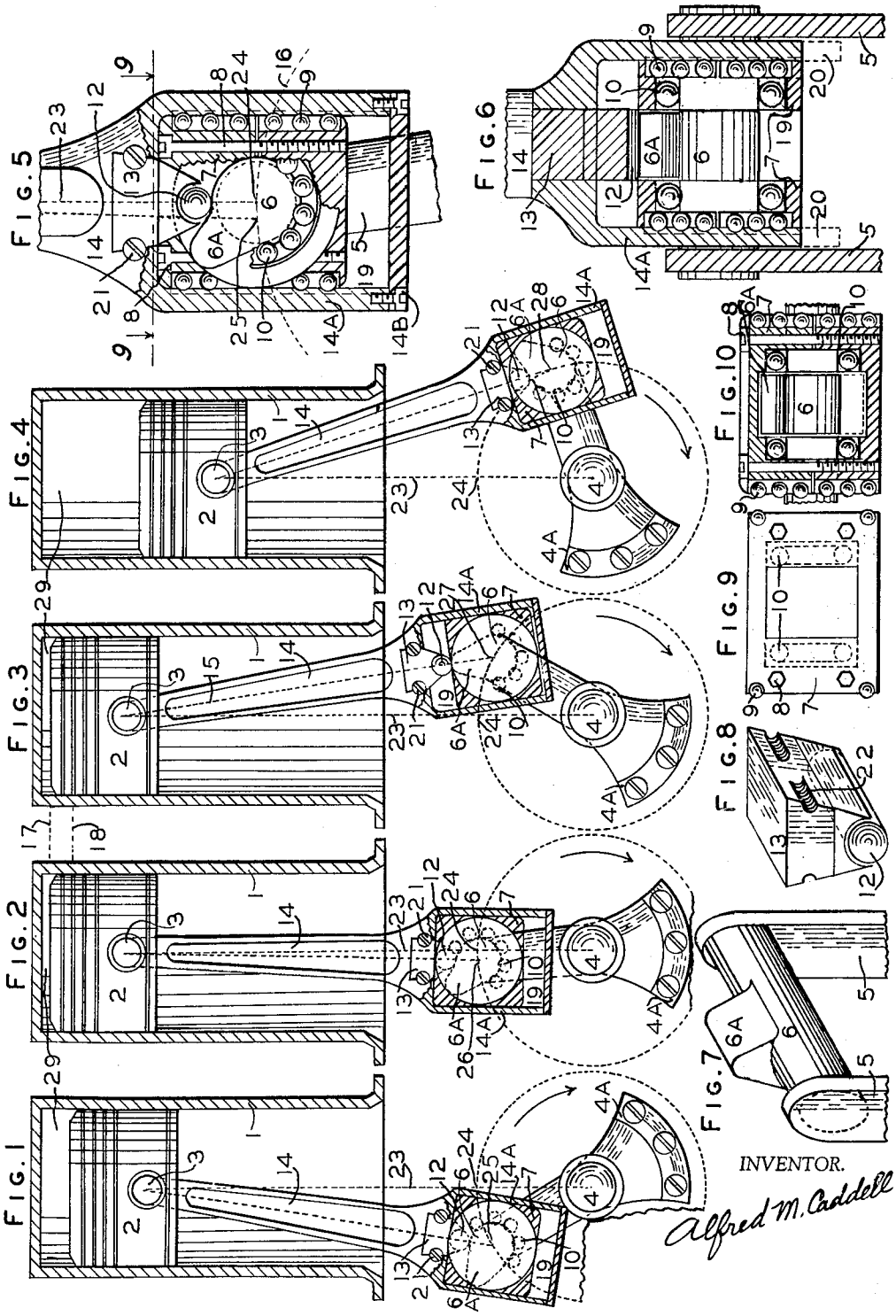
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PISTON-CRANK CONNECTOR ASSEMBLY FOR TWO-CYCLE ENGINES

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PISTON-CRANK CONNECTOR ASSEMBLY FOR TWO-CYCLE ENGINES

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This is a continuation-in-part application superseding the application of the same title, Piston-Crank Connector Assembly for Two-Cycle Engines, Serial No. 812,665, filed May 12, 1959, and now abandoned.

