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INVENTOR

BY *Harry M. Saragovitz*
Edward J. Kelly, Herbert Berl
E. J. D. Edgerton ATTORNEYS

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FLUID-DRIVEN ENGINE WITH IMPROVED FLUID AMPLIFIER VALVE MEANS

Kenneth E. Woodward, McLean, Va., assignor to the
United States of America as represented by the Secretary of the Army

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ABSTRACT OF THE DISCLOSURE

The present invention relates to a fluid operated engine and, more particularly, to a fluid system embodying improved fluid amplifier valving means in lieu of the customary intake and exhaust valves and their associated timing mechanisms, for oscillating a piston within a cylinder and from which piston power can be obtained. The movement of said piston generates appropriate fluid pulses to synchronize properly the associated fluid amplifier. The input to the fluid amplifier determines both the rate of oscillation of the piston and the output of the system. The simplicity of the engine system is hereby considerably improved over existing piston engines by the utilization of a fluid amplifier in conjunction with and to achieve my improved fluid exhausting means.

The invention described herein may be manufactured and used by or for the Government of the United States for governmental purposes without the payment to me of any royalty thereon.

Cross references to related application and patents

More specifically, the instant invention represents an improvement over my earlier U.S. Patent No. 3,124,999, directed to a novel system for controlling a piston by a fluid amplifier, in that the instant invention embodies my improved fluid exhaust valving system which precludes the exhaust fluid from returning to the fluid amplifier. Another of my inventions disclosed in U.S. Patent No. 3,234,934 further elaborates on the control of a piston by a fluid amplifier. An alternate method of providing an exhaust means is described in my still earlier U.S. Patent No. 3,053,276.

Brief summary of invention

The fluid engine of this invention preferably utilizes a bistable fluid amplifier of the boundary layer type, described in my earlier Patents No. 3,053,276 and No. 3,124,999, wherein the amplifier output provides the energy for the power stroke of a double acting combination valving and work-producing piston housed by cylinder means of the engine. The amplifier also provides a negative pressure through an entrainment means for aiding the reciprocation of the piston to a small degree.

Fluid amplifiers of this type utilize a fluid stream, emanating from a suitable source, hereinafter referred to as the power stream, which issues from the nozzle or orifice which is constructed in a manner to well define the power stream. Control fluid means is associated therewith comprising a control fluid stream directed toward the power stream from opposite sides, preferably but not necessarily in a substantially perpendicular direction in order to provide a predetermined differential pressure or pressure gradient across the power stream. The amplifier is also provided with at least two outlet or fluid-receiving passages facing the power stream in a generally converging Y-like manner such that the power stream can be deflected by the control stream into one or the other of said fluid-receiving passages. Suitable inherent load devices, such as the piston and opposite ends of the piston chambers and the intercommunicating conduits of

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the control fluid means, communicate with these passages. The power supply is of a capacity to produce a steady output with sufficient power to meet the demands of the load plus losses in the system.

In some of the aforementioned prior art amplifier-oscillator devices, such as Patent No. 3,124,999, certain non-productive or exhaust fluid flow necessarily was returned to the amplifier, inherently reducing the efficiency of the device. Said flow therein is alternately channeled back through the fluid-receiving passages which in turn are shown mutually interconnected with a bleed or exhaust conduit centered therebetween and leading from the amplifier housing to the ambient.

Accordingly it is the primary object of the present invention to provide a fluid operated engine of simplified construction by providing an improved quick-acting exhaust system in conjunction therewith which will deflect and preclude the exhaust fluid from returning to the amplifier utilized therewith.

It is a more specific object hereof to provide an improved exhaust system which utilizes a portion of the power stream fluid pressure to generate a supplementary fluid flow for effecting deflection of the exhaust fluid to the ambient.

