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(54) FOUR STROKE RELATIVE MOTION CYLINDER WITH DEDICATED COMPRESSION SPACE

(57) Implementations are disclosed herein that relate to a cylinder occupying structure. An example provides a cylinder system comprising a mechanical cylinder including an internal space in which a fluid is introduced, and a piston configured for reciprocating motion in the internal space, and a cylinder occupying structure including a floating piston, wherein the floating piston is variably advanced into, and retracted from, the internal space of the cylinder in correspondence with the reciprocating motion of the piston and where parts of the occupying structure and the piston may surround the combustion space, and where fluid compression and fluid combustion is conducted within separate spaces.

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Description

Cross Reference to Related Applications

[0001] This *Conventional application taking priority from* U.S. non-provisional patent application number 16/998,771, filed on August 20,2020 and PCT application PCT/US2019/068510 having filing date December 25, 2019.

Field of the Invention

[0002] The present invention relates generally to mechanical devices used to perform work, and more particularly to hydraulic and combustion cylinders.

[0003] Definitions of certain reciprocating cylinder components and operations:

1. Reciprocating motion of a crankshaft piston: a crankshaft reciprocates between a maximum expansion point, at the bottom of a cylinder, known as Bottom dead Center (BDC) and between maximum retraction point know as Top Dead Center (TDC).
2. Swept volume: is a crankshaft surface area multiplied by a stroke distance, between BDC and TDC.
3. Clearance volume: is the space located between TDC and the cylinder head where fluid is compressed, in a conventional cylinder, in preparation for combustion.
4. Displaced volume: is the volume of air and fuel mix required to be replaced after each reciprocating cycle, which, in a conventional cylinder, equals the sum of clearance volume and swept volume. A simple positioning an occupying structure within the clearance volume, can change the clearance volume, and the compression ratio, but can never make displaced volume, different from the sum of clearance and swept volumes.
5. Pascal law as a function of position, used to calculate forces transferred by displaced fluid to a crankshaft surface during a power stroke, where the force output times the stroke distance represents a mechanical work output that is equal to mechanical work input, or to equivalent thermal input.
6. Pascal law as a function of time, is a new mathematical method introduced by the disclosed system, to describe how competing with combustion fluid for space behind a crankshaft piston surface, can make a displaced volume smaller than the sum of clearance and swept volumes and as result save on the needed mechanical or thermal work input, required to replace fluid after each stroke.
7. Fluid inlet of a cylinder: is a fluid manifold and fluid entry valve. In a conventional cylinder, a fluid inlet can for example, provide variable amount of air between one reciprocation cycle and another, however such variability in a conventional cylinder, can affect the pre-combustion compression ratio. Having a second fluid inlet that can change the fluid volume or pressure during a power stroke of a cylinder, cannot be deployed or used in a conventional cylinder, however it will be introduced in this application.
8. Second air inlet is a term used in this application, to refer to fluid introduced into the compression or combustion space during the time of a power stroke, to increase the combustion or hydraulic driving force. While a first fluid inlet is responsible to introduce fluid into cylinder in each cylinder stroke, a second inlet can introduce fluid selectively during a power stroke, in response to rising resisting forces and increasing a driving load.
9. Four Stroke conventional engine means performing air suction, air compression, combustion and exhaust within two reciprocating cycles. Four strokes can be minimized into conventional two strokes by combining suction, exhaust, and compression in one motion within the same internal cylinder space, to perform a power stroke every stroke in a two-stroke cylinder. Providing a dedicated compression space within the cylinder is not used in a conventional cylinder and can help keeping the suction and compression separate from combustion and exhaust, and yet perform a power stroke every stroke. We may call this method of the disclosed system, a four stroke Relative Motion cylinder.
10. Dedicated compression space is a term used in this application to serve the function of having four strokes performed in one reciprocating cycle.
11. Occupying structure in a conventional refers to insertion body that is positioned inside the cylinder to affect the pre-combustion compression ratio or the clearance volume. In this application, an occupying structure is used to accelerate into the space of cylinder, under the combustion or hydraulic forces. in the direction of the crankshaft during the time of a power stroke to compete with combustion fluid for space, to minimize displacement volume and to increase internal cylinder pressure.
12. Force Control mechanism in this application refers to mechanical assembly capable of increasing or decreasing a crankshaft driving force during the time of a power stroke.
13. Fluid decompression in a conventional cylinder happens during a power stroke where fluid presser decreases toward the end of power stroke. If the motion of the crankshaft piston was more than 15 meter per second, the internal surface of the crankshaft piston suffers what we call a freezing zone, which is not a desired function mainly because of its association with incomplete burning. In this application we will introduce fluid decompression in a dedicated compression spaces, starting with the start of a power stroke, and also another fluid decompression by way of opening a fluid inlet, to allow compressed air to move into and toward the combustion space during a later part of a power stroke for the purpose of

removing exhaust fluid from the primary combustion space, and to provide cooling effects to occupying structure without suffering a lower quality of combustion. For example, if exhaust fluid is about 2:1 atmospheric compression ratio within the cylinder near the end of a power stroke, and if a non-fuel mixed supercharged fluid is at 10:1 compression ratio introduced into the cylinder. Exhaust fluid will departed, and the compressed fresh air will decompress and spread into the cylinder, for providing cooling effects to the inside of the cylinder and to provide partly compressed fresh air, available for a complete compressing in the next piston retraction.

[0004] A wide variety of devices utilize cylinders to perform mechanical functions and produce useful work. A typical internal combustion engine (ICE), for example, employs a number of cylinders in which a fuel-air mixture is compressed and combusted to produce work that is imparted to a respective reciprocating piston. Each piston may be coupled to a crankshaft, with which forces imparted to the pistons can be transmitted, through various intermediate devices, to the wheels of a vehicle to thereby propel the vehicle. Pistons may be coupled to drive a turbine, a pump or electric generator.

[0005] When configured for use in an ICE, hydraulic system, or in other contexts, a typical cylinder produces mechanical work output that is proportional to its swept stroke volume (e.g., the volume through which a piston surface travels) which is the product of a piston surface and stroke distance (e.g., the axial distance through which the piston surface travels). Accordingly, previous systems (e.g., gasoline and diesel ICEs) have turned to increased stroke volumes and/or distances to increase cylinder output. Increasing stroke volume and/or distance may stipulate an increase in cylinder dimensions and thus engine mass, however, reducing the overall economy of an engine and vehicle in which such enlarged cylinders are used. In all conventional cylinders the swept volume plus the clearance volume, equals the displacement volume, which represent how much fluid input is needed to use in each stroke. A solution of making displacement volume, smaller than the sum of clearance and swept volumes, or even smaller than swept volume, would provide an enhanced engine performance proportionate with the percentage of decreasing such displacement volume.

[0006] Other approaches to increasing engine economy may include the use of a recovery system. Hydraulic cylinders, for example, may be coupled to a hydraulic or turbo charger or to an electrical recovery system, though such recovery systems frequently exhibit limited efficiencies (e.g., 20-30%) especially when they work against a high initial pressure around 1000 psi, to enhance a compression ratio. When a turbocharge recovery, system is directed to participate in the cylinder driving forces at lower compression ratio, recovery return can be improved. In the disclosed system, we have example of over 80% recovery potential.

[0007] Direct injection method in four stroke engines, have been implemented for the purpose of satisfying clean environment requirements. Two stroke engines, which are desired for using every stroke as a power stroke, are completely prohibited in certain areas due to their tendency of releasing excessive amounts of non-completely burned exhaust. A solution of performing a four stroke work model (suction, compression, combustion, exhaust) in one reciprocation cycle, where every stroke is a power stroke, but without sacrificing exhaust quality, would provide the benefits of both two and four stroke engines.

[0008] In view of the above, there exists a need for a mechanism to meet environmental requirements of a combustion engine by optimizing cylinder forces and internal pressure while minimizing the release of unburned fluids and fuel mixed fluid, while still achieving excellent power output.

Summary of the Invention

[0009] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the detailed description. This summary is not intended to identify key features of essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.

[0010] According to embodiments of the present disclosure, in its most simple form, an engine block including one or multiple cylinders is disclosed, the cylinder system comprising a mechanical cylinder including an internal space in which a fluid is introduced, and a crankshaft piston configured for reciprocating motion in the internal space; and a cylinder occupying structure including a floating piston, wherein the occupying structure is variably advanced into, and retracted from, the internal space of the cylinder in correspondence with the reciprocating motion of the crankshaft piston and wherein the occupying structure contains or surrounds a combustion space, in the clearance area between the crankshaft piston and the top of cylinder, wherein the occupying structure have an edge facing toward the head of the engine, where in such edge of the occupying structure creates a primary and secondary combustion spaces, and wherein the occupying structure and the crankshaft piston have a male -female engagement.

[0011] In another aspect of the present disclosure, an engine block including multiple cylinders is disclosed, the cylinder system comprising a mechanical cylinder including an internal space in which a fluid is introduced, and a crankshaft piston configured for reciprocating motion in the internal space; and a cylinder occupying structure including a floating piston, wherein the occupying structure is variably advanced into, and retracted from, the internal space of the cylinder in correspondence with the reciprocating motion of the crankshaft piston and wherein the occupying structure contains or surrounds a combustion space, in the clearance area between the crankshaft piston and the top of cylinder. The cylinder system includes a first and a second fluid inlet for each cylinder, where the fluid inlet comprises a fluid manifold and a valve.

[0012] In another aspect, the cylinder system in an engine block, may comprise a set of conventional cylinders, beside a set of cylinders equipped with floating pistons, or it may comprise a one type of cylinders equipped with floating pistons.

[0013] In another aspect, the floating piston progressively displaces a portion of the internal space in a cylinder, such that an actual displaced volume, is smaller than the sum of clearance and swept volumes.

[0014] In another aspect, the floating piston decreases fluid intake by way of decreasing displacement volume.

[0015] In another aspect, the floating piston accelerates after the crankshaft piston, in the same direction, under the forces of combustion.

[0016] In another aspect, the engine comprises a cylinder force controller mechanism, configured to control the cylinder occupying structure, via electromagnetic actuator, a turbocharge pump mechanism, or a supercharge pump mechanism.

[0017] In another aspect, the floating piston may be a fixed structure for serving certain application, or it may perform as a second floating piston that may, through a mechanical link, magnetic control, or hydraulic communication, add a secondary force to selectively, dynamically, and controllably increase and/or decrease cylinder internal pressure during expansion or compression strokes, respectively, as required by the particular application of the system.

[0018] In another aspect, the force control mechanism is responsive to throttle position.

[0019] In another aspect, triggering an electromagnetic actuator at each mechanical cycle is substantially initiated by mechanical or magnetic sensors that monitor and respond to throttle pedal position.

[0020] In another aspect, triggering the flow of supercharge or turbocharge fluid through a second fluid inlet into the cylinder, is initiated by mechanical or magnetic sensors that monitor the engine driving load and the positive and negative driving force of the crankshaft pistons.

[0021] In another aspect, sensors of the control mechanisms, are responsive to crankshaft or crankshaft rod position and to floating piston position.

[0022] In another aspect, sensors of the control mechanism, are responsive to the magnitude of the engine load or the crankshaft force resistance.

[0023] In another aspect, sensors of control mechanism, are responsive to engine speed.

[0024] In another aspect, sensors of the control mechanism are responsive to engine temperature.

[0025] In another aspect, an electromagnetic actuator of the control mechanism, uses three electromagnetic poles for alternation rather than two. When two electromagnetic poles alternate their polarity, electrons travel from one side to the other at each alternating cycle. Using three poles can provide alternating attraction and repulsion forces without needing electrons to alternate positions, where such setup may not only provide higher frequency of cycling motion, but also higher power output.

[0026] In another aspect, the magnetic field interacts with a permanent magnet in the floating piston to variably remove the floating piston from, the internal space of the cylinder during the expansion stroke

[0027] In another aspect, the force control mechanism is a turbocharge or supercharge mechanism, where the charged fluid, is directed to fill in the space between the floating piston and the cylinder head, during the time of a power stroke, to increase fluid pressure between the floating piston and the cylinder head, and as a result increase the floating piston acceleration, and indirectly increase the combustion pressure and the force acting on the crankshaft piston.

[0028] In another aspect, the charged fluid path may include a second fluid inlet beside a first inlet, where a first inlet is used for a continuous engine fluid input, at every stroke, and a second inlet used for a variable engine fluid input, under the control of the force control mechanism and in response for load and speed requirements.

[0029] In another aspect, the cylinder is a hydraulic cylinder, and the fluid is a hydraulic fluid primarily injected within a space surrounded by a crankshaft piston and the floating piston (occupying structure).

[0030] In another aspect, the cylinder is a combustion cylinder, and the fluid is a combustible fluid.

[0031] In another aspect, the floating piston undergoes motion at a substantially same rate as the crankshaft piston and in the same or opposite direction of the crankshaft piston's location during an expansion stroke and in the same direction as the crankshaft piston's motion during the compression stroke.

[0032] In another aspect, the floating piston is advanced into the internal space of the cylinder during an expansion stroke of the cylinder, and wherein the floating piston is completely retracted from the internal space of the cylinder during a compression stroke of the cylinder; and wherein the floating piston is further advanced or retracted from a certain position during an expansion stroke.

[0033] In another aspect, the combustion space is partially contained or surrounded by the body of the floating piston, where the effective diameter of the combustion space is smaller the diameter of the cylinder.

[0034] In another aspect, the engagement surface of the actuating crankshaft piston and the floating piston is partly or completely having a cone shape.

[0035] In another aspect, the floating piston is a second piston that may change the direction of its acceleration during an expansion stroke.

[0036] In another aspect, the floating piston, having an edge marking two separate cavities, with a male female engagement interface with crank shaft piston utilized in a four-stroke cylinder, where the four strokes performed in a two reciprocating cycles, and where fluid compression is performed in a conventional four strokes motions, where compression and combustion share same space within the cylinder.

[0037] Disclosed as another example is, by initiating compression in a dedicated compression space, a method of performing two engine strokes per cylinder combustion, including a power expansion stroke and a retraction stroke, to provide four stroke functions of a four-stroke engine including air intake, air compression, power stroke and exhaust strokes.

[0038] Disclosed as another example is, a method of increasing engine acceleration by increasing the internal cylinder pressure through the delivery of compressed fluid in the space behind a floating piston during a power stroke.

[0039] As another example, disclosed is a method of decelerating an engine through moving a floating piston in an opposite direction of the crank shaft, causing a decrease in cylinder internal pressure and a decrease in crank shaft power without the need for an early release of the unburned exhaust.

[0040] In another aspect, the cylinder occupying structure is further advanced and retracted via an electromagnetic actuator, hydraulic press supercharger or turbocharger.

[0041] In another example, disclosed is a method for hybrid electromagnet-petrol cylinder drive, or hybrid hydraulic-petrol cylinder drive where a second piston communicates secondary pressure forces to a crank shaft linked piston.

[0042] Disclosed in another example is a method of enhancing an energy return of a second piston linked to electromagnet by assigning such electromagnet a one repelling or attraction task, and where such electromagnet uses three magnetic poles rather than two.

[0043] In another aspect, the cylinder is a combustion cylinder, the method further comprising injecting a combustible fuel into the dedicated compression space.

[0044] In another aspect, the cylinder is a hydraulic cylinder, the method further comprising compressing fluid during the compression stroke.

[0045] Disclosed in yet another example a cylinder system, comprising: a mechanical cylinder including an internal space in which a fluid is introduced, and a crankshaft piston configured for reciprocating motion in the internal space, a cylinder occupying structure including a floating piston as a second piston, wherein the floating piston is variably advanced as a second piston in a first direction during an expansion stroke of the cylinder, and retracted from in a second direction substantially opposite to first direction during a compression stroke wherein the insertion rod partially surrounds the combustion space, wherein the cylinder occupying structure is moved initially by the combustion forces to a certain distance after which it further advances or retracts by an electromagnetic or hydraulic actuator.

[0046] Disclosed as yet another example, is a mechanical engine cylinder system, comprising: a cylinder including an internal space, an occupying structure, and a crankshaft piston, wherein the internal space of the cylinder is modified by the occupying structure such that combustion pressure applied to the crankshaft piston is applied to a smaller surface area of the crankshaft piston during an early part of an expansion stroke and to a larger surface area of the crankshaft piston during a later part of the expansion stroke.

[0047] Disclosed in yet another example is a cylinder system, comprising: a mechanical engine cylinder including an internal space in which a fluid is introduced, and a crankshaft piston configured for reciprocating motion in the internal space, a cylinder occupying structure including a cylinder shape structure with cavity as a floating piston, wherein the floating piston is variably advanced as a second piston in a first direction during an expansion stroke of the cylinder, and retracted in a second direction substantially opposite to first direction during a compression stroke wherein the floating piston partially surrounds the combustion space, between crankshaft piston and cylinder head, wherein the cylinder occupying structure is moved initially by the combustion forces to a certain distance after which it further advances or retracts by an electromagnetic or hydraulic actuator.

[0048] In another aspect, the system is configured such that combustion occurs within a cavity of the occupying structure to apply combustion pressure to both the occupying structure and the crankshaft piston.