The invention has to do with a modified operating cycle for engines, and has for its purpose the following prime objectives:

A large increase in power output per bore and per number of cylinders; vibrationless operation of an engine; application of energy only through a favorable leverage range on the power stroke—not before, as at present; the achievement of a very considerable saving in fuel per horsepower developed; making possible the employment of smaller cylinder capacity and a slower turning engine compared to the cubic inch displacement and high r.p.m.'s now necessary to attain a stated power output.

These objectives are made possible by employing a new type of crank assembly that includes a crankpin having a cam extending a considerable distance from its rounded surface, a connecting rod with a roller pin in its base for periodically being engaged by said cam and a hood-like housing merged with said base and rotating with said crank assembly, said housing also moving reciprocally relative to said assembly in accordance with the dictates of said cam acting against said roller pin.

The built-in travel distance of a piston may be measured from the top of a rounded crankpin to the top of a piston. In a conventional engine cycle this distance remains constant throughout the operating cycle. But in the present invention the radial length of the cam is added to said built-in distance during that portion of the cycle between top center and an advanced position, such as 30 degrees, on the power stroke. Thus, by means of coaction between the cam and the connecting rod assembly the movement of the piston is halted at the heighth of its travel in the cylinder and remains halted without any displacement change occurring in the combustion chamber between the top of the piston and the cylinder head until the crankpin arrives at an advanced position in the operating cycle—in the herein described example, 30 degrees on the power stroke. If the engine is of the internal combustion type, ignition of the fuel-air mixture takes place during this momentary non-movement of the piston, and combustion pressure is built up and maintained in said chamber. The crankpin already being at the 30-degree position on the power stroke before the combustion pressure is allowed to expand, the piston commences its travel under full expansion pressure at this most favorable leverage position, resulting in a great increase in power with freedom from vibration. A much greater percentage of the energy created during the combustion process is thus made available at the crankshaft.

The commencement of the power stroke at said 30-degrees after top center is especially important in the operation of an internal combustion engine. For, unlike steam, which exerts continuous follow-up pressure against a piston throughout the power stroke, the application of energy in an internal combustion engine is limited to a single explosive impulse per revolution if the engine is of the two-cycle design or every other revolution if it is the four-cycle type.

In conventional Otto cycle engines, the power stroke covers a range from 0 degree (top center) to approximately 125 degrees on the power stroke. In contrast, in the operating cycle made possible by this invention, the build-up of pressure commences after top center and consequently will exert greater pressure on the power side of the engine. For in this cycle, the range of piston travel commences at said 30 degrees on the power stroke and may extend with perfect safety to 160 degrees or more before the exhaust valve commences to open, thus assuring maximum expansion pressure through 130 degrees in the aforesaid favorable leverage range. And, obviously, the greater the energy being applied throughout said favorable leverage range, the greater will be the turning effort at the crankshaft.

Then, too, in conventional engines, especially the aviation type, the fuel-air mixture is fired from 30 to 45 degrees before top center so that combustion pressure will build up to its maximum at the point of maximum compression pressure—when the piston is at its maximum heighth in the cylinder. Although the employment of energy in an anti-leverage position in the crankthrow is contrary to the law of physics, such build-up of pressure in present-day engines is most essential for maximum power output. This paradoxical situation is due to the comparative slowness of flame travel compared to that of piston travel. Although the time period involved is infinitesimally small, the difference in power output between advanced and retarded firing is overwhelmingly great.

As an instance of said comparative slowness, in an aviation engine having a 6-inch bore and ignition taking place 30 degrees before top center, the flame travels from the igniter across the bore through said 30 degrees to top center at a speed of approximately 75 feet per second; which, as will be observed by checking the following table, is considerably slower than that of the travel of the piston throughout the same number of degrees.