The aforementioned objects are achieved by the addition of separate fluid exhaust outlets provided, preferably closely adjacent the opposed end walls of the cylinder which houses the double acting piston, as diverging branched outlet passages leading from the outlet conduits or passageways interconnecting the opposite ends of the piston chamber and the respective outlet ports of the fluid-receiving channels of the amplifier. Additionally, two fluid flow conduits of smaller cross-sectional area than those latter described conduits are operatively interposed between said latter described conduits, each having one terminal end operatively interconnected with one of the respective outlet conduits at an intermediate point and the other terminal end connected at substantially right angles with the other of said conduits at a point opposite the newly formed exhaust outlet aforesaid. Accordingly, during a given operational cycle, it will be apparent that a relatively small portion of the fluid of the power stream issuing from a given fluid-receiving channel of the amplifier will be diverted through said smaller diameter conduit. This diverted fluid will issue forth as a secondary flow at the other end to deflect any residual fluid issuing from that end of the cylinder responsive to the power stroke of the piston by the primary pulse. With help of the entrainment principle, said residual fluid will be scavenged via the said exhaust outlet to the ambient, thereby precluding return of the exhaust fluid to the amplifier.

Figure description

The foregoing and other objects and advantages will become more apparent to one skilled in the art from the following more detailed description taken in conjunction with the illustrative drawing figures wherein:

FIGURE 1 is a diagrammatic view of a fluid driven engine having the improved fluid amplifier valve means constructed in accordance with this invention;

FIGURE 2 is an enlarged fragmentary diagrammatic detail representative of the improved fluid pressure exhaust means of this invention; and

FIGURE 3 is an enlarged fragmentary diagrammatic view similar to FIGURE 2 but depicting an alternate embodiment of the improved fluid pressure exhaust means thereof.

Referring now to FIGURE 1 there is shown a fluid operated engine assembly generally designated A, comprising oscillating means B, a fluid amplifier means C and a fluid power source D.

The amplifier means C is preferably of the bistable boundary layer type described as a Class II type in my earlier Patent No. 3,124,999, although it will become evident that a Class I type amplifier may be used. Amplifier means C as illustrated comprises a transparent plastic body 10 which houses a substantially Y-shaped configuration passageway system formed in a manner as to provide a fluid power stream conduit 12, a power nozzle 14, left and right fluid-receiving channels 16 and 18 respectively and an interaction chamber 20. Left and right control nozzles 22 and 24 are disposed in opposed relationship shown at substantially right angles to the power nozzle 14 and interaction chamber 20, although the angled relationship may be other than perpendicular. My improved system to be described in detail hereinafter eliminates the use of a fluid bleeding channel normally disposed within the amplifier housing 10, the position of which as used in prior art systems is indicated in broken lines and designated 26. Such a channel in prior art devices communicated with the interaction chamber 20 and would serve as a bleed off or exhaust means to limit the build up of fluid pressure in chamber 20. My improved system locates the fluid bleeding channels distal to the amplifier and controls them actively rather than passively as in the prior art.

The source of pressurized fluid D, preferably a gas generator although the fluid may be air, gas, water or other liquids, is connected with the amplifier's power stream conduit 12 by a tube or the like designated 28. A fluid regulating valve 30 may be used to regulate the amount of fluid entering said tube 28, and thereby will control the speed of the engine for any given load.

When fluid under pressure is applied to the power nozzle 14, there is a flow through said nozzle which results in the creation of a well-defined power stream or power jet which issues into the chamber 20. Control signals in the form of fluid pulses are alternately developed at the control nozzles 22 and 24, in a manner to be described hereinafter in detail, to effect switching of the power stream back and forth between fluid-receiving channels 16 and 18.