[0049] In another aspect, the occupying structure is a movable structure relative to the cylinder, and wherein movement of the occupying structure is controlled by one or more forces applied by a force application mechanism.

[0050] In another aspect, the force application mechanism is responsive to throttle position by way of throttle position sensors such that one or more forces applied to the occupying structure are dependent on throttle position.

[0051] In another aspect, the force application mechanism is configured to apply a retracting force to the occupying structure during the expansion stroke.

[0052] In another aspect, the force application mechanism is configured to apply an advancing force to the occupying structure during the expansion stroke.

[0053] In another aspect, the system is configured to partially execute a compression stroke function during the expansion stroke by pumping fresh air behind the occupying structure via the force application mechanism, or a fluid suction stroke by natural engine breathing through a first fluid inlet.

[0054] In another aspect, the system is configured to perform a fluid decompression, early during an expansion stroke and within the expanded space behind the occupying structure, such decompression applies to fluid that was compressed in a previous reciprocation cycle and remained out of the combustion space.

[0055] In another aspect, the system is configured to perform a fluid decompression for cooling effects, by allowing fluid compressed in the dedicated compression space, to move during a later part of a power stroke from the dedicated compression space, located between the occupying structure and cylinder head, to the cavity of the occupying structure.

[0056] In another aspect, the system is configured to have compressed fresh air or fluid, enters the occupying structure cavity, to clear it from exhaust fluid, during a later part of expansion stroke.

[0057] In another aspect, the system is configured such that a turbocharged or supercharged compressed air enters the cylinder internal space through a second fluid inlet, during an expansion stroke.

[0058] In another aspect, The system is configured to have occupying structure and crankshaft piston disengage during a power stroke, by means of designing surface areas of occupying structure such that combustion forces, insures such disengagement during a power stroke, within a range of allowed minimum and allowed maximum of initial compression ratios.

[0059] In another aspect, the system is configured such that exhaust fluid departs the internal space of cylinder, during an early part of retraction stroke, and before the engagement of occupying structure and the crankshaft piston.

[0060] In another aspect, the system is configured to have fluid compression completes later on during a retraction stroke, between the time of crankshaft engages with occupying structure and the time of complete retraction, where during this time, an inlet valve is open between occupying structure cavity and between the dedicated compression space.

[0061] In another aspect, the system is configured to perform intake, compression, expansion, and exhaust functions within two strokes per combustion.

[0062] In another aspect, the force application mechanism includes an electromagnetic actuator.

[0063] In another aspect, the force application mechanism includes a hydraulic system.

[0064] In another aspect, the force application mechanism includes a forced induction system.

[0065] In another aspect, the system is configured to deliver fluid to an intake side of the occupying structure to increase cylinder pressure and engine acceleration.

[0066] In another aspect, the system is configured to cause engine deceleration by applying a retracting force to the occupying structure, magnetically or by withdrawing fluid through a second fluid inlet.

[0067] In another aspect, the system is configured to cause engine acceleration by applying an advancing force to the occupying structure.

[0068] In another aspect, the system is configured to have the initial movement of the occupying structure drag the combustion fluids and forces in the direction of the crankshaft piston to absorb part of the engine vibration forces.

[0069] In another aspect, the occupying structure changes direction during the expansion stroke.

[0070] As yet another example, disclosed is a mechanical engine cylinder system, comprising a set of cylinders: each cylinder including an internal space; an occupying structure; and a crankshaft piston; wherein the internal space of the cylinder is modified by the occupying structure, having dedicated compression and dedicated combustion spaces; wherein the occupying structure provides a surface interface with the dedicated compression space, and wherein the occupying structure contains within its cavity and away from the side wall of the cylinder, a primary combustion space, during an early stage of a power stroke, and wherein, the occupying structure has an edge, that separates the primary and secondary combustion spaces, wherein combustion pressure applied to the crankshaft piston is applied to a smaller surface area of the crankshaft piston during an early part of an expansion stroke and to a larger surface area of the crankshaft piston during a later part of an expansion stroke, and wherein combustion pressure applied to occupying structure, applies a net-force to the occupying structure, in the direction of the crankshaft piston, during early part of an expansion stroke, and in opposite direction, that we may call the direction of camshaft side during a later part of an expansion stroke, wherein surfaces of occupying structure, and crankshaft piston, are sized such that, a disengagement happens during an expansion stroke, between the occupying structure and crankshaft piston; and wherein the motion of occupying structure, during an early part of expansion stroke, creates a suction force of compression fluid into the dedicated compression space.

[0071] In another aspect, the system is configured such that combustion occurs within a cavity of the occupying structure, with a diameter smaller than the internal diameter of cylinder.

[0072] In another aspect, time lapse of acceleration is reduced, such that a power output of a stroke can be done using less fuel requirement.

[0073] In another aspect, the occupying structure cavity, has an edge facing toward the camshaft and cylinder head.

[0074] In another aspect, the occupying structure edge, causes turbulent motion of combustion fluid for more complete burning.

[0075] In another aspect, an edge under pressure within the cavity of occupying structure, causes a progressive advance of occupying structure within the cylinder, competing with combustion fluid for space, and causing less fluid intake requirements.

[0076] In another aspect, the engagement of the occupying structure and crankshaft piston, is a cone shape engagement.

[0077] In another aspect, the advance of occupying structure under combustion forces, creates suction forces of compression fluid.

[0078] In another aspect, the surface sizing of the occupying structure and of crankshaft piston, balances combustion forces, such that disengagement happens without mechanical interference during a power stroke.

[0079] In another aspect, the occupying structure is responsive to a force application mechanism.

[0080] In another aspect, the force application mechanism is responsive to throttle position by way of throttle position sensors such that one or more forces applied to the occupying structure are dependent on throttle position.

[0081] In another aspect, the force application mechanism is configured to apply a retracting force to the occupying structure during the expansion stroke.

[0082] In another aspect, the force application mechanism is configured to apply an advancing force to the occupying structure during the expansion stroke.

[0083] In another aspect, any turbocharge forces used to increase fluid compression, during an early part of a power stroke, is part of a force application mechanism.

[0084] In another aspect, the force application mechanism includes electromagnetic actuator.

[0085] In another aspect, the force application mechanism includes a magnetic induction system.

[0086] In another aspect, the force application mechanism includes a hydraulic system.

[0087] In another aspect, the system is configured to cause engine deceleration by applying a retracting force to the occupying structure.

[0088] In another aspect, the system is configured to cause engine acceleration by applying an advancing force to the occupying structure.

[0089] In another aspect, the cylinder is cooled by a cooling jacket.

[0090] In another aspect the cylinders is cooled by decompressing fluid inside the cylinder, during a later part of a power stroke.

[0091] In another aspect, the advance of occupying structure, decompresses part of compressed fluid remaining out of the combustion space, providing a cooling effect to the cylinder head, during an early part of a power stroke.

[0092] In another aspect, the advance of occupying structure, by dragging combustion fluid, minimizes the vibration caused by initial forces of combustion.

[0093] In another aspect, four independent strokes, are carried in two separate compression and combustion spaces.

[0094] In another aspect, four strokes are performed along with every reciprocating cycle of a crankshaft piston.

[0095] In another aspect, friction between crankshaft piston and cylinder, is reduced as a function of time, where every reciprocation cycle of a four-stroke Relative Motion cylinder, perform a power stroke.

[0096] In another aspect, the occupying structure is a movable part relative to the cylinder.

[0097] Furthermore, disclosed is a method of introducing an occupying structure within a cylinder system,

the system including a cylinder including an internal space, and the system including a crankshaft piston,

the method comprising: modifying an internal space of a cylinder using the occupying structure such that pressure applied to the crankshaft piston is applied to a smaller surface area of the crankshaft piston during an early part of an expansion stroke and to a larger surface area of the crankshaft piston during a later part of the expansion stroke;

and executing a pressure-increasing action within a cavity of the occupying structure to apply pressure to both the occupying structure and the crankshaft piston, such that, the occupying structure accelerates in the direction of the crankshaft during an early stage of power stroke, and in opposite direction during a later stage of power stroke, due to changing the direction of net force applied to occupying structure surfaces;

wherein the occupying structure includes an elongated cylindrical body to be accommodated within the internal space, the elongated cylindrical body defines a first cavity of primary space and a second cavity of a secondary space.

wherein the occupying structure competes with fluid in filling the space of displaced volume created by the motion of a crankshaft piston during an expansion stroke; and

wherein the occupying structure is introduced such that volume filled by the combustion fluid is smaller than the sum of clearance volume and swept volume by the crankshaft piston due to the occupying structure competing with combustion fluid for space within the cylinder.

[0098] In another aspect, the cylinder is a hydraulic cylinder, and wherein the fluid is a hydraulic fluid.

[0099] In another aspect, the cylinder is a combustion cylinder, and wherein the fluid is a combustible fluid.

[0100] These and other objects, features, and advantages of the present invention will become more readily apparent from the attached drawings and the detailed description of the preferred embodiments, which follow.

Brief Description of the Drawings

[0101] The preferred embodiments of the claimed subject matter will hereinafter be described in conjunction with the appended drawings provided to illustrate and not to limit the scope of the claimed subject matter, where like designations denote like elements, and in which:

FIG. 1 schematically shows an example of an engine system including an improved cylinder system, in accordance with aspects of the present disclosure.

FIGS. 2 and 3 show another example of the disclosed cylinder occupying structure method where a separate space is shown behind a cylinder occupying structure, in accordance with aspects of the present disclosure.

FIG. 4 shows a first exemplary cylinder occupying structure, in accordance with aspects of the present disclosure.

FIG. 5 shows a cross sectional view, in accordance with aspects of the present disclosure.

FIG. 6 schematically shows how a crankshaft piston moves during an expansion stroke, in accordance with aspects of the present disclosure.

FIG. 7 shows an indication of a crankshaft rod and a crankshaft rotation diameter, in accordance with aspects of the present disclosure.

FIGS. 8 schematically show a magnetic arrangement for attracting or repelling a cylinder occupying structure, in accordance with aspects of the present disclosure.

FIG. 9 shows an example occupying structure and its various edges and surfaces; in accordance with aspects of the present disclosure.

FIG. 10 schematically shows a cylinder occupying method using any of the disclosed cylinder occupying structures, in accordance with aspects of the present disclosure.

FIG. 11 shows work output of various disclosed systems, where more work energy availability offers higher torque/horsepower output or lower fuel requirements.

FIG. 12 shows a table of values for various product emissions for compared conventional and Relative Motion designs.

FIG. 13 shows testing results for chemical and exhaust, in accordance with aspects of the present disclosure.

FIGS. 14-17 various graphs showing the work output benefits and possibilities of the disclosed cylinder occupying systems.

Detailed Description

[0102] The following detailed description is merely exemplary in nature and is not intended to limit the described embodiments or the application and uses of the described embodiments. As used herein, the word "exemplary" or "illustrative" means "serving as an example, instance, or illustration." Any implementation described herein as "exemplary" or "illustrative" is not necessarily to be construed as preferred or advantageous over other implementations. All of the implementations described below are exemplary implementations provided to enable persons skilled in the art to make or use the embodiments of the disclosure and are not intended to limit the scope of the disclosure, which is defined by the claims. Furthermore, there is no intention to be bound by any expressed or implied theory presented in the preceding technical field, background, brief summary or the following detailed description. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

[0103] Disclosed is a cylinder occupying structure. An example provides a cylinder system comprising a mechanical cylinder including an internal space in which a fluid is introduced, and a crankshaft piston configured for reciprocating motion in the internal space, and a cylinder occupying structure including a floating piston, wherein the floating piston is variably advanced into, and retracted from, the internal space of the cylinder in correspondence with the reciprocating motion of the crankshaft piston. As shown in the figures, a combustion space is contained within walls of an occupying structure, between crankshaft piston and cylinder head.

[0104] The illustration of FIG. 1 presents an exemplary engine system that employs a cylinder-based engine 102 to produce useful work. As non-limiting examples, engine 102 may be utilized to propel a vehicle; including but not limited to seafaring vessels, wheeled vehicles, and aircraft; actuate various devices, such as hydraulic lifts, forklift arms, and backhoe arms, among other components of excavating devices and industrial machinery; and/or for any other suitable purpose. The illustration of FIG. 1 schematically shows the inclusion in engine 102 of one or more cylinders 104, with which useful work may be derived to perform such functions. Cylinders can include a set of modified cylinders containing occupying structure and a set of conventional cylinders.

[0105] In some examples, engine 102 may be an internal combustion engine (ICE) configured produce useful work by combusting fuel in cylinder(s) 104. Cylinder(s) 104 may be arranged in any suitable configuration (e.g., 1-4, V6, V8, V12), in a linear or circular arrangement. While not shown in the illustration of FIG. 1, in some examples engine 102 may be assisted by an electrical system comprising an energy source (e.g., battery) and a motor operatively coupled to one or more wheels of a vehicle in which the engine may be implemented. Such a configuration may be referred to as a "hybrid" configuration and may employ techniques such as regenerative braking to charge the energy source.

[0106] Cylinder(s) 104 may include pistons (e.g. first and second pistons in one cylinder) that undergo reciprocating motion caused by fuel combustion therein. In some examples, the reciprocating crankshaft piston motion may be converted to rotational motion of a crankshaft, which may be coupled to one or more vehicle wheels via a transmission to thereby provide vehicle propulsion. In other examples, the reciprocating crankshaft piston motion may be converted to other components and/or other forms of motion, including but not limited to articulation of an arm of an industrial vehicle (e.g., forklift, backhoe) and linear actuation. To this end, the illustration of FIG. 1 shows an output 108 produced by engine 102, which may include the rotational motion, articulation, or actuation described above, or any other suitable output.

[0107] An intake passage may be pneumatically coupled to engine 102 to provide intake air to the engine, enabling mixing of the air with fuel to thereby form charge air for in-cylinder combustion. Air intake may be introduced via a first and a second inlets per cylinder. Intake air of fluid may be compressed in an intake space behind the occupying structure and advanced into a combustion space within the occupying structure when the occupying structure is retracted toward the intake passage. To this end, the illustration of FIG. 1 shows the reception at engine 102 of an input 106, which may comprise the fuel/air mixture, hydraulic fluid, fresh air under atmospheric pressure, compressed air. Input 106 may include any suitable combination of fuels, including but not limited to gasoline, diesel, nitrous oxide, ethanol, and natural gas. An intake throttle may be arranged in the intake passage and configured to variably control the air ingested into engine 102 - e.g., as a function of mass airflow, volume, pressure. The intake passage may include various components, including but not limited to a charge air cooler, a compressor (e.g., of a turbocharger or supercharger), an intake manifold, etc. Respective intake valves may variably control the ingestion of charge air into cylinder(s) 104. A fuel system may be provided for storing and supplying the fuel(s) supplied to engine 102.

[0108] An exhaust passage may be pneumatically coupled to engine 102 to provide a path by which the products of charge air combustion are exhausted from the engine and to the surrounding environment. Various aftertreatment devices may be arranged in the exhaust passage to treat exhaust gasses, including but not limited to a NOx trap, particulate filter, catalyst, etc. For implementations in which engine 102 is boosted via a turbocharger, a turbine may be arranged in the exhaust passage to drive the turbocharger compressor. Respective exhaust valves may variably control the expulsion of exhaust gasses from cylinder(s) 104.

[0109] A controller 110 may be operatively coupled to various components in engine 102 for receiving sensor input, actuating devices, and generally effecting operation of the engine. As such, controller 110 may be referred to as an "engine control unit" (ECU). As examples, ECU may receive one or more of the following inputs: throttle position, barometric pressure, transmission operating gear, engine temperature, and engine speed and engine change of speed at a given force input. As described in further detail below, controller 110 may control the operation of a cylinder operation structure that is variably introduced into the internal space of cylinder(s) 104 in accordance with the operating cycle of the cylinder(s).

[0110] Controller 110 may be implemented in any suitable manner. As an example, controller 110 may include a logic machine and a storage machine holding machine-readable instructions executable by the logic machine to affect the approaches described herein. The logic machine may be implemented as a controller, processor, system-on-a-chip (SoC), etc. The storage machine may be implemented as read-only memory (ROM, such as electronically-erasable-programmable ROM), and may comprise random-access memory (RAM). Controller 110 may include an input/output (I/O) interface for receiving inputs and issuing outputs (e.g., control signals for actuating components).

[0111] Engine 102 may assume other forms. For example, engine 102 may be configured for hydraulic operation, where cylinder(s) 104 include respective crankshaft pistons that undergo reciprocating motion to variably compress a hydraulic fluid therein. In this example, input 106 may include a hydraulic fluid that is supplied to cylinder(s) 104, such as oil, water, and/or any other suitable fluid(s). Output 108 may include rotational motion, articulation, actuation, or any other suitable type of mechanical output. Alternatively or in addition to mechanical output, output 108 may be considered to include hydraulic fluid that is pressurized by cylinder(s) 104, where the pressure applied by the cylinders may be transmitted to hydraulic fluid in other components that are in at least partial fluidic communication with the cylinders. Such hydraulic output may in turn be utilized to generate mechanical output, as in a hydraulic lift, for example. For implementations in which engine 102 is configured for hydraulic operation, the engine, and/or other elements that may form a hydraulic circuit, may include any suitable combination of hydraulic components, including but not limited to a pump, valve, accumulator, reservoir, filter, etc. In such implementations, controller 110 may be configured to control the operation of hydraulic cylinder(s) 104, engine 102, and/or other components of a hydraulic circuit, based on any suitable sensor output(s) (e.g., pressure, valve state, flow rate).