Crankshaft Revolutions per Minute	Crankshaft Revolutions per Second	Time Required for Crankpin to Travel Through 30 degrees of the 360 degree Revolution, sec.
900	15	.00555
1,200	20	.00417
1,800	30	.00377
2,400	40	.00208
3,000	50	.00165

Which microsecond periods of time focus attention on the speed at which chemical reaction takes place upon the fuel-air mixture being fired by the spark and the critical relation existing between maximum combustion pressure build-up and the aforesaid speeds of crankpin rotation.

But during such microsecond periods of time when the fuel-air mixture is fired before top center the very rapid build-up of combustion pressure raises havoc with an engine. Just as the power output is affected by retardation or advancement of the spark, just so, on the other hand, is considerable of that power lost due to the energy created before top center having no chance to do any work until the piston passes top center of the crankthrow and picks up speed on the power stroke.

This invention is eminently suitable for two-cycle engines having intake and exhaust ports that are uncovered by the pistons and employing evacuation of the exhaust as described in applicant's Patent No. 2,942,685, together with other applications.

In the drawings:

FIGS. 1, 2, 3 and 4 show the relation between the crank assembly and the piston in several crank angle positions in the modified cycle.

Specifically, FIG. 1 shows in dotted outline the roller pin riding on the rounded surface of the crankpin at 30 degrees before top center on the compression stroke, which position may be considered normal as contrasted to that when the roller pin is engaged by the cam.

FIG. 2 shows the center of the crankpin at 5 degrees before top center with the crankpin cam just starting to make contact with the roller pin of the connecting rod assembly thus assuring that full cam-actuating contact will be made at top center of the crankthrow.

FIG. 3 shows the connecting rod roller pin riding on the apex of the crankpin cam, said cam thereby forcing retention of the piston at an artificial top center extending between 0 degrees and 30 degrees on the power stroke, the center of the crankpin meanwhile having reached the 30-degree beyond top center position of the crankthrow.

FIG. 4 shows the cam having completely passed the roller pin and the latter having rolled down the opposite side of the cam to the crankpin's rounded surface, which occurs at 70 degrees after top center and which contact position is maintained until the actuating cam again forces retention of the piston at top center in the cycle next following.

FIG. 5 is an enlarged end view of the lower part of the connecting rod, together with its movable housing appendage shown in cross section, a structure including bearing means interposed between the crankpin proper and said housing and other features, later fully described. FIG. 5 is based on the position of the crankpin as shown in FIG. 2.

FIG. 6 shows a side view of the crankpin, its cam making contact with the roller pin, the structure containing the longitudinally disposed bearing assemblies that permit anti-frictional reciprocal movement of the hood-like housing appendage that encompasses the structure, and radial bearings to permit rotation of the structure and housing assembly around the crankpin. A pair of crankarms secured to the crankpin ends extend toward a crankshaft, not shown.

FIG. 7 is a three-quarter view of the crankpin itself, showing the cam integrally formed on its rounded surface and crankarms secured on the ends thereof.

FIG. 8 is an enlarged, separate view of the fitting identified as **13** containing the roller pin, said fitting being secured to rod **14** by screw bolts **21** as indicated by threaded half-holes in the base of the connecting rod.

FIG. 9 is a top view of the split-half structure taken on the lines **9—9**, FIG. 5, wherein is shown the longitudinally disposed bearing assemblies that make contact, as shown in FIG. 5, with the housing appendage on each of its sides, the central opening in the top of the structure that permits the in-and-out passage of the roller pin to be contacted by the crankpin cam, and heads of the bolts that secure the bottom half of the split-half structure to each other.

FIG. 10 is a cross sectional side view of the split-half structure, showing a portion of the crankpin extending through the split-half structure identified as **7**, FIGS. 5 and 6, the longitudinal ball bearing assemblies for permitting reciprocal motion between structure **7** and the enveloping housing **14A**, and radial bearings **10** mounted in structure **7** to permit rotary motion of the structure and housing assemblies around the crankpin.

Cylinder **1**, shown in FIGS. 1, 2, 3 and 4, may be of conventional design, as may also piston **2** and piston pin **3**. The crank assembly consists of crankshaft **4**, crank balance weights **4A**, crankarms **5**, crankpin **6** and crankpin cam **6A** integrally formed on the crankpin's rounded surface, split-half structure **7**, tie-bolts **8**, longitudinally disposed bearing assemblies **9** and crankpin bearing assemblies **10**.

