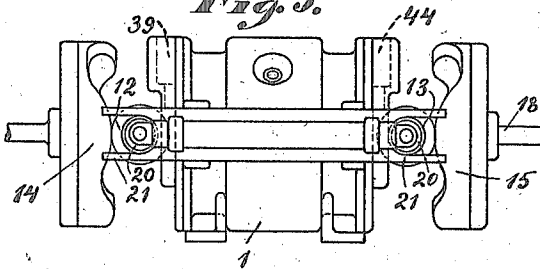


Fig. 3.



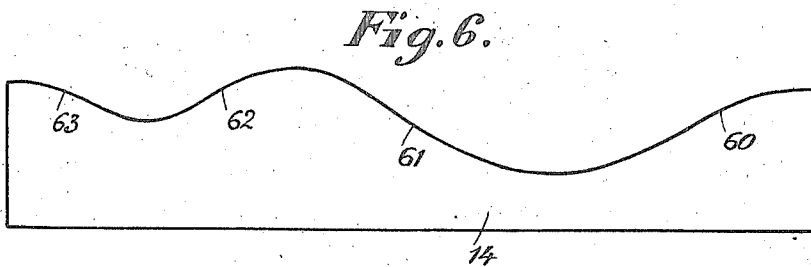
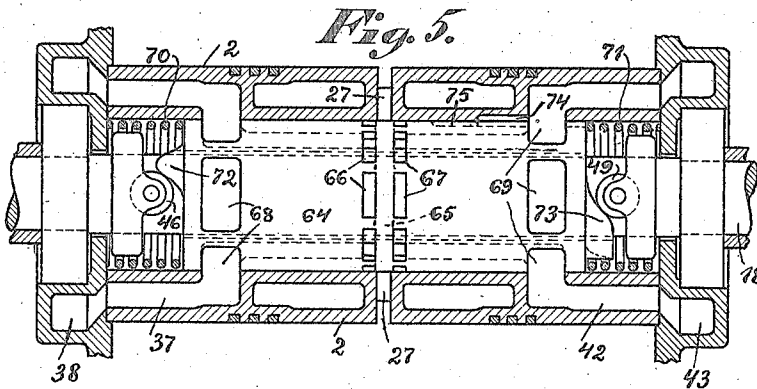
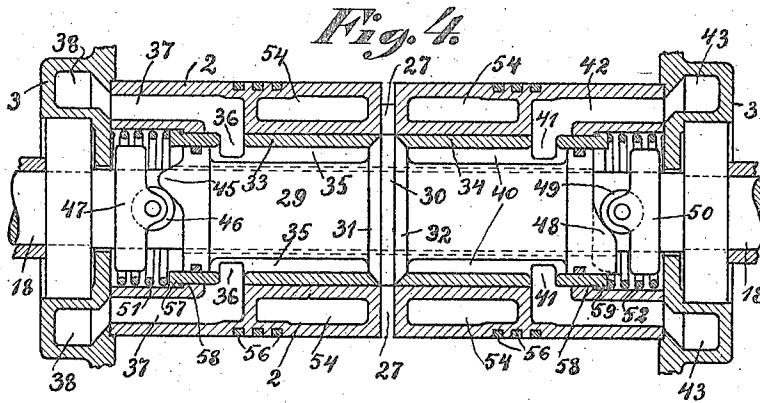
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3. SHEETS—SHEET 3.



UNITED STATES PATENT OFFICE.

CARL ALRIK HULT, OF STOCKHOLM, SWEDEN.

INTERNAL-COMBUSTION ENGINE.

Application filed August 7, 1920. Serial No. 401,984.

To all whom it may concern:

Be it known that I, CARL ALRIK HULT, a subject of the King of Sweden, residing at Torsgatan 4, Stockholm, in the Kingdom of Sweden, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to reciprocating internal combustion engines.