[0112] To increase cylinder output and avoid the drawbacks described above associated with existing approaches to increasing cylinder output, cylinder(s) 104 include a cylinder occupying structure 202 (i.e. floating piston) that is variably advanced into, and retracted from, the internal space of the cylinder(s) in which the operative fluid(s) (e.g., hydraulic fluid, combustible fluid) used to produce output are introduced. The figures show exemplary implementations of the cylinder occupying structure for a combustion cylinder, where the occupying structure configured to be subjected to a retracting and/or advancing force toward a combustion space, and/or toward a crankshaft piston by an electromagnetic actuator, hydraulic charger, turbo charger, or the like.

[0113] The figures show cylinder 104 including a cylinder occupying structure 202, also referred to herein as an insertion rod or second piston. The cylinder occupying structure 202 acts as a second piston in addition to crankshaft piston 204 (e.g. the crankshaft piston 204 is a first piston), and the occupying structure 202 partially surrounds a combustion chamber.

[0114] Crankshaft piston 204 is coupled to a connecting rod, which may be coupled to another device such as a crankshaft to thereby translate reciprocating motion of the crankshaft piston to rotational crankshaft motion or another form of motion, which in turn may be used to propel a vehicle, operates an electrical generator, drive a pump, actuate a device, etc. Reciprocating motion of crankshaft piston 204 may be caused by charge air combustion in an internal space 208 of cylinder 104. Combustion may be controlled in part by an intake valve 210 actuated via an intake camshaft, which is operable to selectively inject natural or charge air into internal space 208 for compression and ignition therein. A spark or glow plug may be controlled to cause ignition of injected charge air. Combustion products may be exhausted via an exhaust valve 216 actuated via an exhaust camshaft. To draw heat away from cylinder 104 in the course of charge air combustion, and thereby maintain desired operating temperatures and avoid thermal degradation, a coolant jacket may be arranged between the inner cylinder wall that defines internal space 208 and the outer cylinder wall that defines the exterior of the cylinder. A suitable coolant, which may comprise any suitable substance(s) such as water, antifreeze, etc., may be circulated through coolant jacket via a cooling system. The cooling system may include a radiator that radiates heated coolant to an exterior environment, for example. The cooling system may include compressing fluid in parts of the engine that can be reached by cooling jackets, and decompressing fluid withing a cylinder and near an occupying structure, where it is difficult to reach out by a cooling jacket.

[0115] As described above, cylinder 104 includes a cylinder occupying structure 202 that is variably inserted into internal space 208 to increase cylinder output and efficiency. Structure 202 is a floating piston that is variably advanced into internal space 208 in correspondence with the reciprocating movement of crankshaft piston 204. In some examples, floating piston 202 may be progressively inserted into internal space 208 as crankshaft piston 204 moves downward (with respect to FIG. 2 for example) through the internal space. The occupying structure may have a fluid accumulation space, or compartment, behind it near an intake side dedicated for fluid compression (upper side,704- FIG. 2), dedicated fluid compression space, is configured to have four stroke functions performed in two crank shaft piston motions. However, cylinder 104 may be configured according to any suitable operating cycle, based on which the introduction of insertion rod 202 into internal space 208 may be controlled. Generally, occupying structure 202 may be inserted into internal space 208 as crankshaft piston 204 moves downward (with respect to FIG. 2).

[0116] Cylinder 104 may execute a compression stroke (e.g., for a two or four-stroke operating cycle) or exhaust stroke (e.g., for a four-stroke operating cycle). The insertion rod 202 may be variably inserted in and removed from internal space 208 in correspondence with movement of crankshaft piston 204 downward and upward (with respect to FIG. 2). The correspondence between movement of floating piston 202 and crankshaft piston 204 may assume any suitable form. In some examples, the movement of floating piston 202 and crankshaft piston 204 may be substantially synchronized, such that the floating piston is actuated at substantially the same rate and direction as the crankshaft piston.

[0117] Occupying structure 202 enables a reduction in the intake requirement of cylinder 104, and, as a result of its occupancy of internal space 208, the occupying structure further causes the volume of the displaced volume that is utilized in a combustion or hydraulic process - the so-called displaced "combustion volume" or displaced "hydraulic volume" to be less than the internal space itself, where such internal space is the sum of the clearance volume and the swept volume by the crankshaft piston.

[0118] An electromagnet may be dedicated for either repelling or attracting the occupying structure, depending on a specific application. Fig-8. Whichever (repelling or attracting) the electromagnet is dedicated to, the remaining function (e.g. repelling or attracting) may be passive in functionality. The electromagnetic force may be used to retract the occupying structure in an early stage of an expansion stroke for the purpose of responding to an engine, vehicle, or throttle slow down command, to avoid having to release exhaust early. In this implementation, occupying structure 202 includes a magnet 227 (e.g., a permanent magnet) to enable interaction with magnetic fields generated by electrical currents transmitted through coil 224,Fig-2, and the solenoid-type electromagnetic extension and retraction of the occupying structure. Magnetic force lines produced by coil 224 - specifically the portions thereof within the internal space of the coil below the upper end of the coil and above the lower end of the coil - may be substantially parallel with the direction in which floating piston 202 extends and retracts. To facilitate the electromagnetic actuation of floating piston 202 described herein, electrical system 226 may include a current source with which current is selectively provided to coil 224. Electrical system 226 is operatively coupled to a controller 110, which may control the electrical system to selectively position insertion rod 202, and/or provide retracting or advancing forces to the occupying structure 202, in accordance with the operating cycle of cylinder 104 as described above, and/or based on any other suitable inputs (e.g., camshaft timing, valve timing, intake or charge air variables, other operating conditions). In some examples, controller 110 may be controller 110 of FIG. 1, but may also include various devices and systems to subject the occupying structure 202 to retracting or advancing forces, or to add pressure to an upper side (e.g. intake side of FIG. 2) of the occupying structure 202. Such devices and systems of the controller 110 may be hydraulic or turbo chargers, electromagnetic actuators, or any appropriate system that can control forces that the occupying structure 202 is subjected to, generally referred to herein as "force application mechanisms". One or more of coil 224, electrical system 226, magnet 227, and controller 110 may form what is referred to herein as an "electromagnetic actuator". In some examples, the electromagnetic actuator may be considered a solenoid, where insertion rod 202 acts as a slug translated by the electromagnetic actuator. It is to be understood that, as shown in FIG. 2, the retraction and advancing forces are applied to the body of occupying structure (floating piston) 202.

[0119] Cylinder 104, Fig-2 and Fig-3, may be configured with other aspects that increase cylinder output, such as configuring the occupying structure and/or the crankshaft piston to have a cone shape engagement surface, that can match the shape of a combustion wave.

[0120] An internal surface of the crankshaft piston may include dents and/or protrusions to increase the shear stress forces during a relative motion of the crankshaft piston.

[0121] Coil 224 may be arranged in a housing, which interfaces with an insulation barrier that enables low-friction movement of insertion rod 202 and substantial sealing between internal space 208 and the housing. Coil 224 is electrically driven by an electrical system 226, which is coupled to a controller 110.

[0122] The occupying structure 202 may be made of any one or more parts or cylindrical layers. The occupying structure may be of different sizes in different engine cylinders. For example, some occupying structure 202 shapes may be designed for higher torque requirements, as a non-limiting example. Unlike for the crankshaft piston, cooling an occupying structure can be challenging, however, a solution can be implemented using a solid body of higher heat bearing material, or using an empty core filled with a gas like helium, and interfaced with a cooling jacket in the cylinder. Cooling the occupying structure can be achieved by fluid decompression during an early part and a late part of expansion stroke. Furthermore, the contact between the occupying structure and the internal surface of cylinder can be through bearing rings before and after the cooling jacket or such that compressed air is allowed to pass from the compression compartment to fill in the tiny space between cylinder and occupying structure to minimize friction.

[0123] The cylinder occupying structure 202 and cylinder implementations described herein are provided as examples and are not intended to be limiting in any way. "Cylinder" as used herein may not require cylindrical geometry, but rather refers to a mechanical device in which reciprocating crankshaft piston motion is used to produce useful work and output. Non-spherical geometries, such as hemispherical or wedged geometries may be employed. Various cylinder components may be added, removed, or modified, including cylinder head components, valves, etc. Further, alternative insertion body configurations are contemplated. For example, the insertion body disclosed herein may enter a cylinder internal space from the bottom, side, or from any other direction, including at oblique angles, in anon linear cylinder 104. The cylinder 104 may itself have a curved shape as part of a circular shape engine with the piston and floating piston following a circular or curved path during a stroke motion. Still further, implementations are possible in which electromagnetic actuation is employed to control a floating piston.

[0124] In some implementations, a hybrid solution may be employed in which fluid is mechanically pumped as well as magnetically, using magnetic force actuator, advanced against a crankshaft piston. For example, fluid may be pressed against a crankshaft piston plunger without using a hydraulic pump during an active press, or for example having a second adjacent cylinder, not equipped by occupying structure, dedicated to compressing air, and acting as a hydraulic cylinder for using its compressed air into the compression space of the first cylinder to increase its effective compression ratio or to cause an advancing force to the occupying structure during a power stroke. The first cylinder equipped with occupying structure 202 can also use hydraulic fluid between occupying structure and crankshaft piston to work as a hydraulic mechanism.

[0125] The cylinder occupying structure implementations described herein may produce various technical effects and advantages. For example, the cylinder occupying structure 202 may reduce the required fluid intake, described as displacement volume per stroke. In other examples, the cylinder occupying structure may allow using a similar fluid volume for a larger distance stroke. Further, the cylinder occupying structure may enable the application of a larger force per square inch on a crankshaft piston's internal surface. In some examples, such as those that employ electromagnetic actuation, the cylinder occupying structure may maintain combustion pressure magnitude, by advancing occupying structure, with a magnetic field being initiate. In some examples, the cylinder occupying structure may facilitate laminar crankshaft piston movement with a slower pressure decline. In hydraulic implementations, a floating piston may reduce the amount of fluid required by a hydraulic fluid intake pump. These and other technical effects may increase the economy of a vehicle in which the cylinder occupying structure is implemented.

[0126] The herein described steps, tasks, and methods may be repeated throughout operation of the cylinder, at any suitable frequency, interval, duty cycle, etc., which may include continuous operation or may be interrupted (e.g., in response to controller input, operator input).

[0127] Combustion space 208 may be surrounded by parts of the floating piston 202 and the crankshaft piston 204, that may adjust its pre-combustion positions, making the combustion compartment itself relatively move or change in shape and size within the cylinder with respect to the cylinder.

[0128] Dedicating an electromagnet (Fig2-226) to act only with a repelling task, or only with an attraction task, and using a three poles electromagnetic actuator, the magnetic actuator would then keeps its poles orientation unchanged and its electrons gathering would stay on one side all the time. If such arrangement is adopted, then it is expected that the magnetic field strength added to a solenoid component could be enhanced by hundreds of times in force magnitude, to saving electric energy that is spent to move electrons back and forth between the positive and negative poles.

[0129] A solution for decreasing the cylinder internal pressure would be moving the second piston 202 in opposite direction (e.g. away from) the crank shaft piston instead of releasing unburned exhaust, by using a secondary force from an electromagnet 226 or other force source.

[0130] Having a second piston 202 positioned between intake pathways 210 on the compression dedicated space side and between a combustion space 804, along with maintaining higher fluid pressure at the intake side helps keep intake pathways cleaner and more reliable for a long time.

[0131] When the occupying structure 202 surrounds the combustion chamber, with an edge 202-2 facing cylinder head and fluid inlet side, it advances as part of the initial acceleration as a second piston, and it can change direction when subjected to pressure from the crankshaft side after the two pistons disengage, making the floating piston, without interference, changes acceleration direction and stops during the expansion stroke and slowly start reversing direction.

[0132] It is to be understood that the phrase "moving in a direction of the crankshaft piston" may refer to a direction pointing to a location of the crankshaft piston, rather than a direction of movement of the crankshaft piston.

[0133] The fluid accumulation compartment 704 behind the occupying structure 202 allows four strokes performed in two crankshaft motions, which means decreasing friction forces by cutting engine RPM (rounds per minutes) in half. The system provides energy saving configurations also by way of managing engine acceleration and deceleration with decreased pollution emissions.

[0134] To execute four strokes in two crankshaft piston motions, fresh air or premix fluid is initially introduced behind the occupying structure 202 during an expansion stroke in a port injection chamber 704 to add driving force to the expansion stroke and also (as part of the compression stage) to partly compress the air. When the compression stroke starts, this partly compressed fluid will move into the combustion space 804 as an indirect injection method with further compression (e.g. complete compression) through the communication channel 706 installed behind the space occupier. In another method (direct injection) a special channel may reach directly along with a spark plug to the combustion chamber 804. An exhaust outlet 216 may have various positions and configurations. It is to be understood that the definition of "premix" fluid may be port injection fluid or indirect injection fluid, and a "premix chamber" may be a port chamber.

[0135] When the compression stroke starts and pistons start to retract, the partly compressed air in space 704 will move to the combustion space for further compression, it initially creates a decompression cooling effects on the occupying structure, and drives exhaust fluid away from area 804, toward exhaust valve 216, and by the time the pistons start to engage and the combustion space is clean from exhaust, then fuel fluid will be completely or partly injected into one of the port injection chambers to mix with the fresh air, and with complete piston retraction, the air-fuel mix will complete its compression in the combustion chamber 804. In another method of direct injection through special channel or path, fuel may reach directly along with spark plug to the combustion chamber and fuel injection will apply to the combustion space rather than the port-injection chamber. Exhaust outlet 216 may have different positions however it may align with the area between the two pistons as they start to engage during the compression stroke.

[0136] The illustrations of FIGS. 2-10 will now be described in more detail below.

[0137] Shown in FIGS. 2-10 are various examples, components, and features that may be included in a cylinder occupying system. For example, the cylinder 104 may include an internal space 208, an occupying structure 202, and a crankshaft piston 204. The internal space 208 of the cylinder 104 is modified by the occupying structure 202 such that combustion pressure applied to the crankshaft piston 204 is applied to a smaller surface area of the crankshaft piston 204 during an early part of an expansion stroke and to a larger surface area of the crankshaft piston 204 during a later part of the expansion stroke.

[0138] For example, as seen in FIG. 2, A first fluid inlet 210-1 including air manifold and one-way valve, allows air entry into a dedicated compression space with every power stroke performed. The first fluid inlet manifold may be configured for natural engine breathing or may be connected to a turbo-charge or supercharged fluid path or reservoir. A second fluid inlet 210-2, including a fluid manifold and one way valve, allows compressed fluid to enter cylinder, into the dedicated compression space 704, or into the primary combustion space 804, in selective times, to increase cylinder internal pressure, in response to force application mechanism, upon an increased resistance to the crankshaft drive, or upon a change in a throttle position. a fluid channel 706 allows fluid to travel from the intake side 704 to the combustion chamber 804 during a retraction stroke.

[0139] For example, as seen in FIG. 6, a smaller surface area 802 is exposed to combustion in a combustion cavity 804 in an early time of an expansion stroke. And in a later time of an expansion stroke, a larger surface area 806 is exposed to combustion that originated in the combustion cavity 804. This concept is applied to all examples shown in the figures. The partial cone shape or profile of the crankshaft piston provides that a grater surface area exposed to the advancing combustion pressure wave compared to a right-angle profile.

[0140] For example, the crankshaft piston may include an end portion that changes from a thinner dimension 808 to a thicker dimension 810, such that the thinner dimension portion is what is exposed to the combustion pressure early, and the thicker portion is exposed to the combustion pressure later, as shown in FIG. 6. The thinner portion may be inserted into the combustion space, or alternatively placed right next to an end of the combustion space. The profile of the occupying structure may exactly, match, be congruent to, or generally match, that of the crankshaft piston.

[0141] The system may be configured such that combustion occurs within a cavity 804 of the occupying structure 202 to apply combustion pressure to both the occupying structure 202 and the crankshaft piston 204.

[0142] The occupying structure 202 may be a movable structure relative to the cylinder 104. Movement of the occupying structure 202 may be controlled by one or more forces applied by a force application mechanism 702. The occupying structure 202 may change direction of acceleration during the expansion stroke.

[0143] The force application mechanism 702 may be responsive to throttle position (e.g. of a vehicle) by way of throttle position sensors such that one or more forces applied to the occupying structure 202 are dependent on throttle position. The force application mechanism 702 may be configured to apply a retracting force to the occupying structure 202 during the expansion stroke or the contraction stroke.

[0144] The force application mechanism 702 may include an electromagnetic actuator, a hydraulic system, and/or a forced induction system. Examples of forced induction systems are turbo chargers, hydraulic chargers, and super chargers. The occupying structure may be mechanically coupled to the electromagnetic actuator.