As aforesaid, structure **7** is comprised of split-half sections (see FIG. 10) which have radial bearing assemblies **10** embodied therein for permitting said structure and housing **14A** on the end of connecting rod **14** to revolve around the crankpin and, at the same time, carrying bearing assemblies **9** that permit longitudinal motion between structure **7** and housing **14A**.

Bearing assemblies **10** provide freely movable connections between the crankpin and the crankshaft by means of crankarms **5** which are integrated with crankshaft **4** and with crankpin **6**, as shown in FIGS. 1, 2, 3 and 4, and partially in FIGS. 5 and 6.

Rotation of the crank assembly is maintained constantly during operation of the engine by means of these crankarms while the piston is momentarily halted in its travel by means of crankpin cam **6A** engaging roller pin **12**, which is floatingly installed in fitting **13** and which fitting is, in turn, secured in the connecting rod's base.

As will be seen by referring to FIGS. 5 and 8, the sides of fitting **13** extend slightly below center of the pin so that the pin will be retained at all times within said fitting and yet permit free contact of the cam thereagainst. And inasmuch as the entire crank assembly, including roller pin **12**, operates within the crankcase area, all moving parts thereof, including roller pin **12**, will at all times be adequately lubricated.

As before stated, the action of the cam against the roller pin translates into retaining the piston at the height of its travel in the cylinder until the crankpin arrives at and passes the 30-degree position on the power stroke. Said in another way, the normal distance that would prevail from the center of the crankpin at the 30-degree position of the cycle to the top of the piston is compensated for in this instance by the additional linear distance provided by the radial length of the cam on the crankpin when it is in full engagement with the roller pin. This linear distance is indicated by comparing the position of the piston and the crankpin cam in FIG. 2 with that of the positions shown in FIG. 3 when, as depicted by dotted line **15**, the apex of the crankpin cam and the center of the roller pin come in direct line between the center of crankpin **6** and the center of piston pin **3**.

Immediately upon the apex of the cam passing the center of the roller pin at the 30-degree position, roller pin **12** rolls down the opposite face of the cam to the rounded surface of the crankpin with which it, the roller pin, maintains contact until the actuating face of the cam again comes in contact with the roller pin during the next-following cycle. Thus, as will be seen in FIG. 4, the distance of the piston travel lost during the retention of the piston at top center, as shown in FIG. 3, is recovered by the time the crankpin arrives at the 70-degree position, as indicated by numeral **28**, on the power stroke.

As shown in FIGS. 1, 2, 3, 4 and 5, connecting rod **14** merges into housing **14A** which encompasses split-half structure **7**. An opening **7A**, FIG. 9, is provided in the top of said structure for the admission therethrough of fitting **13** which carries in its base roller pin **12** for it to be contacted by cam **6A**. When this cam fully engages said roller pin, as in FIG. 3, connecting rod **14** and appendage **14A** are caused to move upward, causing retention of the piston at top center during the extent of such engagement, after which said housing returns to its former position relative to said structure and the crank assembly. The reciprocal travel of this housing is shown by dotted lines **20**, FIG. 6.

The added linear distance made possible by cam **6A** engaging roller pin **12** is also indicated by dotted lines **17** and **18** between FIGS. 2 and 3. Line **17** shows the artificial top center maintained by the piston, FIG. 3, while the crankpin is at the 30-degree position on the power stroke, and line **18** indicates the position in the cylinder where the piston would be at in a conventional engine at the 30-degree position on the power stroke.

The crankthrow is identified by dotted outline **16**, FIG. 5, and is also shown in circular dotted outline in FIGS.

1, 2, 3 and 4. The center line is identified as **23** and where the center line crosses the crankthrow the numeral **24** indicates top center.

In FIG. 1, the numeral **25** indicates the 30-degree position before top center; in FIG. 2, **26** indicates the 5-degree before top center position; in FIG. 3, **27** indicates 30 degrees after top center and, in FIG. 4, **28** represents 70 degrees after top center.