An internal combustion engine, constructed according to this invention, has an annular cylinder with two pistons, working to and from each other and co-operating with cam tracks, fixed to an engine shaft in order to effect a relative rotary movement between the cylinder and the said shaft, said shaft being mounted axially with regard to the cylinder. A common explosion or combustion space is provided. For the admission of the gas mixture and the exhaust of the combustion gases the annular space between the inner wall of the annular cylinder and the engine shaft is used. By an opening in the inner wall of the cylinder this annular space communicates with the common combustion space. On that account the device for the admission and the exhaust of the gases can be made very simple and effective, the regulation being made by means of simple valves or a slide valve provided in the said room and actuated by cam discs on the engine shaft. The cam tracks first mentioned are so arranged that the effect of the engine will be the greatest possible. According to the invention the cam tracks further may be so arranged that two impulses of power are gained at each revolution of the engine shaft, thus as many as in a four-cycle engine with four cylinders. The above mentioned and other arrangements are more particularly described in the following description, reference being had to the accompanying drawings.

In these drawings, as an example, a combustion engine constructed according to the invention is shown.

Figure 1 is a longitudinal section of the engine.

Figure 2 is a transverse section of the engine along the line 2—2 in Figure 1.

Figure 3 is an outside view of the engine on a reduced scale. Figure 4 is a longitudinal section of the central part of the engine

and shows on a larger scale the valve device of the engine.

Figure 5 is a longitudinal section of the central part of the engine but with a slide valve substituted for the valve device shown in Figure 5.

Figure 6 shows the half of one of the two cam tracks of the engine evolved.

In the engine shown in the drawings, the frame 1 constitutes the outer cylindrical wall of the working-cylinder. The inner cylindrical wall consists of a cylinder 2, which is fastened to the cylinder covers 3, which in turn are fixed to the outer cylinder. In the working cylinder thus formed, two annular pistons 4 and 5 operate, each of them being provided with two pistons rods 6 and 7, 8 and 9 respectively fixed to the pistons, diametrical to each other.

To the outer end of the piston rods 6 and 7 a cross beam 10 is fastened, and to the outer end of the piston rods 8 and 9 a similar cross beam 11 is fastened. On the cross beams 10 and 11 rollers 13 are provided, journaled by means of roller or ball bearings 12. The rollers 13 co-operate with cam tracks 14 and 15 respectively, fastened to discs 16 and 17, which are mounted upon the engine shaft 18. The engine shaft 18 extends through the engine co-axial to the annular working cylinder and is carried by ball bearings 19 in the cylinder covers 3.

On the cross beams 10 and 11 guide rollers 20 are provided journaled in ball bearings and running in guides 21, fastened to the frame or the outer cylinder 1. To the frame is further fastened a cylindrical casing 22 for a buffer spring 23, with which the cross beams 10 and 11 co-operate. At the opposite side of the engine there is a cylindrical casing 24, containing two plungers 25 and 26 fastened to the cross beams 10 and 11 respectively, the whole constituting a pneumatic buffer for the same, for the purpose hereinafter described.

In the wall of the inner cylinder 2 a transverse central inlet 27 is provided, Figures 1 and 4, which extends around the whole circumference of the cylinder except where short stays 28, Figure 2, formed by the cylinder wall connect both parts of the cylinder 2. Within the cylinder 2 there is a co-axial sleeve shaped valve body 29, sliding axially and provided with a flange 30, situ-

ated at the inlet 27, concentric to the cylinder 2 and directed outwardly towards same. The said flange 30 is provided with conical surfaces 31 and 32, by means of which the flange 30 seats against the sliding sleeves 33 and 34. These are guided by the cylinder 2 and constitute a guide for the sleeve shaped valve 29.

Between the sleeves 29 and 33 there is a passage 35, which by the opening 36 in the sleeve 33 communicates with a passage 37 formed in the cylinder 2, which passage communicates with a space 38 in the left cylinder cover 3, to which space or recess an inlet channel 39 Figure 3 for the gas mixture is connected.