[0145] As shown in FIG. 7, 300 is a crank shaft, 301 is a crankshaft diameter, and 302 is a crankshaft rod. In a Relative Motion cylinder, the system is able to provide more torque by way of supercharging compressed fluid during early stage of expansion stroke, and the ratio of the crankshaft rod (302) / crankshaft diameter (301) can be reduced to a lesser standards than used today in commercial heavy vehicles, for accommodating higher torque based on a longer rod, causing a slower motion of such heavy vehicles.

[0146] The disclosed system provides work per time enhancement, when applying hydraulic turbocharge, as a secondary force mechanism, to increase compression forces, during an expansion stroke, which translate as a further increase in pressure within the combustion compartment and as additional drive force. Maintaining positive force drive in a cylinder minimizes the acceleration time lapse of work and as a result eliminates part of required work energy. In comparison, compression forces in a conventional cylinder, result in a complete loss of energy which is ultimately deducted from power stroke forces.

[0147] The illustration of FIG. 8 shows a first electromagnet 1802 that may be activated during crankshaft piston expansion providing a repelling action (advancing force). A second electromagnet 1804 may be activated during crankshaft piston retraction, providing an attracting action (retracting force). Poles 1802,1804 and 227 make a three-pole electromagnetic arrangement. In a conventional arrangement, a magnetic arrangement would include two poles only like 227 and 1802. In a three-pole arrangement, pole 1802 and 227 for example, will always be activated as similar poles to perform a repelling force, and poles 1804 and 227 will always be activated to perform an attraction force. In a three-pole arrangement, electrons will not need to travel between poles, which will not only increase the magnitude of the force output per second, but also this may allow a higher frequency of motion.

[0148] The system may be configured to partially execute a compression stroke, by compressing fluid at the intake side, during the expansion stroke which also means applying a force to the occupying structure 202 via the force application mechanism 702. As such, the system may be configured to perform intake, compression, expansion, and exhaust functions within two strokes per combustion. The Relative-Motion cylinder arrangement initiate fluid compression in a dedicated space 704.

[0149] The system may be configured to deliver fluid to an intake side 704 of the occupying structure 202 to increase cylinder pressure and engine acceleration. The system may be configured to cause engine deceleration by applying a retracting force to the occupying structure 202. The system may be configured to cause engine acceleration by applying an advancing force to the occupying structure 202.

[0150] The fluid channel 706, also referable as a communication channel, may have a control valve to separate the timing between: stage 1 and stage 2 of fluid management. Stage 1 includes fluid accumulation behind the space occupier (floating piston) during the expansion stroke which partly compresses fresh air using a turbo or super charger, applying secondary driving forces to the pistons, or premix fluid while applying driving force to pistons. Stage 2 includes transferring partly compressed fresh air or premixed fluid to the combustion space 804 within the occupying structure 202 through a communication channel which may contain multiple valves and pathways. The communication channel, or channels, may include a path to fresh air entry and another path to an exhaust outlet.

[0151] The communication channel may have a one way valve, and the valve may open to allow partially compressed fluid to move to combustion space, and the valve may close during the entire expansion stroke, or it may open during a later part of expansion stroke to add positive pressure to combustion space and to clean space 804 from exhaust. A port injection compartment may expand in size during an expansion stroke.

[0152] The system may be configured to, due to combustion pressure between the crankshaft piston 204 and the occupying structure 202, allow the occupying structure 202 to accelerate in a retracting direction away from the crankshaft piston 204 to absorb part of combustion forces.

[0153] The illustration of FIG. 9 shows an edge 202-1 of an occupying structure facing a compression space and edge 202-2 of occupying structure facing primary combustion space, and edge 202-3 of occupying structure facing a secondary combustion space. Edge (202-2) when subjected to combustion, or when there is an increase in hydraulic pressure, causes the advance of the occupying structure variably in the internal space of combustion or a hydraulic cylinder and causes a change in the physics of Pascal law as a function of position, where the floating piston is competing for volume and space with the combustion fluid, and such compete is never calculated in a Pascal law. A power output of a stroke is dependent on a crankshaft piston surface and distance of stroke. In Pascal law as a function of time, an additional power output is to be calculated and added to Pascal as a function of position. That addition is proportionate with the combustion or hydraulic volume displaced by the advance of the occupying structure.

[0154] Also shown in Fig.9, The difference between surface 202-3 and 202-2 causes the acceleration of the occupying structure, during early stages of expansion stroke, and then deceleration and retraction during a later stage.

[0155] As shown in FIG. 10, disclosed method includes, at 1902 starting combustion within boundaries of moving parts enclosed between a piston and a cylinder occupying structure, at 1904, accelerating both parts into a cylinder internal space until acceleration of the cylinder occupying structure changes direction and subsequently comes to a complete stop during an expansion stroke, at 1906,Fluid compression starts early during expansion stroke, in a dedicated space, at 1908 further advancing or retracting the cylinder occupying structure by way of a force application by a secondary device such as an electromagnetic actuator, hydraulic system, or a turbocharger, and at 1910 compressed fluid compressed fluid is allowed to move into combustion space, during a later part of expansion stroke, to clean up the primary combustion space from exhaust, and to apply cooling effects to occupying structure by way of fluid decompression; at 1912 early during a retraction stroke, exhaust fluid is released before occupying structure and floating piston start to engage; At 1914, fluid compression completes by completing the retraction of occupying structure and the crankshaft piston, an inlet valve closes to leave most part of compressed fluid into the primary combustion space within the boundaries of occupying structure, with a smaller part left in the communication channel, where this smaller part will decompress at the beginning of the next reciprocation cycle to apply cooling effect to occupying structure.

[0156] The illustration of Fig.11 shows work output measured by joule. W

[0157] For example, when 50 mg of fuel in a conventional cylinder was providing about 150 Joules of work output, some simulation tests of disclosed system provided about 400 Joule. In one test, we used 25 mg for combustion, and 25 mg was calculated as energy source of driving a turbocharge pump, and the work output was advanced to near 800 Joules. Some energy studies claim that conventional engines utilize about 20% only of thermal energy available in fuel as work energy for moving a vehicle on the road, and our simulation test results mean that disclosed system can optimize the use of fossil fuel. Work output enhancement can also be assessed theoretically by the following equation, used in textbooks where (performance enhancement is proportionate with pressure increase inside the cylinder and inversely proportionate with displacement volume). Pressure tests as in Fig. 17 show that we accomplished over 200% pressure increase in the disclosed system, while the floating piston can also compete for space with combustion fluid for about 50% of swept volume. In such case performance enhancement can be theoretically assessed at 400% over conventional cylinder.

[0158] The illustration of Fig. 12 shows one of the best test results, associated with port fuel injection, where simulation test revealed zero% HC, and near Zero% CO and NO in exhaust.

[0159] The illustration of Fig. 13 shows the lower hydrocarbon residual in exhaust fluid in the disclosed system. In certain arrangements, simulation tests revealed zero HC output by the completion of a power stroke.

[0160] The Illustration of Fig. 14 shows a mechanical work output assessment graph using direct injection where that the new design D3 offers a bigger area under the work vs. time graph than ordinary cylinder. That is about 200% better work energy efficiency according the area difference. Conventional design D1-T3 has a bigger combustion exposure area (802 FIG. 6) at the beginning of the expansion stroke than disclosed system D3-T2. Conventional system (D1-T3) offers higher work energy at the beginning of the expansion stroke and lower work output later during a power stroke. Bigger area under graph, have been seen historically when we compare direct injection with indirect injection graphs, in conventional designs and now the disclosed system further increase are under graph of mechanical work output per time. In certain designs of disclosed system, mechanical work out graph shows a positive increase in the end of stroke,Fig. 14, and that is when distance between crankshaft piston and floating piston regain higher pressure when crankshaft piston comes to full stop while the floating piston is still slowly advancing.

[0161] The illustration of Fig. 15 shows work graph when applying a sudden advancing force to the floating piston, where power used to deploy such force was recovered at over 80%, and that shows the great potential of using the disclosed system as a replacement of pressure accumulation applications, where power recovery potential is no more than 25%. Also the potential of disclosed system, being able to add secondary forces, like turbo-charge fluids through a second inlet, into the cylinder during the course of a power stroke, means we do not anymore need to sacrifice power output of an engine, to accommodate better torque numbers, because higher torque drive can be leveraged by way of super-charging or turbo-charging a cylinder when a high resistance suddenly challenges the driving force of engine.

[0162] The illustration of FIG. 16 shows a Force vs. Distance graph. This graph shows that initial force in disclosed cylinder, D2-T1 is less than ordinary cylinder. This graph shall not be confused for energy assessment between new and conventional designs, because work energy performance shall be assessed based on (Force*Distance/sec), and that we may call (work/sec) which can be presented as work vs. time.

[0163] The illustration of FIG. 17 shows a pressure vs. distance and Pressure VS Time, graphs. The test was done without resisting load. The disclosed system D2-T1, has much bigger area under the curve than conventional cylinder D1-T1. During the expansion stroke, when the cylinder is continuously maintaining higher internal pressure by about 300%, this shall reflect as a higher thermal efficiency, cleaner fluid burning, enhanced exhaust ratio of $NO2/NOx$. When the test was repeated under resisting load applied to crankshaft piston, the area under graph of disclosed system, D2-T1 (named then D2-T3) was showing further increase of cylinder internal pressure when compared with the ordinary cylinder and fluid burning was further enhanced and simulation tests revealed zero HC , zero CO and near zero NO (0.000035) output.

[0164] The herein disclosed methods may include: 1) a hybrid engine method utilizing two sources of force at the cylinder level. 2) A method of exhaust fluid filter work at the cylinder level by converting bigger portion of CO and free hydrocarbon radicals into manageable CO_2, N_2, and NO_2 by increasing the relative internal pressure and decreasing crank-shaft piston speed. 3) a method of cutting on vibration by using an occupying structure as a shock absorber. 4) A method of saving energy by means of using an occupying structure as a second frame in a Newton-Galilean relativity. 5) a time dependency method of energy exchange and savings.

[0165] Due to the shape of the occupying structure, during the expansion stroke a decrease in fluid intake requirement is effected. For example, if the sum of clearance and swept volume of the crankshaft piston is 10 cubic inches then in the disclosed relative motion cylinder, the displacement requirement of combustion space in both the primary and secondary combustion spaces would be about 5 or 6 cubic inches.

[0166] It is to be understood that advancing the occupying structure into the cylinder, mainly into a combustion cylinder, is used to manipulate the combustion or hydraulic forces to perform more torque or more horse power or to optimize the power in different conditions. The disclosed relative motion cylinder enhances power output greatly especially if optimization is performed for torque and horsepower. Such enhancement is based on a Pascal law as a function of time. For example, some studies of physics portray that energy can be spent during a vehicle's motion due to friction, between the wheel and the road, which is only a small percentage of energy spent on motion. Most of the inefficiency is located in the energy spent on accelerating the crankshaft piston, and if the value of such acceleration, calculated per second during an hour of motion, is half the value of another vehicle in a similar weight, and for a similar clock time of motion, then the first vehicle would need half the fuel to reach a similar distance. For such time lapse of acceleration, we introduced an energy equation as a function of time ($E=1/2\ Mf^*g^{2*}t$) which is explained further herein. This equation shows how (t) time lapse of acceleration (acceleration time) is in exchange with work energy calculated by Joules, where minimizing the value of (t) from 2 seconds to 1 second changes energy output from 1 Joule to 2 Joules, which happens before optimizing the output to be deployed for more torque or more horsepower. And this is the core difference between this application and between prior attempts to solving better engine efficiency, because thermal output is considered fixed per cubic inch of fuel regardless of mechanical design, while minimizing the value of time lapse of acceleration significantly changes the energy output.

[0167] In the disclosed novel system, one power stroke is achieved per reciprocating cycle rather than every other cycle, which cuts down on friction losses by 15% of an overall thermal potential. Additionally, one power stroke per every other reciprocating cycle in traditional engines means that about 6000 RPM is a highest allowed reciprocation limit for a given power output, where challenges can be seen for engine breathing supply and mechanical failures, and the disclosed method solves this problem by way of decreasing the RPM in half. This means that a typical RPM of 6000 is actually reduced to 3000 RPM, where we accomplish about 15% power output advantage with a 50% friction loss, more air breathing and less mechanical failures. This is before counting losses spent on compression, where also the disclosed system aids, since every Joule spent on compression is a joule used indirectly to increase the internal combustion pressure, or a Joule recovered by adding a force to a crankshaft piston during a power stroke.

[0168] The disclosed system introduces the Pascal law as a function of time, where time lapse of acceleration is found to play a role of not only being a coordinate as known in Newtonian or in special relativity physics, but as a form and a source of energy, where objects, in its motion as a function of time, may exchange energy measured by joules with time lapse of acceleration, and where a work unit like Newton, will not be sufficiently defined by physical distances when the motion is in fact a function of time. As a function of time, it is not enough to calculate the physical distance traveled by the crankshaft piston, to know how many Newtons are needed for such motion, but instead we need to define a virtual distance traveled, based on different conditions of pressure and fluid displacement, before calculating the Newtons.

[0169] In the disclosed Relative-Motion cylinder solution, The cavity of the occupying structure contains an edge surface facing the camshaft side of cylinder. The surface area (202-2) is smaller than the surface edge facing the crankshaft piston, allowing an initial acceleration of occupying structure, in the crankshaft direction, and in an opposite direction later during expansion stroke. Having an edge within the cavity of occupying structure, secondarily serves creating turbulence of fluid motion between primary and secondary combustion compartments, to allow better mixing of fluid and more complete burning.

[0170] Furthermore, a force application mechanism can be a magnetic force application or a turbocharge application, that can accelerate the occupying structure during an expansion stroke, causing an increase in the internal pressure of the combustion space without the need to suddenly use more combustion fuel, and without the need to exaggerate in the increase of a Rod/Diameter ratio for a crankshaft rod or mechanical gear.

[0171] Turbocharge and supercharge can be used in engines to enhance the compression ratio of pre-combustion fluid. Turbocharge or supercharge in the disclosed system is used as part of a force application mechanism, to manipulate engine acceleration by force advancing the occupying structure, or through decelerating engine by minimizing pressure in the compression space. The turbocharge in this application can also be a force application mechanism, that may connect multiple cylinders to a wind turbine. In today's practice, the unsteady wind speeds, creating unsteady rotation velocity of a wind turbine, creates difficulties in connecting a wind turbine to electric motor, solved by either expensive brakes arrangements or by positioning a pressure accumulator between the wind turbine and the electric generator, where such pressure accumulator could be responsible for more than half of the total wind input power. In the disclosed relative motion cylinder, the wind turbine can drive and operate a one or more hydraulic turbo charge pump, and where the operated fluid, is driven toward one or more cylinders, such that during a high wind speed, a force application mechanism, will direct fluid to more cylinders and still maintain steady velocities of operated electrical generators.

[0172] The illustrations of FIG11. Through FIG.17, show test results using ANSYS analysis. and similar Initial parameters of combustion conditions in a (4) inches bore cylinders:

Mass Flow Injection = 0.05 kg/s;
Time of Injection = 0.001 sec;
Pressure of Injection = 17405 PSI;
Temperature of fuel = 300 K;
Mass of Injection fuel = 50 mg;
Nozzle diameter = 1 mm;
Approx. Rotation of Engine = 4000 RPM.

Initial Parameters of Compressed Air:

Initial Volume = 4.81 inch^3;
Pressure of Air = 500 PSI;
Temperature of Air = 830 K;
Mass Concentration of N2 = 0.7675
Mass Concentration of O2 = 0.2325
Resistance Pressure = 20 PSI (1074 N of resistance on crank shaft piston)

[0173] As shown throughout graphs of FIGS. 11-17, eliminating hydrocarbons is doable in a Relative Motion Cylinder. H12C23 tests showed 500% reduction of hydrocarbons, where mass fraction in comparable direct injection parameters decreased from 6.59% to 0.67% at 18:1 compression ratio. Using 10:1 compression with a (premix and turbocharge forces) Hydrocarbons were eliminated, with 0.000000 parts per million found in the exhaust. The disclosed premix option alone (without turbo charging) will eliminate this black material output of exhaust down to 0.00024%, which is 1000% less than it is in the direct injection method. The premix can be partly used in the Relative-Motion Cylinder, with controlled CO2 output level, while in a Conventional Cylinder, premixing would increase CO2 to levels prohibited everywhere.

[0174] Non-manageable exhaust CO and NO reduction was proportionate with increasing internal pressure of primary combustion space, however with earlier mix of fuel and air, CO was eliminated with zero output was possible to accomplish. NO was decreased to 35 parts per million, compared to 11,000 parts of conventional cylinder.

[0175] Internal pressure in a Relative Motion Cylinder, increases with higher driving loads, applying turbocharge forces, or using earlier injection or premix fluid.

[0176] The Relative-Motion Cylinder, as a function of time, introduces the concept of negative mass (mass of combustion fluid, displaced by floating piston) moving to a positive distance (power stroke), which mathematically means in Newtonian terms, producing rather than consuming energy, by way of minimizing time lapse of acceleration of the motion, where our method of dealing with such statement, is done by using complex numbers, to address the negative values of mass, where potential energy is given a Cartesian coordinate volume of acceleration vectors, rather than treated as a scaler in real number.