Assuming that the fluid power stream has attached itself to the left hand wall of chamber 20 by the boundary layer lock-on principle described in my earlier Patent No. 3,124,999, the fluid will flow out through the left-hand fluid-receiving channel 16 via primary output conduit 32 and into the oscillating means B. Means B includes a cylinder 33 having an elongated piston chamber 34 formed therein within which piston 36 is disposed for reciprocatory or oscillatory movements. The opposed ends of the cylinder 33 are provided with inlet ports 38 and 40 respectively, and another pair of outlet ports 42 and 44 are disposed intermediate the ends as shown in FIGURE 1. Cylinder 33 is further apertured at one end to accommodate piston rod 46 which by means including a connecting arm 48 and suitable pivotal connections is mechanically connected with a crankshaft 50 of the gas engine A.

Fluid entering the left end port 38 of chamber 34 will exert a force against the piston 36, move it toward the right until it uncovers outlet port 42 through which some of the fluid will pulse via return tube 52 whereupon it will issue as a fluid jet control from the left control nozzle 22 in the amplifier. Fluid issuing from said control nozzle 22 will engage the boundary layer of the power stream, increasing until there is no tendency for the power stream to remain locked-on to the left wall of chamber 20. The power stream will then be deflected into the right receiving channel 18, and via the other primary output conduit 54 connecting said channel 18 with the right end port 40 of cylinder 33, the fluid will then drive piston 36 in the opposite direction. When outlet port 44 is then uncovered, thereby permitting some of the fluid to enter the other return tube 56, it will issue as a fluid jet control from the right control nozzle 24. This de-

scribed portion of the cycle, with attendant exhausting of the cylinder to be described hereinafter, thereafter continues and the rate of oscillation of the double acting piston 36 will depend upon the length and mass of the piston, the volumetric flow rate of the power stream, the spacing between the ports 42 and 44 and the general efficiency of the amplifier. The general efficiency of the amplifier is affected by factors such as back loading and exhaust valving which are contributing factors to the overall efficiency of the fluid engine.

The improved exhaust features of this invention will now be described in detail. Separate exhaust ports 58 and 60 having associated exhaust conduits 59 and 61 respectively are provided, preferably closely adjacent the opposed end walls of the cylinder 33. The exhaust conduits 59 and 61 are illustrated as branched conduits or passages disposed angularly away from the juncture of primary conduits 32 and 54 respectively with the end wall and ports of the cylinder 33. In addition, two secondary fluid pressure conduits 62 and 64 are operatively interposed between and are of substantially smaller cross-sectional diameter than the primary conduits 32 and 54. Their disposition, as illustrated in FIGURE 1, is such that each of these smaller conduits has one terminal end operatively interconnected with one of the respective outlet conduits, 32, 54, at an intermediate point 66 and 68, respectively, and the other terminal end connected at substantially right angles with the other of said conduits 32 and 54 at a point opposite the newly formed exhaust ports. It will be apparent during operation of the fluid engine, that a relatively small portion of the fluid of the primary power stream issuing from one or the other of the fluid-receiving channels of the amplifier will divert into the adjoining smaller diameter secondary conduit, as at 66 or 68. This diverted fluid will then issue forth from nozzle 76 as a secondary flow at the other end of said conduit. The latter fluid flow is directed at substantially right angles to the flow of any residual fluid issuing from the adjacent end of the cylinder 33 responsive to the power stroke of the piston 36 initiated by the primary fluid flow of the power jet. Accordingly, it is now apparent that the exhaust fluid will alternately exit via the exhaust passages 59 and 61 to the ambient, thereby enhancing the operational efficiency by precluding return of the exhaust fluid to the amplifier which would otherwise occur through conduits 32 and 54.

It is to be understood that while the exhaust fluid is shown discharging to the ambient, it may also be discharged into a vessel where it would be collected and recompressed for recycling use.