Between the sleeves 29 and 34 a passage 40 is provided, which by openings 41 in the sleeve 34, a passage 42 in the wall of the cylinder 2 and a space or recess 43 in the other cylinder cover 3 communicates with an outlet 44, Figure 3, for the combustion gases. The sleeves 33 and 34 together with the flange 30 on the sleeve 29 constitute valves for the admission of the gas mixture into the working cylinder and the exhaust of the combustion gases respectively.

The left end of the sleeve 29 is provided with a suitable projection 45, Figure 4, which, when the suction of the gas mixture is to take place, is actuated by a roller 46 /or cam/ on a collar 47, fixed to the engine shaft 18. The sleeve 29 on its right end has a similar projection 48, which, when the exhaust of the combustion gases is to take place, as actuated by a roller 49 /or cam/ on a collar 50, fastened to the engine shaft 18. A spring 51 bears with one of its ends against the cover 3 of the cylinder and with the other end against the sleeve 33. A similar spring 52 is provided between the sleeve 34 and the other cover 3 of the cylinder.

The outer cylinder 1 and the inner cylinder 2 are provided with water jackets 53 and 54 respectively.

The pistons 4 and 5 are on the outer circumference provided with piston rings 55 and in the wall of the cylinder 2 rings 56 are provided seating against the inner side of the pistons.

The engine as above described, which is a four cycle engine, works in the following manner. When at the start the pistons are moved from each other, the gas mixture is sucked into the cylinder space between same. At the beginning of the suction stroke the roller 46 actuating the projection 45, forces the sleeve 29 toward the right, so that the flange 30 is moved from the sleeve 33 and the gas mixture passes through the space 38, the passages 37 and 35 and the inlet opening 27 into the cylinder. During the said movement of the sleeve 29 the sleeve 33 is kept in its position by a flange 57 bearing against flange 58 on the inner cylinder 2. The

sleeve 34 on the other hand is moved toward the right against the action of the spring 52.

When the roller 46 has passed the projection 45 at the left end of the sleeve 29, the spring 52 forces the sleeve 34 and the sleeve 29 toward the left, so that the sleeve 30 again bears against the sleeve 33 and the inflow of the gas mixture is cut off.

During the inward motion of the pistons the gas mixture is compressed, and when the compression has taken place, the gas mixture is fired by means of an electrical ignition device, (not shown), or otherwise. During the next outward stroke of the pistons the expansion takes place. At the end of the same the roller 49 on the collar 50 actuates the valve sleeve 29 and forces the same toward the left from the sleeve 34, so that the space between the pistons by the opening 27, the passages 40 and 42 and the space 43 is brought in communication with the outlet 44, and the combustion gases are driven out during the next inward stroke of the pistons. The sleeve 34 is kept in its position by a flange 59 resting against a flange 58 on the right end of the inner cylinder 2.

Owing to the fact that the opening 27 extends substantially around the whole circumference of the cylinder 2 and in consequence of the spacious channels 35 and 40 the gas mixture can be sucked into the cylinder and the combustion gases be driven out at a low speed for which reason any essential reduction of the admission pressure or increase of the counter pressure at exhaust of the combustion gases does not occur, which is advantageous to the efficiency of the engine. As seen from the drawings the valve device is very simple and requires a small space, and further the length of the valve strokes can be very short. Moreover it may be pointed out that the clearance including the passage communicating with the same is reduced to a minimum.

The cam tracks 14 and 15, carried by the engine shaft 18, are arranged in the same manner wherefore only one of them is shown in Figure 6. This figure only shows one half of the cam track evolved. The second half is arranged in quite the same way as that shown. Each cam track has two series of curves, each of the series comprising one curve for the period of suction, one curve for the period of compression, one curve for the period of expansion and one curve for the period of exhaust, so that the engine receives two impulses at each revolution.

In consequence of this, the impulses are quadrupled, compared to a common four cycle cylinder engine and the advantage is gained, that the fly wheel or the fly wheels can be made very light and the engine can be so arranged that it requires a small space, which cheapens the cost of its manufacture. The cam curves in Figure 6 are designated

by 60, 61, 62 and 63, the curve 60 corresponding to the period of expansion, the curve 61 to the period of exhaust, the curve 62 to the period of suction and the curve 63 to the period of compression.