[0177] The negative mass in our method, represents combustion fluid volume, that is displaced, and reduced in volume by the occupying structure, to be less than the swept volume created by the motion of crankshaft piston, and calculated as (Negative mass = a crankshaft piston surface multiplied by a stroke distance minus available combustion space).

[0178] The energy difference in such power stroke, in presence of the occupying structure, is a function of Time, where time becomes a direct variable in energy output equation, by way of modifying physical distance value to a shorter virtual distance, calculated by seconds rather than meters, where, Work energy= ½ Mass Force* Acceleration squared* T ($W=1/2\ Mf*g^2*t$), and where (t) is time lapse of universal acceleration to reach an average speed of studied motion.

[0179] Since many modifications, variations, and changes in detail can be made to the described preferred embodiments of the invention, it is intended that all matters in the foregoing description and shown in the accompanying drawings be interpreted as illustrative and not in a limiting sense. Thus, the scope of the invention should be determined by the appended claims and their legal equivalents.

Claims

1. A mechanical engine cylinder system, comprising:

a cylinder including an internal space; an occupying structure; and a crankshaft piston;
wherein the internal space of the cylinder is modified by the occupying structure, having a dedicated compression space;
wherein the occupying structure provides a surface interface with the dedicated compression space, and wherein the occupying structure contains within its cavity, a primary combustion space, during an early stage of a power stroke, and
wherein, the occupying structure has an edge, that separates a primary and secondary combustion spaces,
wherein combustion pressure applied to the crankshaft piston is applied to a smaller surface area of the crankshaft piston during an early part of an expansion stroke and to a larger surface area of the crankshaft piston during a later part of an expansion stroke, and
wherein combustion pressure applied to occupying structure, applies a net-force to the occupying structure, in the direction of the crankshaft piston, during early part of an expansion stroke, and in opposite direction during a later part of an expansion stroke.
wherein surfaces of occupying structure, and crankshaft piston, are sized such that, a disengagement happens during an expansion stroke, between the occupying structure and crankshaft piston; and
wherein the motion of occupying structure, during an early part of expansion stroke, creates a suction force of compression fluid into the dedicated compression space.

2. The system of claim 1, where magnitude of acceleration of the crankshaft piston during a power stroke, is reduced such that, the power output of the power stroke can be done using less fuel requirement.

3. The system of claim 1, wherein an edge under pressure within the cavity of occupying structure, causes a progressive advance of occupying structure within the cylinder, competing with combustion fluid for space, and causing less fluid intake and less displacement requirements.

4. The system of claim 3, where fluid displacement requirement by a power stroke, is smaller than the sum of clearance volume of the cylinder and swept volume of the crankshaft piston during a power stroke.

5. The system of claim 3, wherein the surface sizing of the occupying structure and of crankshaft piston, balances combustion forces, such that disengagement happens without mechanical interference during a power stroke.

6. The system of claim 1, wherein the occupying structure is responsive to a force application mechanism.

7. The system of claim 6, wherein the force application mechanism is responsive to throttle position by way of throttle position sensors such that one or more forces applied to the occupying structure are dependent on throttle position.

8. The system of claim 6, wherein a turbocharge or supercharge fluid, is part of a force application mechanism.

9. The system of claim 6, wherein the force application mechanism includes electromagnetic actuator.

10. The system of claim 1, wherein the advance of occupying structure, decompresses part of compressed fluid remaining in the compression space, providing a cooling effect to the cylinder head.

11. The system of claim 1, wherein fluid compression starts in the dedicated compression space, during a power stroke.

12. A method of introducing an occupying structure within a cylinder system,
the system including a cylinder including an internal space, and the system including a crankshaft piston; and
the method comprising: modifying an internal space of a cylinder using the occupying structure such that pressure applied to the crankshaft piston is applied to a smaller surface area of the crankshaft piston during an early part of an expansion stroke and to a larger surface area of the crankshaft piston during a later part of the expansion stroke; and
executing a pressure-increasing action within a cav-

ity of the occupying structure to apply pressure to both the occupying structure and the crankshaft piston, such that, the occupying structure accelerates in the direction of the crankshaft during an early stage of power stroke, and in opposite direction during a later stage of power stroke, due to changing the direction of net force applied to occupying structure surfaces; and
wherein the occupying structure includes an elongated cylindrical body to be accommodated within the internal space, the elongated cylindrical body defines a first cavity of primary space and a second cavity of a secondary space; and
wherein the occupying structure competes with fluid in filling the volume that is swept by the motion of the crankshaft piston during an expansion stroke; and

13. The method of Claim 12, wherein the occupying structure is introduced such that the actual volume of fluid displacement in each power stroke, is smaller than the conventional displacement volume, that is calculated as the sum of the clearance and the swept volumes.

14. A mechanical engine cylinder comprising:

a mechanical cylinder including an internal space in which a fluid is introduced, and
a crankshaft piston configured for reciprocating motion in the internal space; and
a cylinder occupying structure including a floating piston, wherein the occupying structure is variably advanced into, and retracted from, the internal space of the cylinder in correspondence with the reciprocating motion of the crankshaft piston; and
wherein the occupying structure contains within its cavity, a primary combustion space, during an early stage of a power stroke, and
wherein, the occupying structure has an edge, that separates a primary and secondary combustion spaces, and
wherein combustion pressure applied to the crankshaft piston is applied to a smaller surface area of the crankshaft piston during an early part of an expansion stroke and to a larger surface area of the crankshaft piston during a later part of an expansion stroke, and
wherein combustion pressure applied to occupying structure, applies a net-force to the occupying structure, in the direction of the crankshaft piston, during early part of an expansion stroke, and in opposite direction during a later part of an expansion stroke; and
wherein surfaces of occupying structure, and crankshaft piston, are sized such that, a disengagement happens during an expansion stroke, between the occupying structure and crankshaft piston; and
wherein four strokes of suction, compression, combustion and exhaust are performed within two crankshaft reciprocation cycles, and
wherein fluid compression is contained within the primary combustion space of the occupying structure.

15. A mechanical engine system, comprising:

multiple cylinders positioned within an engine block, a force application mechanism including a turbo-charge or super-charge pump or electromagnetic actuator, and a throttle; and
wherein the engine block includes sensors of the position of the crankshaft piston, and
wherein the engine cylinder includes an internal space; an occupying structure; a crankshaft piston; a first fluid inlet; and a second fluid inlet; and
wherein the internal space of the cylinder is modified by the occupying structure, having a dedicated compression space; and
wherein the occupying structure provides a surface interface with the dedicated compression space; and
wherein the occupying structure has an edge within its cavity, that separates a primary and secondary combustion spaces and
wherein the occupying structure contains within its cavity, a primary combustion space, during an early stage of a power stroke; and
wherein the first fluid inlet, including a manifold and a valve, releases fluid into the dedicated compression space, with every reciprocation cycle, and
wherein the second fluid inlet, including a manifold and a valve, releases a charged fluid, into the cylinder, in selective reciprocation cycles, in response to the force application mechanism.

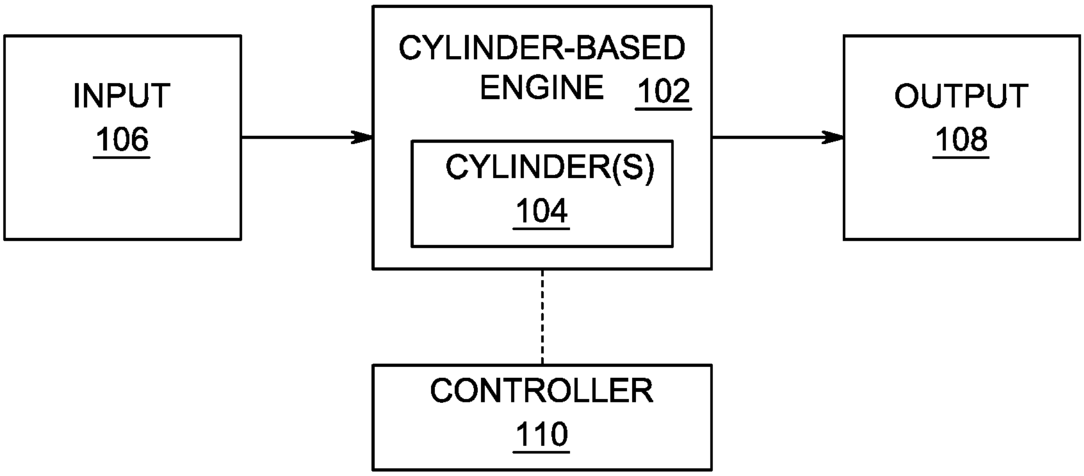
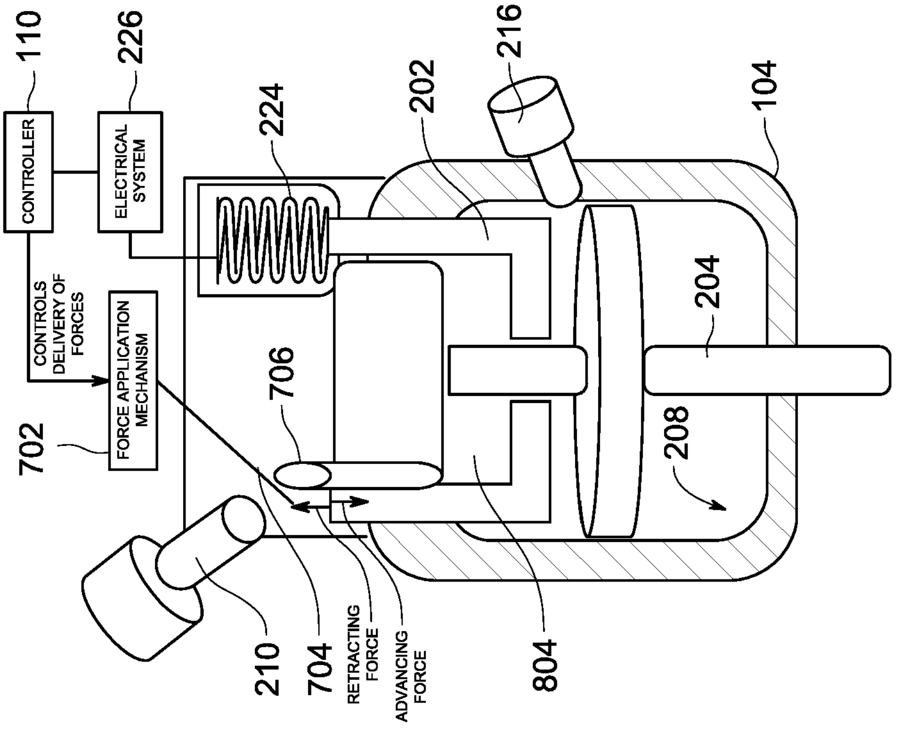
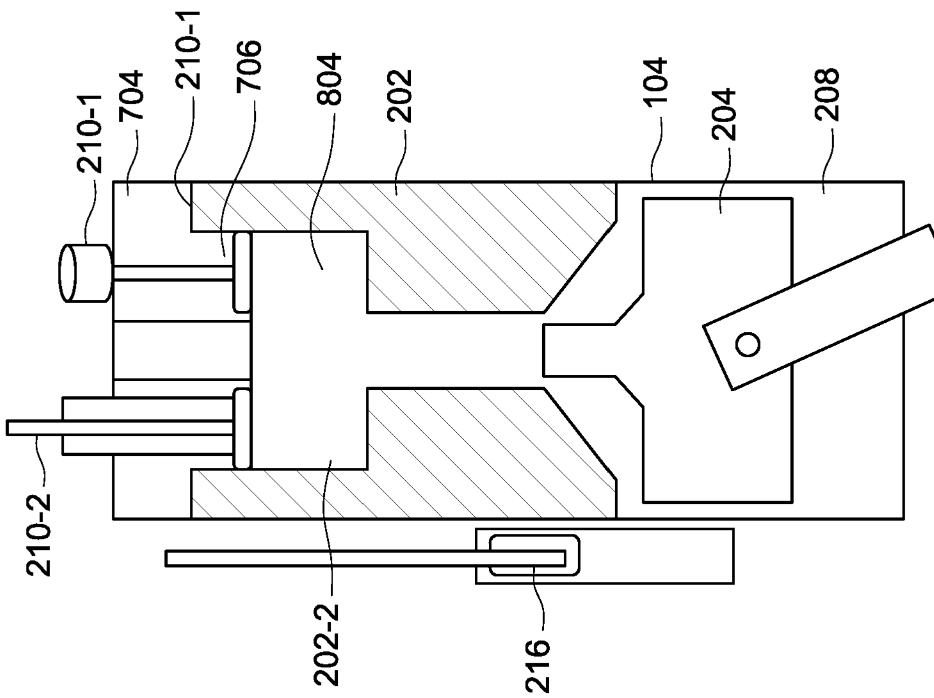

INPUT
106
CYLINDER-BASED
ENGINE 102
CYLINDER(S)
104
OUTPUT
108
CONTROLLER
110

Figure 1



Electromagnetic control mechanism

Fig. 2A



Turbo charge control Through first and second fluid inlets 210-1 and 210-2

Fig. 2B

Figure 2

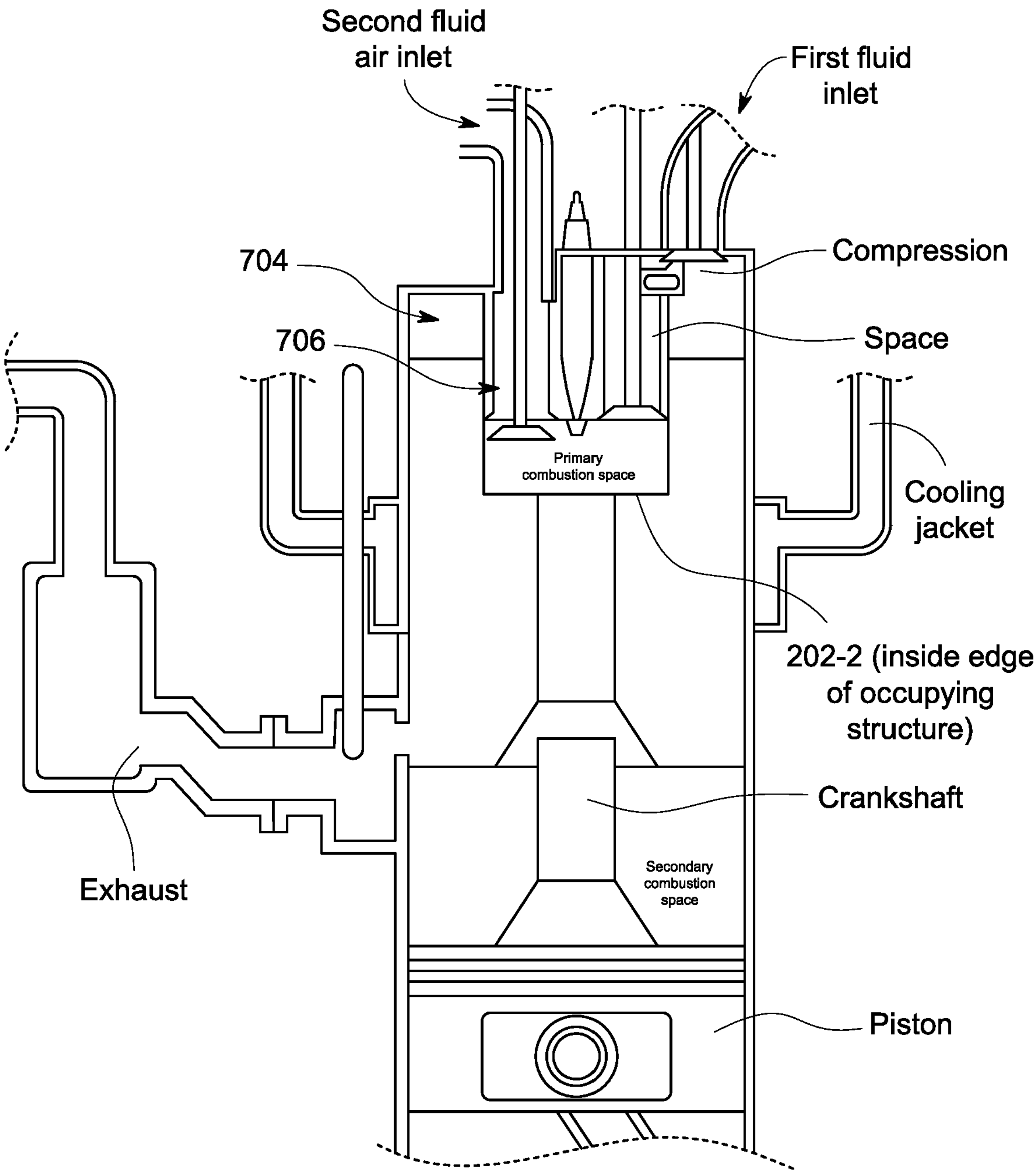

Second fluid air inlet
First fluid inlet
704
706
Compression
Space
Primary combustion space
Cooling jacket
202-2 (inside edge of occupying structure)
Crankshaft
Exhaust
Secondary combustion space
Piston