In FIGS. 1, 2 and 4, space **19** is shown between the bottom of structure **7** and the bottom of housing appendage **14A**, while in FIG. **3**, when the crankpin cam is in full engagement with the roller pin, space **19** occurs, due to the upwardly forced movement of the connecting rod and said housing, between the top of structure **7** and the bottom part of connecting rod **14**.

To provide anti-frictional connection between the connecting rod and the crankpin assembly during the reciprocal travel of the housing relative to the strictly rotary travel of the structure-enveloped crankpin, longitudinally disposed bearing assemblies **9**, as shown in FIGS. 5, 6, 9 and 10, are carried in the four corners of said structure. These bearings absorb the thrust forces incident to the centrifugal throw of the crankpin on both the compression and power strokes and simultaneously maintain accurate alignment of the connecting rod in its relation with the crankpin. For ease of assembly and disassembly, the bottom part of housing **14A** is disengageable from the sides thereof by means of screw bolts **14B**, indicated in FIG. 5.

Roller pin fitting **13** is removably secured in the base of rod **14** by means of screw bolts **21** which engage threaded holes **22**, shown in FIG. 8, which holes are formed half in fitting **13** and half in connecting rod **14**.

The combustion chamber between the top of the piston and the cylinder head is identified in each of FIGS. 1, 2, 3 and 4 by the numeral **29**.

Certainty of contact of roller pin **12** between crankpin **6** and cam **6A** is assured at all times by virtue of the compression pressure obtaining during the compression stroke and expansion pressure on the power stroke.

Having described my invention, I claim:

1. The combination with a rotatable crank assembly and a piston reciprocated thereby, of a rod construction operatively connected to said piston and to said crank assembly, a crankpin of said assembly for establishing a crankthrow cycle, said crankpin having a rounded surface and a cam integrated with and extending radially therefrom, said rod construction including a structure mounted around said crankpin, said structure being comprised of two halves and having means for being secured each to the other, bearing assemblies mounted in said structure and enveloping said crankpin on each side of said cam for permitting anti-frictional rotation of said structure therearound, a construction forming a housing appendage for ant-frictionally enclosing said structure, said appendage being adapted relative to said structure to undergo reciprocal movements equivalent to the radial projection of the cam during the rotation of said crank assembly.

2. The combination with a rotatable crank assembly and a piston reciprocated thereby, of a rod construction operatively connecting said piston with said crank assembly, a crankpin of said assembly, a cam mounted on said crankpin and extending radially therefrom, said rod construction including a structure comprised of divided halves having means for being secured to each other and mounted anti-frictionally around said crankpin, said structure having right angular outer sides relative to the mounting of said crankpin and carrying longitudinally disposed bearings in said sides, said rod construction terminating in a housing having inner sides paralleling the aforesaid outer sides of said structure and being adapted to undergo reciprocal movement relative thereto by means of said cam, said housing having grooveways formed on its inner sides, said bearings extending partially outward from said structure into said grooveways for establishing anti-frictional contact with said housing during said reciprocal movements.

3. The combination with a rotatable crank assembly and a piston reciprocated thereby, of a rod construction operatively connected to said piston and to the crank assembly, a movable fitting having a contact surface comprising a cam follower securely embedded in said rod construction on the crank assembly end, said assembly having a crankshaft and a crankpin for establishing a crankthrow cycle, a line passing through the center of said crankpin and through the center of said piston to establish a top center of said cycle, a rounded surface on said crankpin, a cam having a base and an apex formed integrally with and extending radially from said rounded surface for establishing periodic contacts with said cam follower, a structure carrying radial bearings mounted around said crankpin, said structure being comprised of divided halves and having an opening for the protrusion of said cam follower therethrough, said rod terminating in a housing appendage on said crank assembly end, longitudinally disposed bearings carried by said structure for establishing anti-frictional relation between said structure and said housing, the base of said cam establishing engagement with said cam follower precisely upon the arrival of the piston at top center and increasing said engagement toward the apex of the cam until the crankthrow of said assembly passes the line defining said top center.

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