During the outward movement of the pistons caused by the explosion, the rollers 13, journaled on the cross beams 10 and 11 are forced against the curves 60, whereby a lateral pressure arises, which tends to turn the pistons round their axis. This however, is prevented by the rollers 20 running in the stationary guides 21, which thus will sustain the said lateral pressure, and the pressure of the pistons will turn the cam discs 14 and 15, and thereby the engine shaft 18. By this arrangement no counterpressure between the pistons and the walls of the cylinder arises with loss of power by friction, as is the case with engines where the power is transmitted from the piston to the engine shaft by means of a crank and a connecting rod. By means of the force, which during the stroke of expansion is accumulated in the cam discs, which are made sufficiently large for such an accumulation, the cam discs and the engine shaft continue rotating during the next operations, viz, exhaust, suction and compression.

During the expansion the rollers run down to the deepest points of the curves 60 respectively, which are the deepest points of the cam tracks respectively. The pistons are then driven inward by the curves 61, the rollers 13 running up to the highest point of the cam discs 14 and 15 forcing the pistons close up to each other, so that the combustion gases as completely as possible are driven out of the cylinder. At the inward motion of the pistons the spring 23 and the plungers 25 and 26 resist the driving force of the reciprocating parts. During the continued rotation of the engine shaft 18 and the cam discs 14 and 15 the pistons are forced outwards from each other by the force, accumulated in the spring 23 and the pneumatic buffer, the rollers running along the cam tracks 62. Meanwhile a new charge of gases is sucked into the cylinder, which charge during the continued running of the rollers 13 along the cam tracks 63 is compressed, whereupon the ignition takes place and the cycle, above described, is repeated.

The cam curves 60, 61, 62 and 63 have different heights and lengths as is best shown in Figure 6. The curve 62 for the suction of the charge of gas is preferably so low, that only such a quantity of gases is sucked into the cylinder as can, after compression by the operation of the curve 63, be completely or almost completely expanded to the atmospheric pressure at the end of the piston stroke. Because the combustion gases are almost completely driven out of the cylinder and the next charge of gas consequent-

ly is as pure as possible and further because no greater charge of gases is sucked into the cylinder than can be expanded down towards the atmospheric pressure, the efficiency of the engine will be the greatest possible.

The application of the invention, shown in Figure 5, differs from the one described above only thereby, that a sleeve-shaped slide valve 64 with double walls is substituted for the sleeves 29, 33 and 34. The slide valve 64 is provided with a central partition 65 which, in the position of the slide valve shown in Figure 5, covers the opening 27 of the inner cylinder 2. On both sides of the partition 65 openings 66 and 67 are provided communicating with the spaces between the walls of the slide valve, and at one end of the slide valve there are side openings 68, through which the left chamber of the slide valve communicates with the passage 37, the space 38 and the inlet for the gas mixture. Corresponding side openings 69 at the other end of the slide valve keep the right chamber of the same in communication with the passage 42, the space 43 and the outlet for the combustion gases. The ends of the slide valve 64 are actuated by springs 70 and 71.

The rollers 46 and 49, carried by the engine shaft 18, actuate projections or cams 72 and 73 respectively on the ends of the slide valve 64, which cams are so situated, that the roller 46 during the rotation of the engine shaft 18 at the right moment forces the slide valve 64 toward the right against the pressure of the spring 71, the opening 66 thus coming in register with the opening 27 and the gas mixture being sucked into the cylinder. The slide valve is then returned to its closing position by the spring 71. During the exhaust stroke the slide valve is forced toward the left by the roller 49, actuating the cam 73, so that the openings 67 come into register with the opening 27, whereupon the slide valve is returned to its normal position by the spring 70. A key 74, fixed to the cylinder and engaging a keyway 75 of the slide valve 64, prevents the latter from rotating.