Figure 3

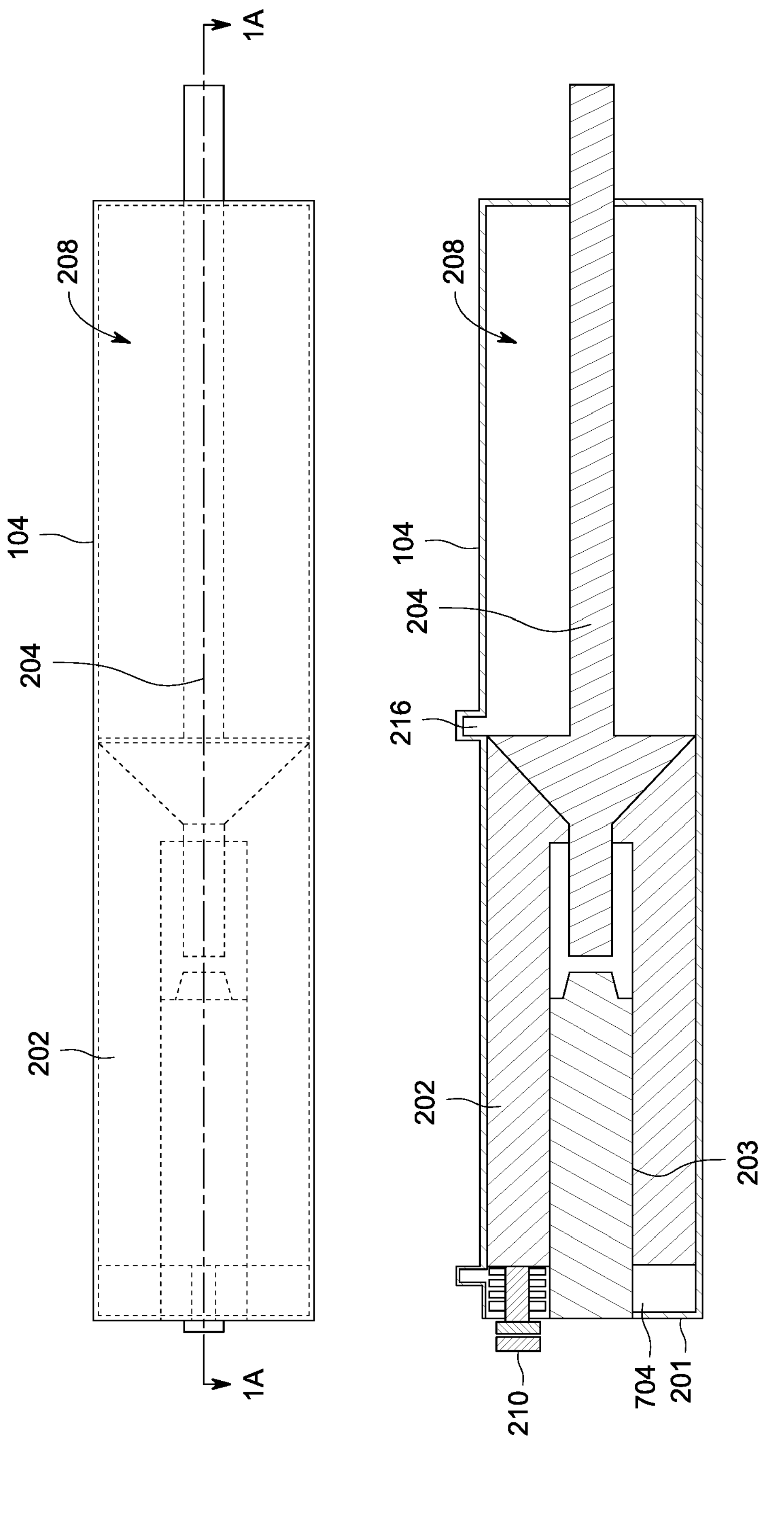


Figure 4

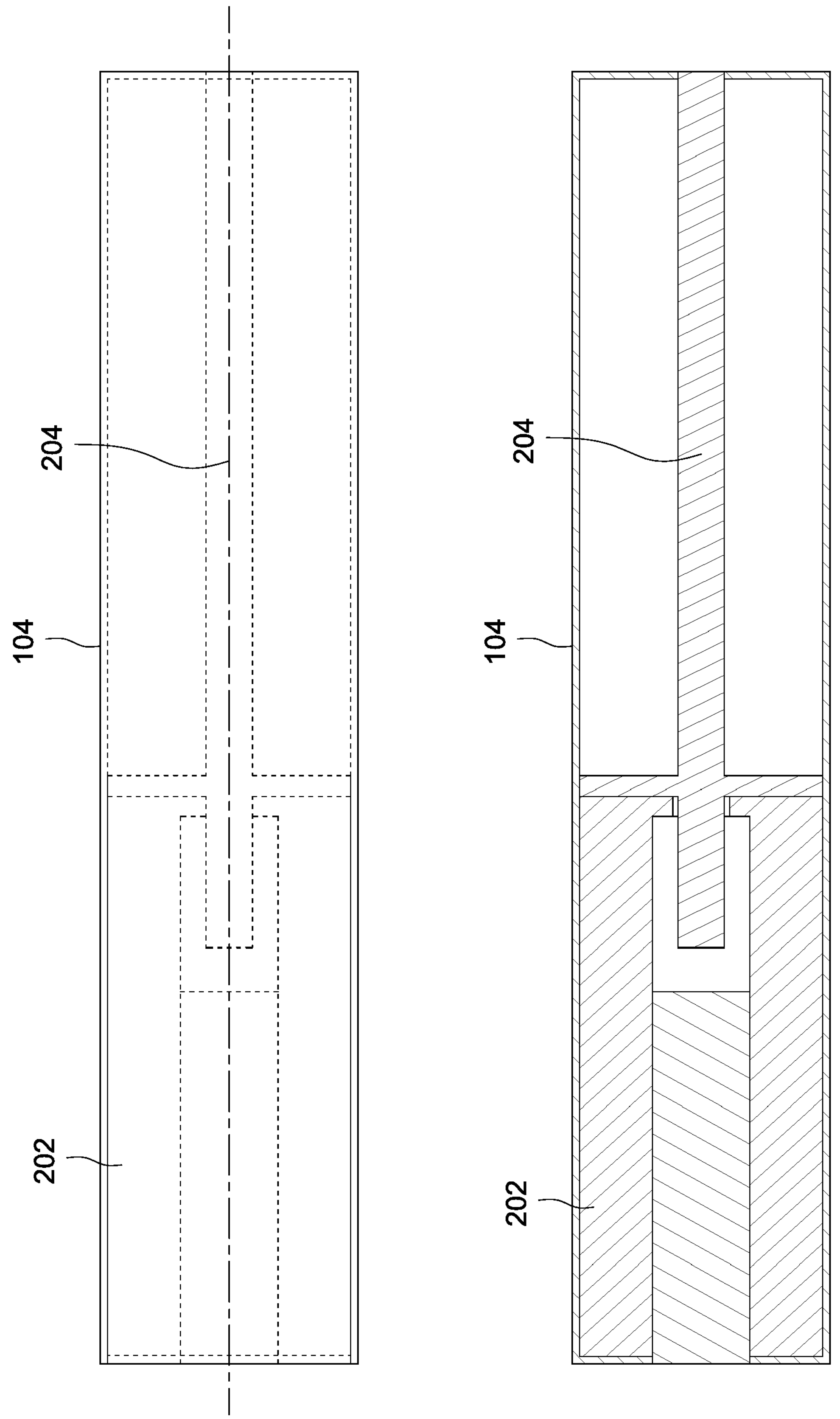


Figure 5

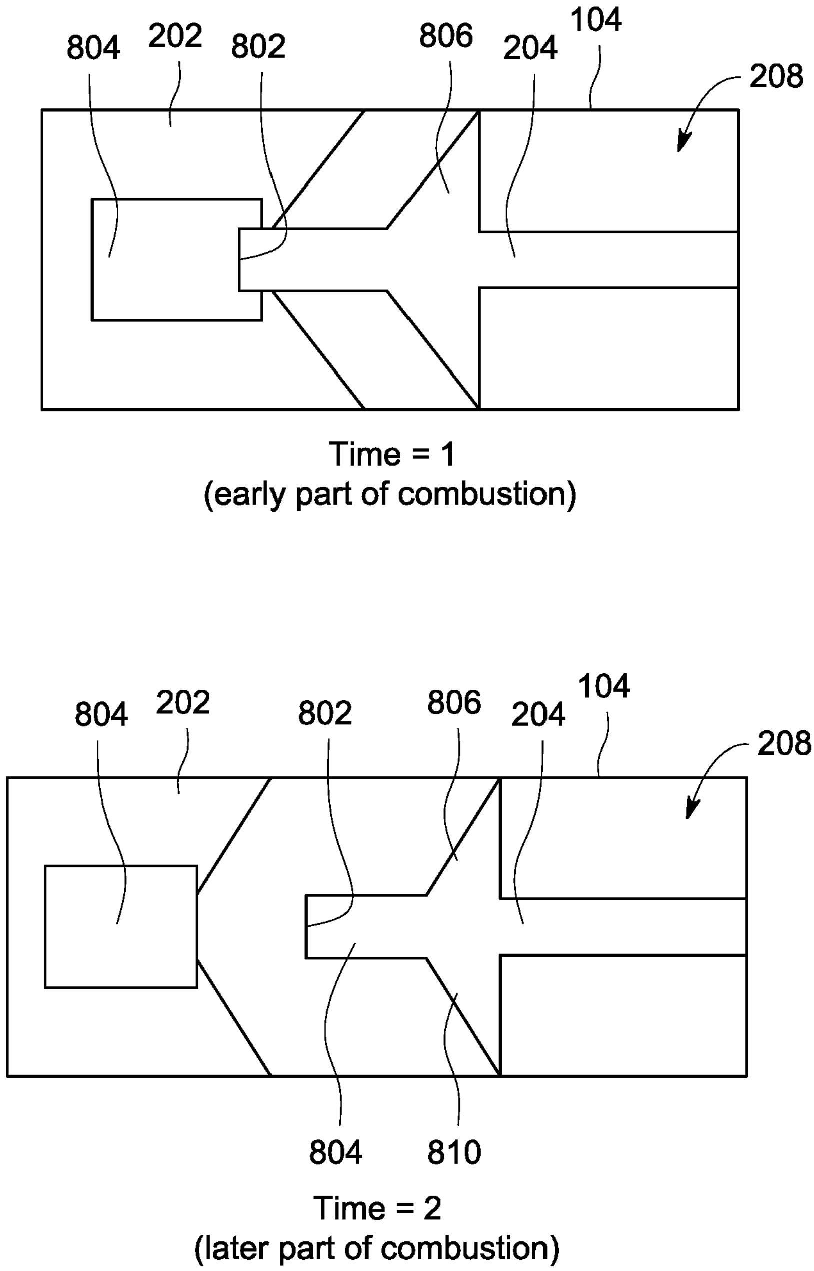

804
202
802
806
204
104
208
Time = 1
(early part of combustion)
804
202
802
806
204
104
208
804
810
Time = 2
(later part of combustion)

Figure 6

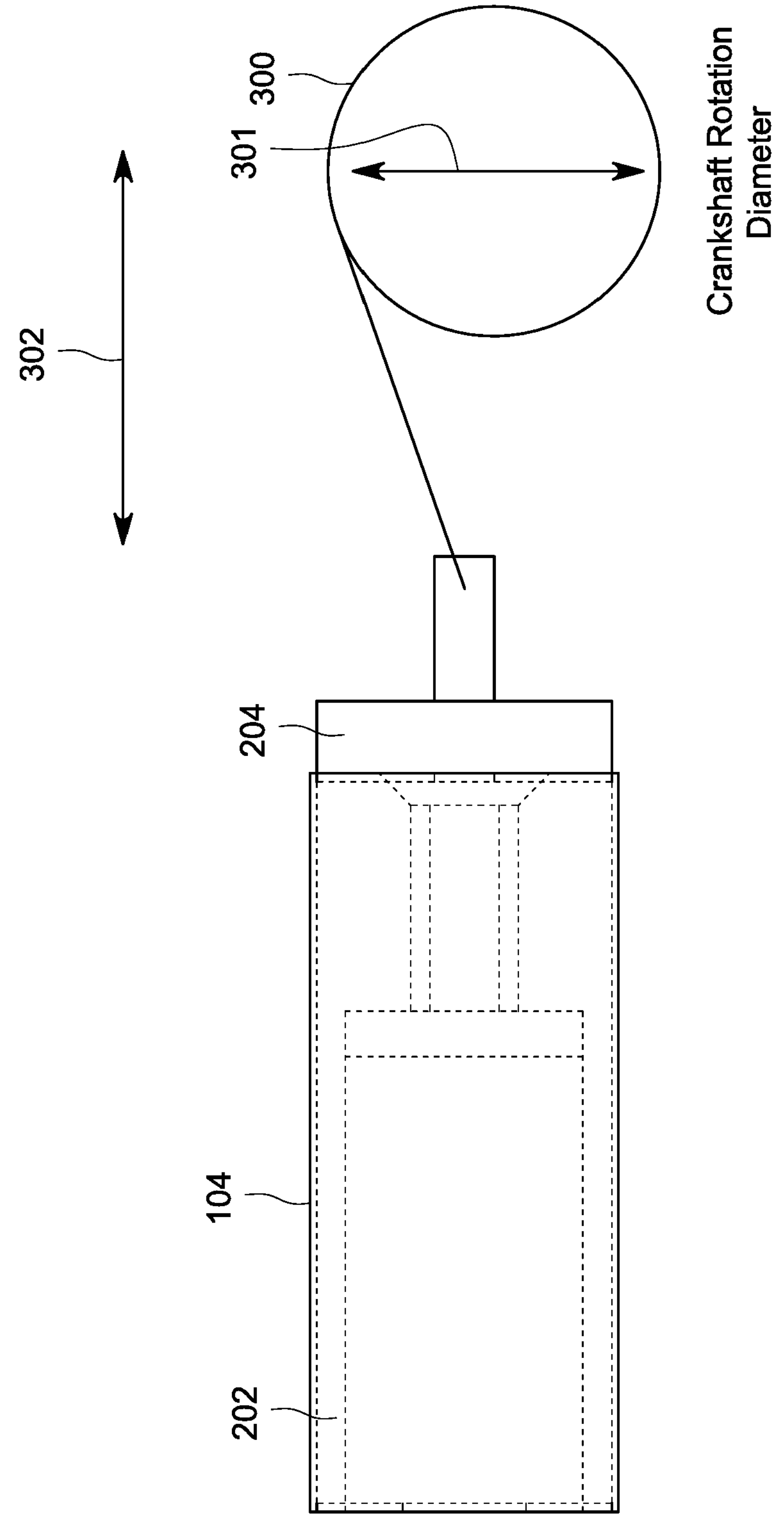


Figure 7

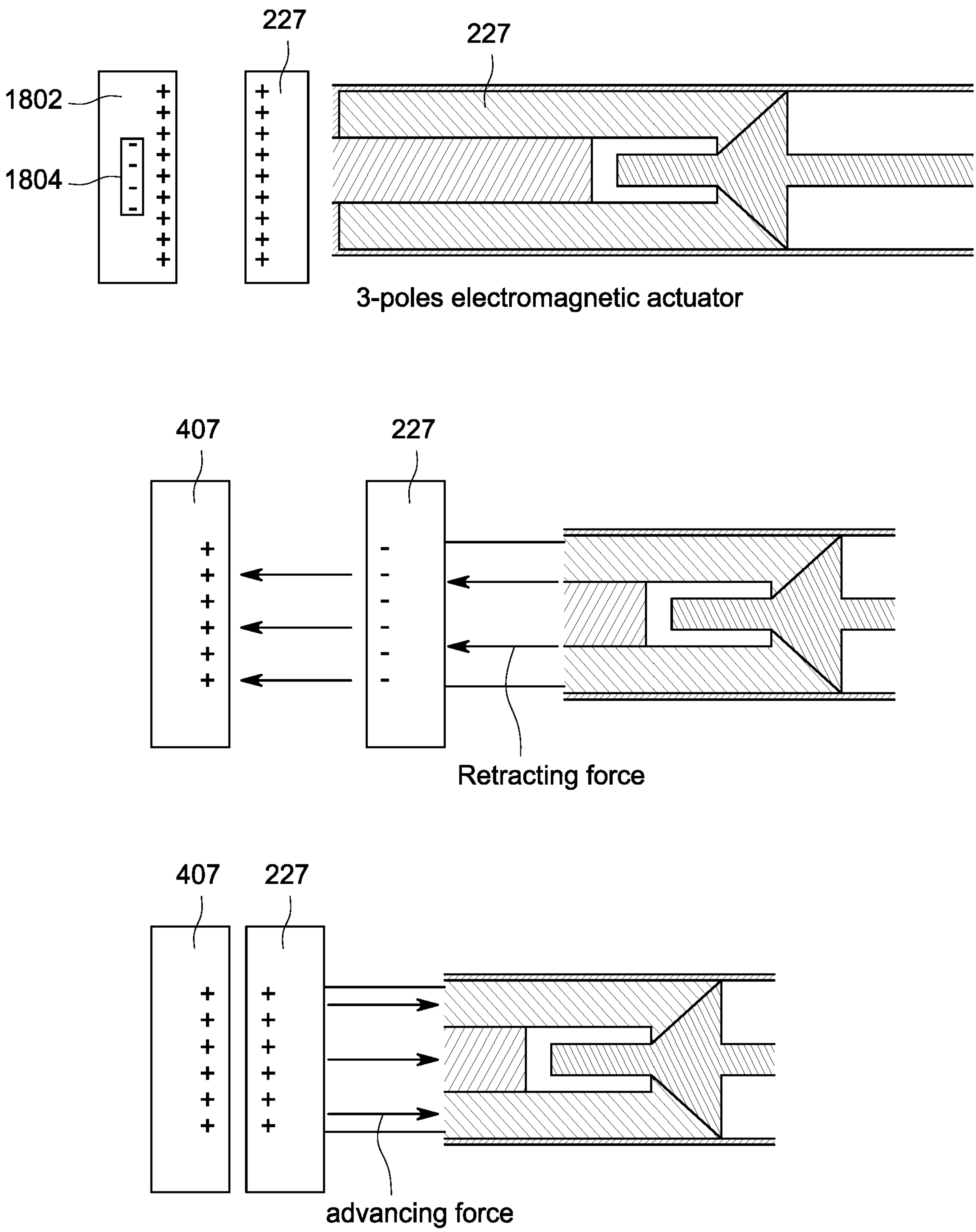

227
227
1802
1804
3-poles electromagnetic actuator
407
227
Retracting force
407
227
advancing force

Figure 8

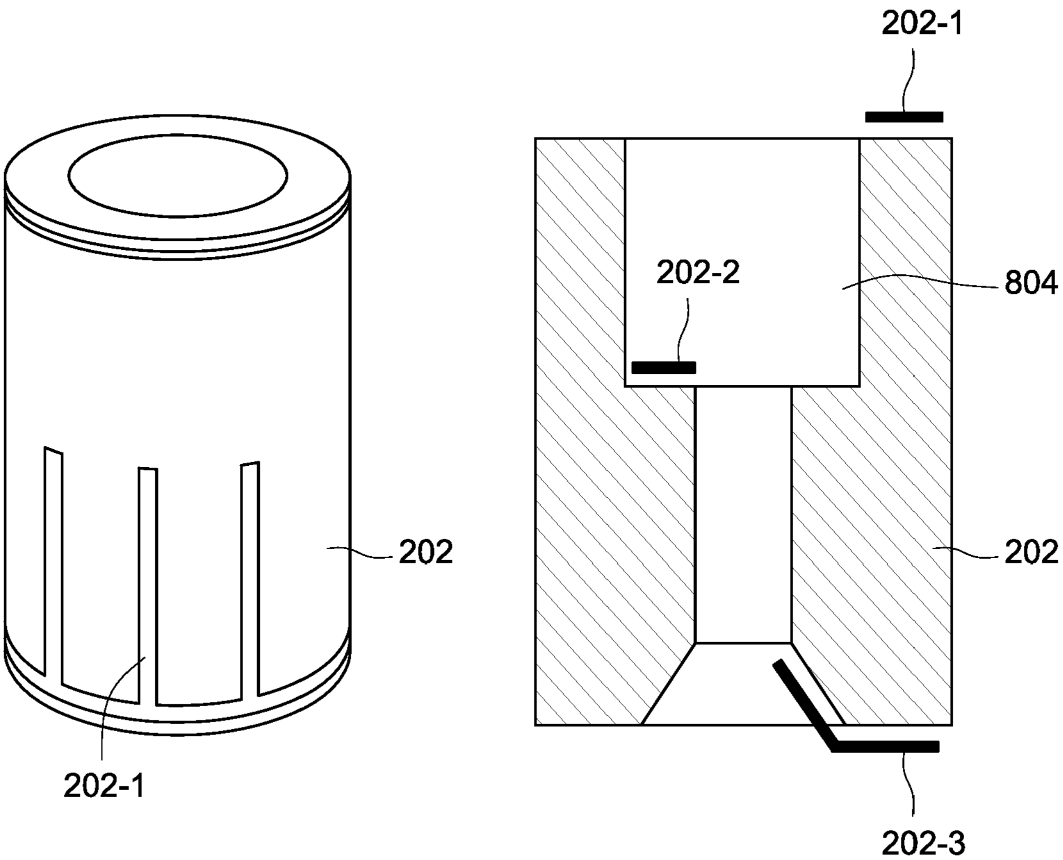


Figure 9

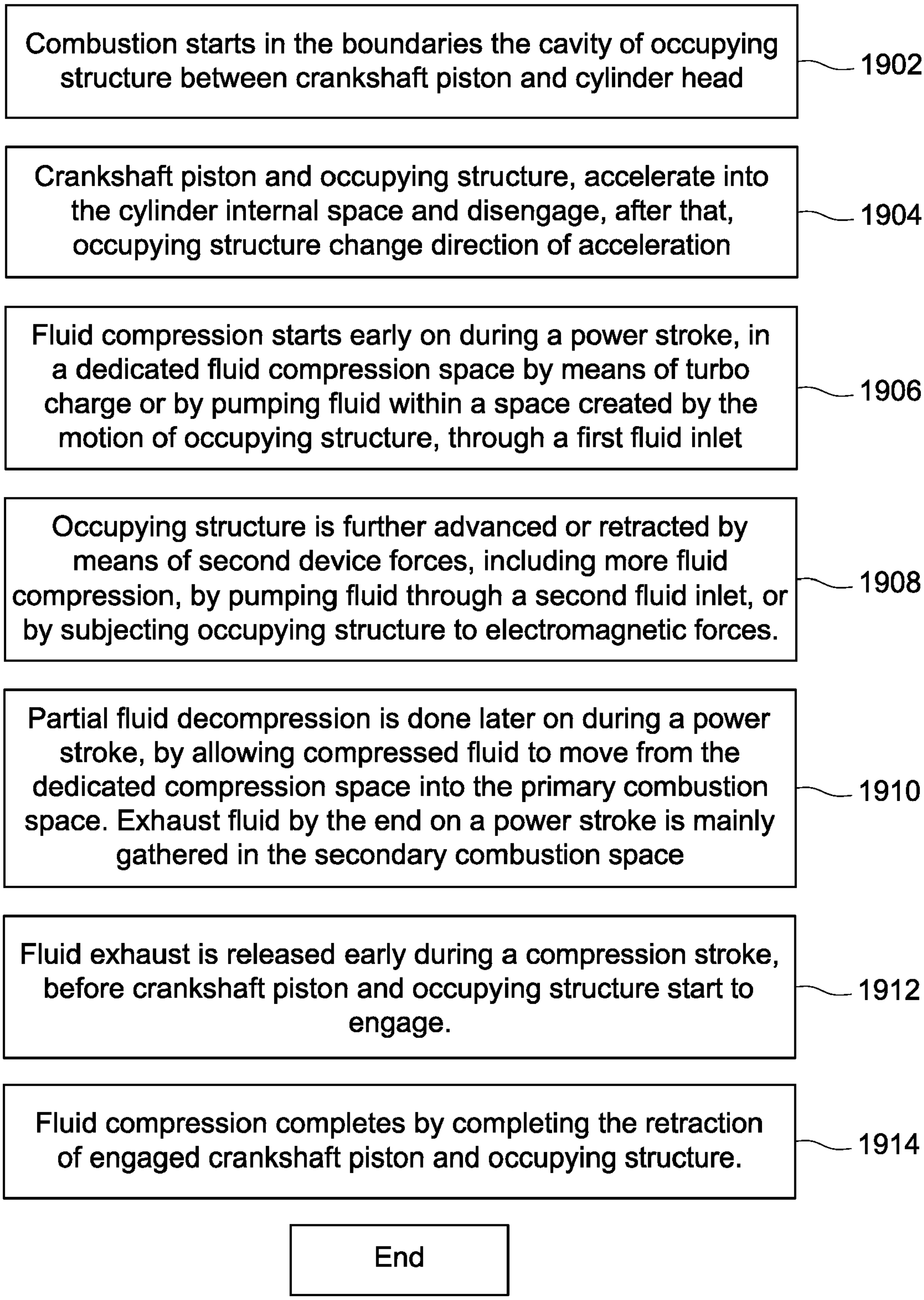

Combustion starts in the boundaries the cavity of occupying structure between crankshaft piston and cylinder head
1902
Crankshaft piston and occupying structure, accelerate into the cylinder internal space and disengage, after that, occupying structure change direction of acceleration
1904
Fluid compression starts early on during a power stroke, in a dedicated fluid compression space by means of turbo charge or by pumping fluid within a space created by the motion of occupying structure, through a first fluid inlet
1906
Occupying structure is further advanced or retracted by means of second device forces, including more fluid compression, by pumping fluid through a second fluid inlet, or by subjecting occupying structure to electromagnetic forces.
1908
Partial fluid decompression is done later on during a power stroke, by allowing compressed fluid to move from the dedicated compression space into the primary combustion space. Exhaust fluid by the end on a power stroke is mainly gathered in the secondary combustion space
1910
Fluid exhaust is released early during a compression stroke, before crankshaft piston and occupying structure start to engage.
1912
Fluid compression completes by completing the retraction of engaged crankshaft piston and occupying structure.
1914
End

Figure 10

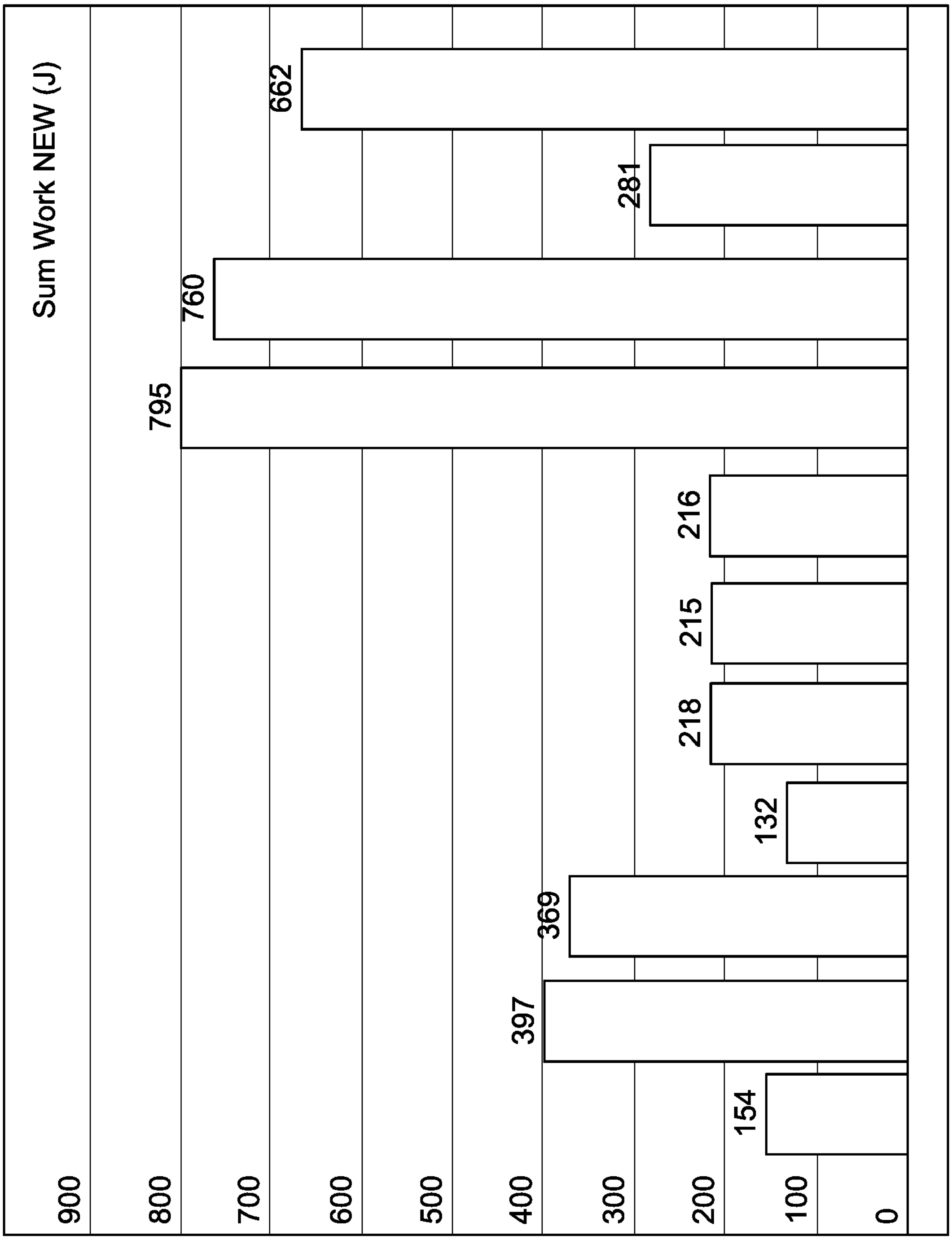

Sum Work NEW (J)
900
800
700
600
500
400
300
200
100
0
154
397
369
132
218
215
216
795
760
281
662

Figure 11

Simulation	C12H23	O2	N2	NO	No2	CO	Co2	H2O	other Products
Conventional Cylinder 50 mg fuel, 150 psi	2,000000%	7,540000%	71,020000%	0,011000%	0,000050%	4,590000%	9,390000%	5,160000%	0,288950%
Relative Motion 50 mg Fuel	0,000000%	3,108585%	72,551693%	0,002738%	0,000043%	0,000001%	16,663243%	5,160000%	0,000039%