In the described examples of the application of the invention the forces of inertia of the pistons are balanced by the simultaneous working of the pistons to and from each other in a common cylinder. By this the pressures on the pistons and consequently also on the cam discs become equal, and the axial pressure on the engine shaft and the discs is completely balanced and neutralized. While the curves of the cam tracks are so shaped, that one curve always corresponds to another curve on the opposite side of the engine shaft, symmetrically equal to the former with regard to the direction motion, and although the curves for the different opera-

tions, compared with one another, may be of a quite unequal shape, as above mentioned and shown in Figure 6, the impulses of power, transmitted by the two rollers 13 of the pair of rollers, are also equally divided and balanced on each side of the engine shaft, and consequently no one-sided radial pressure on the engine shaft arises.

I claim:

1. In an internal combustion engine the combination with an annular cylinder and two annular pistons working therein, of a single combustion chamber between the said pistons and common to the same, in which chamber the said pistons move from and approach close to each other, controlling means provided at the inner annular wall of the cylinder and means for shifting the same, the said controlling means effecting a narrow passage at the inner wall extending round the same and serving as outlet for the combustion gases and preferably also as inlet for the fuel charge.

2. In an internal combustion engine the combination with an annular cylinder and two annular pistons working therein, of a single combustion chamber between the said pistons and common to the same, in which chamber the said pistons move from and approach close to each other, a central slot provided in the inner annular wall of cylinder and extending round the same, an admission passage for the fuel and an exhaust passage inside the said wall and controlling means for the said slot, putting the chamber between the pistons in communication with the said passages respectively.

3. In a four-cycle internal combustion engine the combination with an annular cylinder, two annular pistons working therein and cam tracks co-operating with the pistons in order to effect a relative rotary moment between the cylinder and the cam tracks, of a single combustion chamber between the said pistons and common to the same, in which chamber the said pistons move from and approach to each other, controlling means provided at the inner annular wall of the cylinder and means for shifting the same, the said controlling means effecting a passage at the inner wall extending round the same and serving as outlet for the combustion gases and preferably also as inlet for the fuel charge, and the cam tracks being so arranged, that the expansion and exhaust strokes of the pistons are greater than the suction and the compression strokes of the same.

4. In an internal combustion engine the combination of an annular cylinder, two annular pistons working therein to and from each other, a combustion space between the said pistons and common to the same, a central rotary shaft, cam tracks provided on the said shaft and co-operating with the said pistons in order to effect rotary movement of the shaft, inlet and outlet for the fuel and the combustion gases respectively located in the inner wall of the cylinder, two sliding sleeves guided by the inner wall of the cylinder, one at each side of the said inlet and outlet, the inner ends of the sleeves being shaped as valve seats, a sleeve-shaped valve body, located inside the said sliding sleeves and provided with a flange, co-operating with the said seats, an annular room between the sliding sleeve and the valve body and communicating with the admission passage for the fuel and the discharge opening for the combustion gases, yielding means forcing the said sliding sleeves against the said flange, abutments for the said sliding sleeves, and means provided on the said shaft and actuating the said valve body, so that, when moved in one direction or another, it carries with it one of the sleeves but is removed from the other sleeve and the cylinder is set in communication with the said annular room.

5. In an internal combustion engine the combination of an annular cylinder, formed by one outer and one inner cylinder, the latter being kept in position by covers fastened to the ends of the cylinders, two annular pistons working in the said annular cylinder, a combustion space between the said pistons and common to the same, a rotary shaft, cam tracks provided on the said shaft and co-operating with the said pistons in order to effect rotary movement of the shaft, inlet and outlet for the fuel and the combustion gases respectively located in the said inner cylinder, chambers which are provided in the said covers and to which necessary connections are joined, passages communicating with the said chambers, means controlling the communication between the said inlet and outlet and the said passages respectively, and means provided on the said shaft and actuating the said controlling means.

In testimony whereof I have affixed my signature in presence of two witnesses.

CARL ALRIK HULT.

Witnesses:

ROBERT APELGREN,
ULIN WAHMAN.