Figure 12

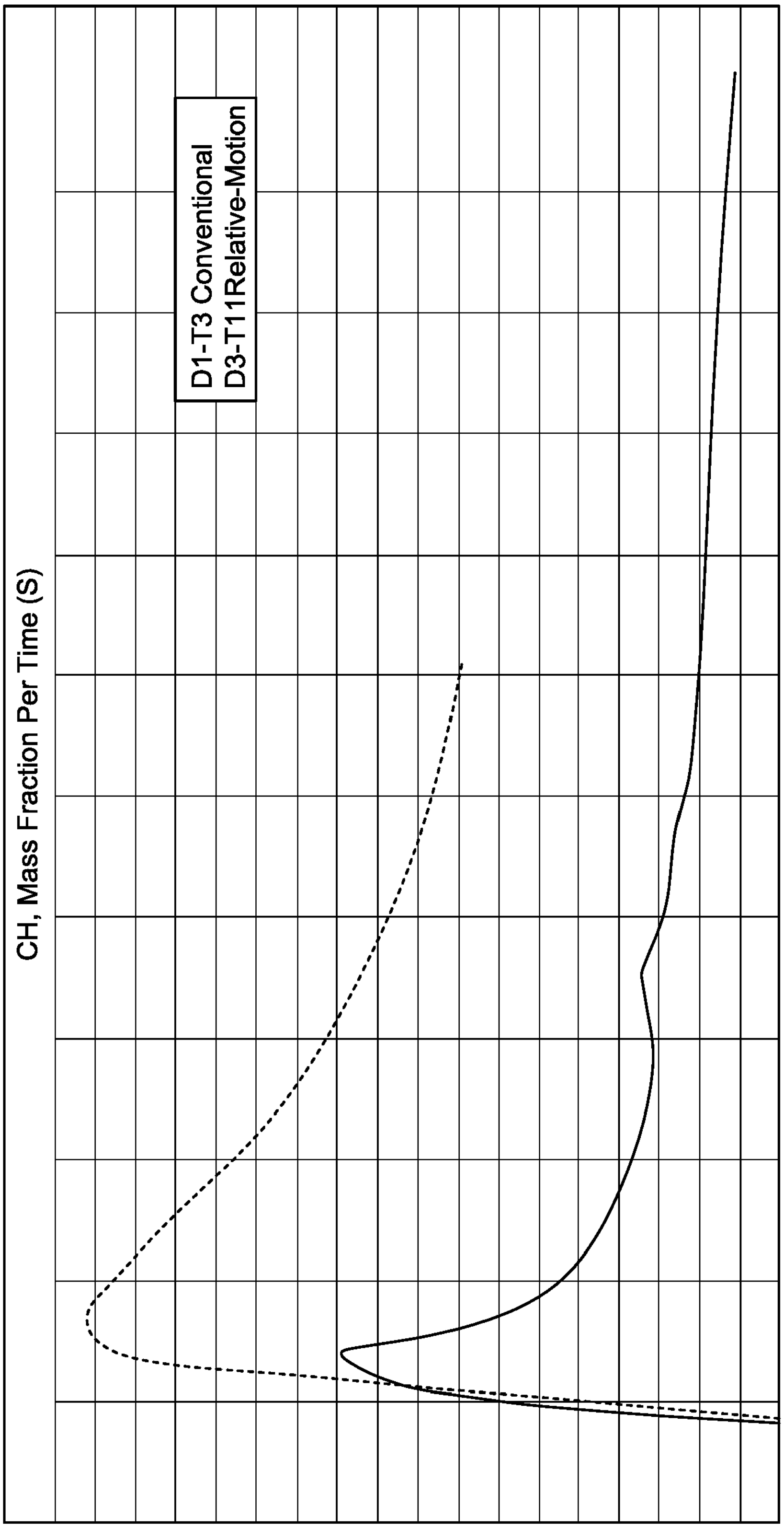

CH, Mass Fraction Per Time (S)
D1-T3 Conventional
D3-T11Relative-Motion

Figure 13

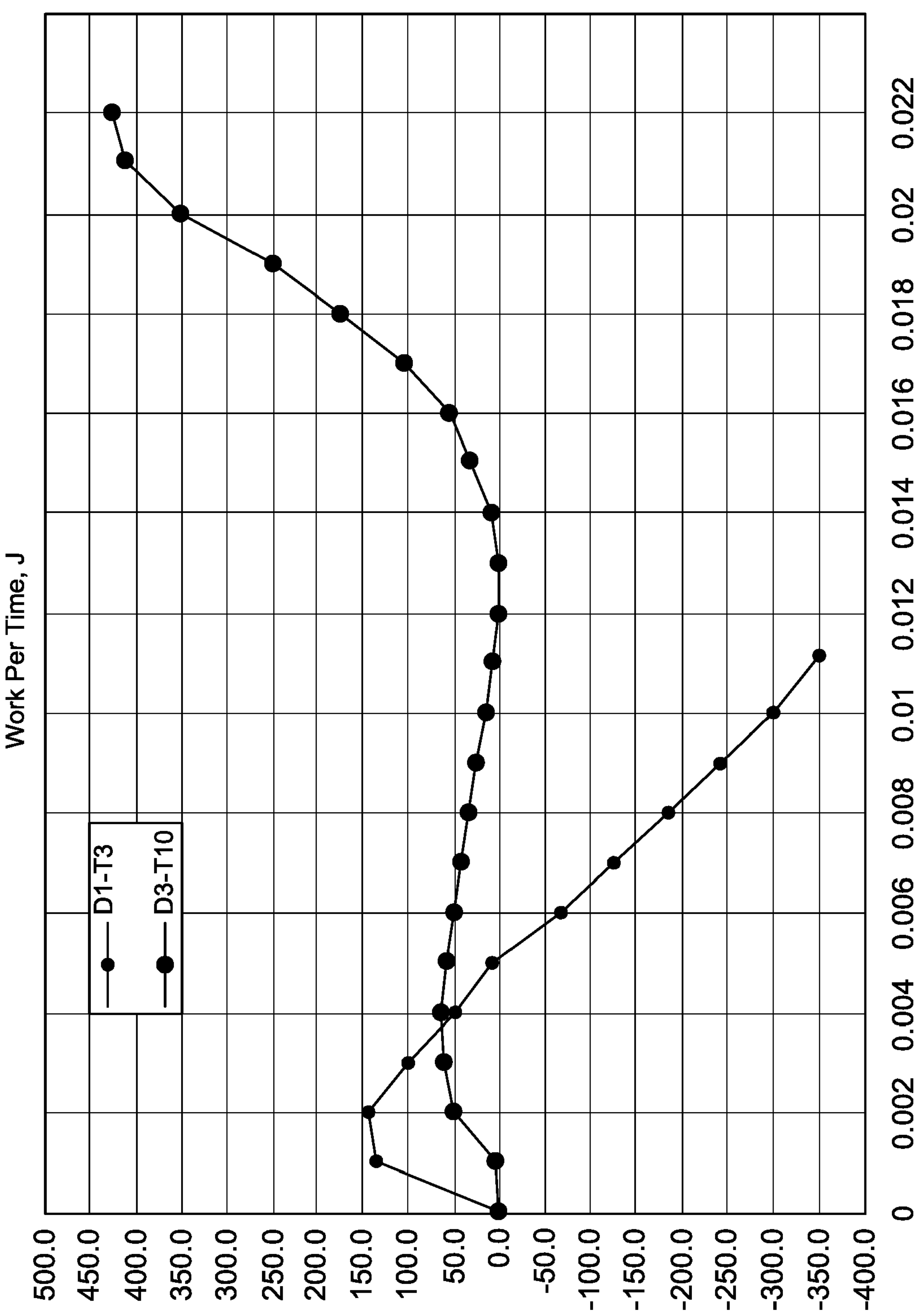

Work Per Time, J
D1-T3
D3-T10
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
-50.0
-100.0
-150.0
-200.0
-250.0
-300.0
-350.0
-400.0
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02
0.022

Figure 14

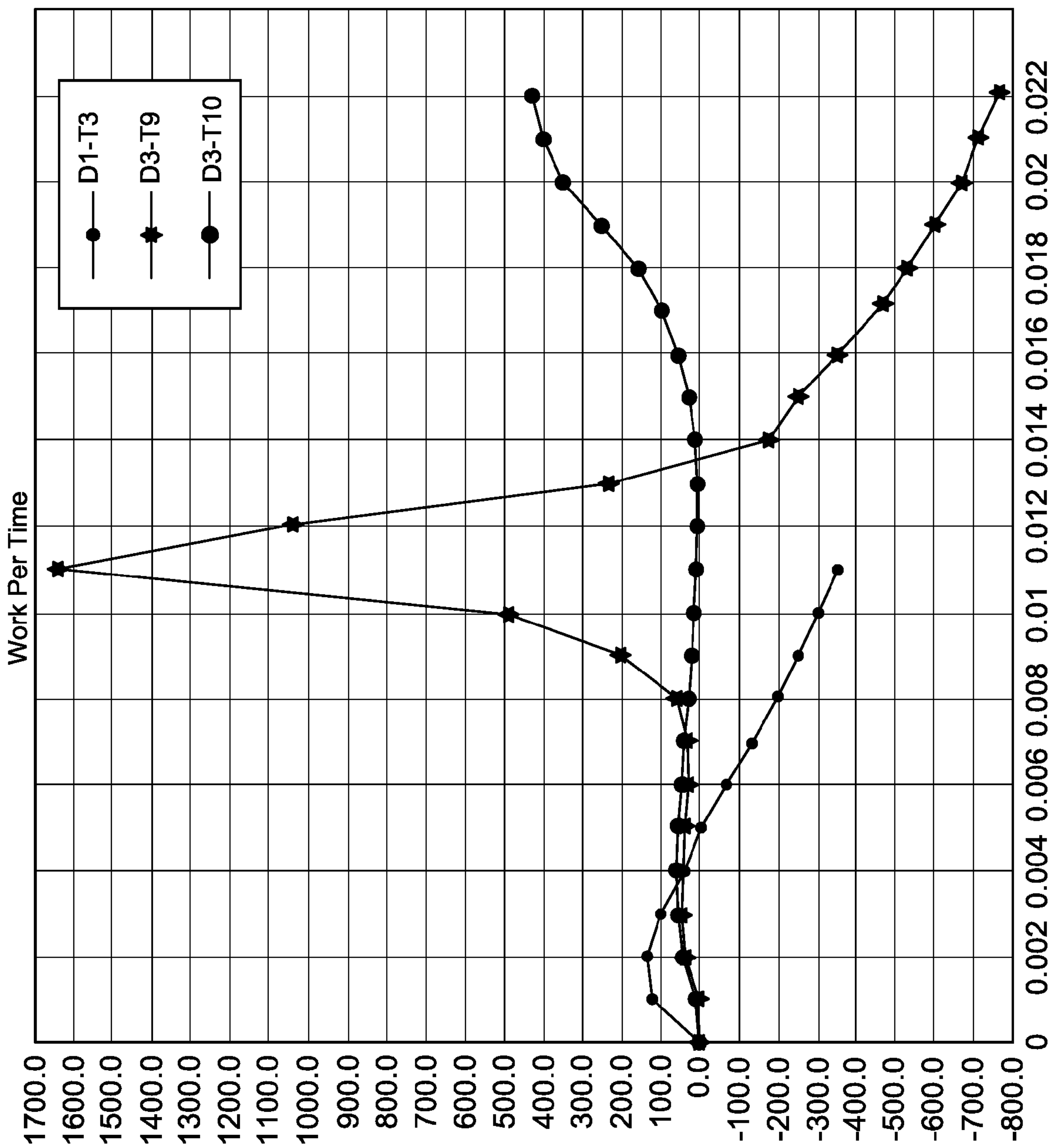

Work Per Time
D1-T3
D3-T9
D3-T10
1700.0
1600.0
1500.0
1400.0
1300.0
1200.0
1100.0
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
-100.0
-200.0
-300.0
-400.0
-500.0
-600.0
-700.0
-800.0
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02
0.022

Figure 15

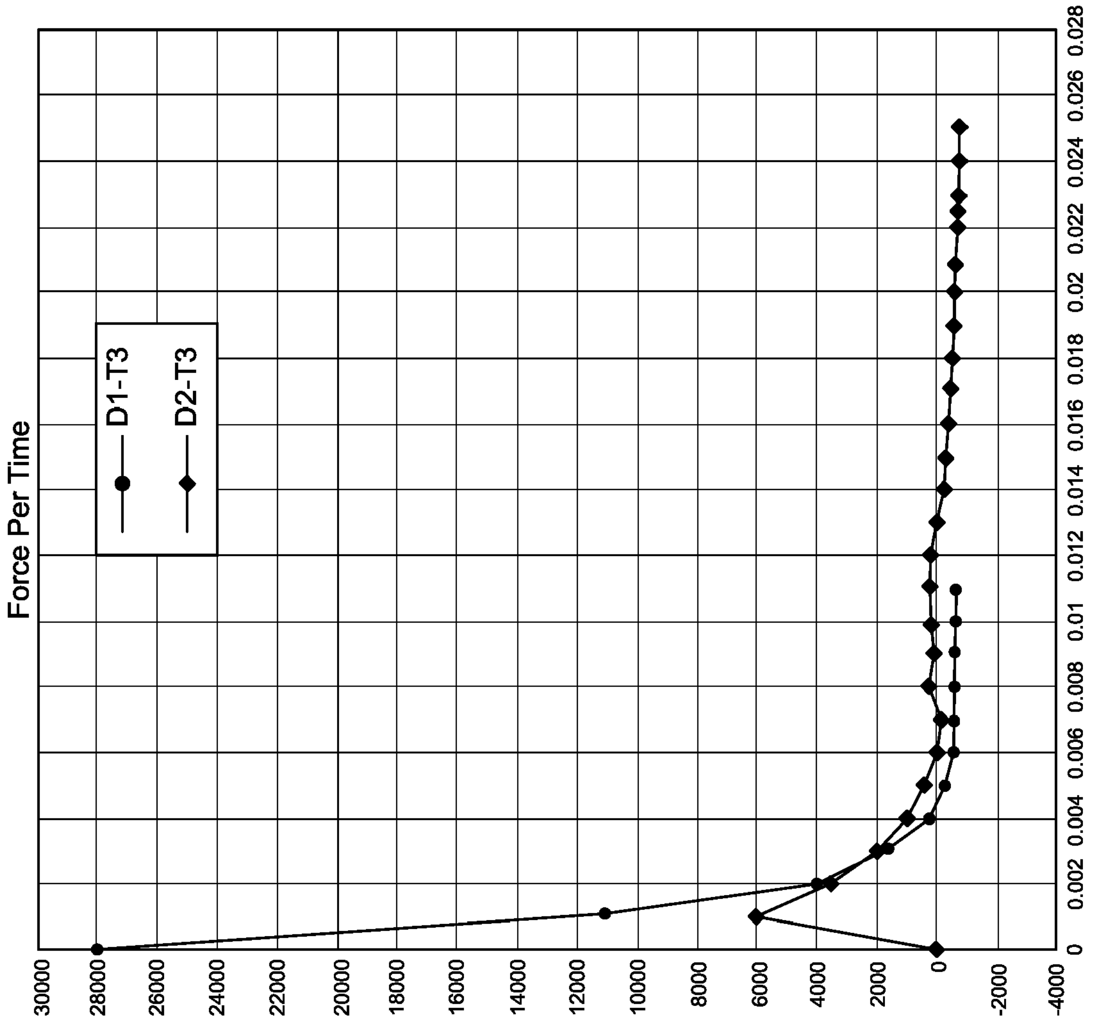

Force Per Time
D1-T3
D2-T3
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02
0.022
0.024
0.026
0.028

Figure 16

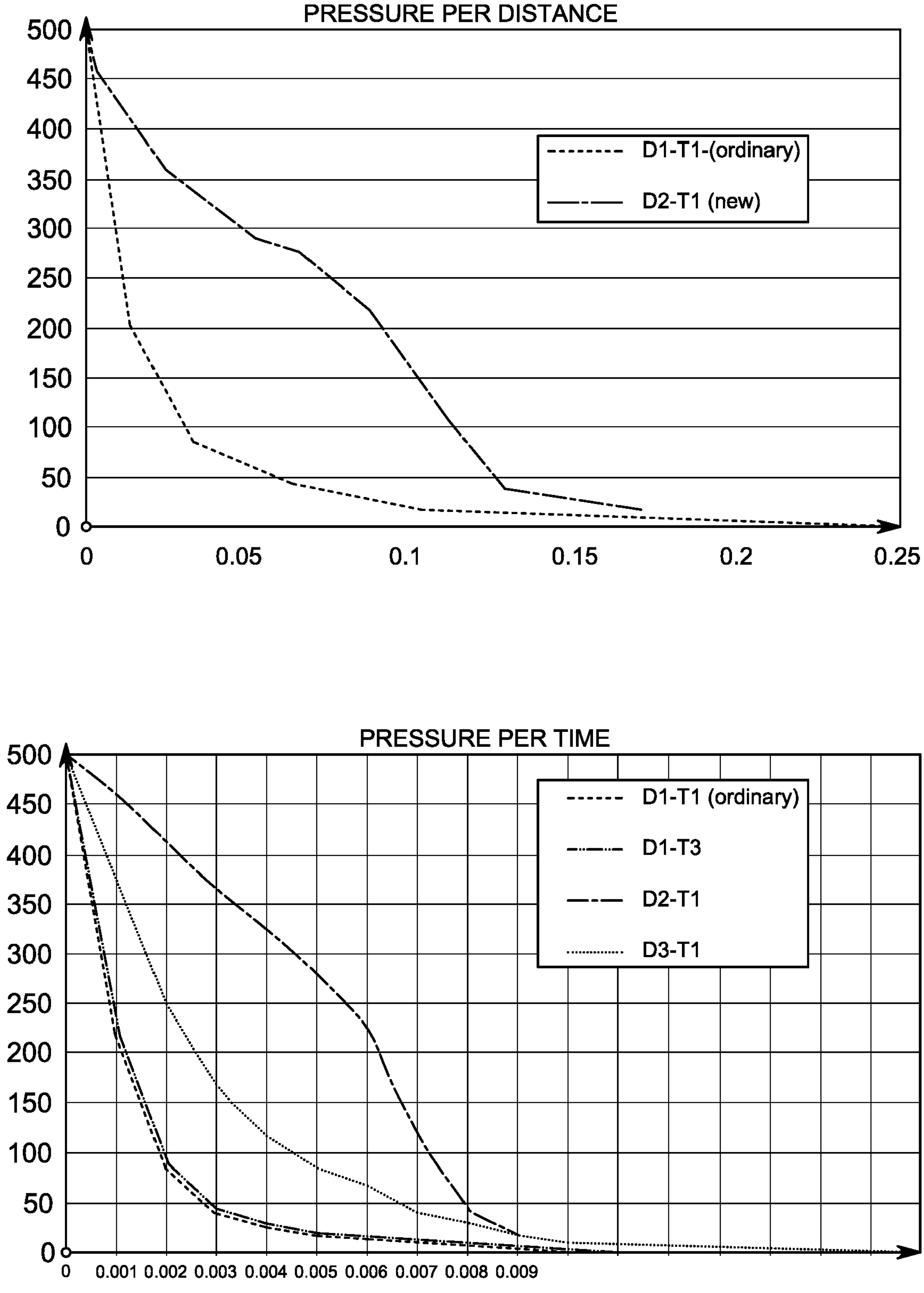

PRESSURE PER DISTANCE
500
450
400
350
300
250
200
150
100
50
0
0
0.05
0.1
0.15
0.2
0.25
D1-T1-(ordinary)
D2-T1 (new)
PRESSURE PER TIME
D1-T1 (ordinary)
D1-T3
D2-T1
D3-T1
0
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009

Figure 17

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 20 2315

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	AU 2019 202 270 B1 (HANNA IBRAHIM MOUNIR [US]) 28 November 2019 (2019-11-28) * claims 1-20; figures 1-19 * -----	1-15	INV. F01B7/18 F01B7/20 F01B31/14 F02B75/04 F02B75/30
X	WO 2019/126833 A2 (HANNA IBRAHIM MOUNIR [US]) 27 June 2019 (2019-06-27) * claims 1-20; figures 1-19 * -----	1-15	
X	US 7 159 544 B1 (STUDDERT ANDREW P [US] ET AL) 9 January 2007 (2007-01-09) * column 3, line 55 - column 8, line 4; figures 1-12 * -----	1-15	
X	US 2009/101004 A1 (JOHNSON JERALD L [US]) 23 April 2009 (2009-04-23) * paragraph [0020] - paragraph [0023]; figures 1,3 * -----	1-15	
X	EP 1 424 473 A1 (MEYER SIEGFRIED [DE]) 2 June 2004 (2004-06-02) * paragraph [0009] - paragraph [0012]; figures 1-10 * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC) F01B F02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 February 2021	Tietje, Kai

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

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