FIGURE 2 is a diagrammatic detail representation more clearly depicting the improved exhaust and related component passageways of the FIGURE 1 assembly as they may be formed in a block-like member 70 with corresponding parts depicted in FIGURE 1 being identified with corresponding reference numbers. It is preferable to provide an enlarged area 72 within the block as shown in FIGURE 2 adjacent to the entrance port 63 of the fluid diverting conduit 62 to better define the jet nozzle 76 requiring predetermined design characteristics to achieve a particular jet flow. The enlarged area 72 is transversely offset from the medial passage 74 the latter of which may correspond generally to the fluid-receiving channels 16 or 18, or to their associated output tubes 32 or 54 as shown in the FIGURE 1 embodiment. Additionally, jet nozzle 76 is shown more clearly defined opposite the exhaust port 60.

Referring now to FIGURE 3 which is similar to FIGURE 2 but is representative of an alternate embodiment thereof, pivotal splitter valve means designated 78 is embodied therewith for the purpose of providing a positive means for directing the exhaust fluid to the ambient via the exhaust passage.

My earlier Patent No. 3,053,276 is directed to similar means for assuring that the amplifier thereof will issue

all of the fluid from the proper aperture or conduit even though heavily backloaded.

Primed reference numerals are used in FIGURE 3 to designate corresponding parts of those so designated in FIGURE 2. As shown in FIGURE 3, the control flow conduit 62', port 63', enlarged area 72' and nozzle 76' are disposed on the same side of the medial passage 74' as the exhaust passage 61'. The enlarged area 72' in this embodiment is primarily to control the momentum flux of the fluid against the splitter valve means 78. However, as depicted in FIGURE 3, these components are preferably disposed so the axis of the jet nozzle is disposed approximately at right angles to the exhaust passage 61'. They are also closely adjacent the juncture of said passages 61' and 74' to enable the aforedescribed secondary fluid pulse issuing therefrom to impinge directly against the free end 80 of the splitter blade 82. Blade 82 is shown mounted for free movement about pivot 84 from its solid line position, as retained by the primary flow of the power stream, to the dotted line position which closes off the medial passageway 74' to preclude undesirable back flow or backloading of the fluid amplifier. Movement of the splitter blade 82 to the dotted line or exhaust position is effected responsive to the timed secondary control flow issuing from nozzle 76' against the adjacent covering face of the blade extremity 80.

The splitter blade means 78 also could be operated in an alternate way (not shown) by having the control flow impinge a lever assembly, which may be a duplicate of and connected with blade 82, that is disposed sub-30 jacent of the amplifier channels or passages.

Various impedances (resistance, inductance and capacitance and their combinations) designated in FIGURE 1 by the letter I may be appropriately placed in the conduits 32, 52, 54 and 56 as well as in conduits 62 and 64. The impedances are designed to load match the vari-35 ous components of the system.

As will be apparent to those familiar in the art, wind-shield wipers and other type of devices which are required to perform oscillating or reciprocating functions may be connected to and driven by the piston; the piston may be employed to valve hot or cold gasses or liquids under high pressure, or to deliver exact amounts of fluids to be canned, such as soft drinks, beer and the like; or more preferably the piston may be mechanically connected to a plurality of vehicle drive wheels.

It should be apparent also that more than one cylinder piston array could be incorporated into a composite engine assembly, wherein synchronization of the piston operation could be accomplished by control of the switching signals to the fluid amplifiers in a manner similar to that shown in FIGURE 2 of my U.S. Patent No. 3,124,999. The gas generator could be of the explosion type or any other appropriate and available kind.

Operational efficiency could be enhanced by staging of the amplifiers. The amplifiers could be either of the bistable or proportioning type depending on the control signal means employed.

Accordingly, from the foregoing detailed description, the operation of my improved valving means is fully apparent and need not be redescribed. Also apparent are the advantages regarding engine cost, life and weight afforded by my improved fluid engine in that by the elimination of many of the moving parts associated with the valving and timing mechanisms in customary gasoline powered engines. Further, the stop-start advantages of internal combustion engines would be retained while the simplicity of the turbine would be approached. Also engine operation would be considerably smoother than that obtained in internal combustion engines due to the elimination of the explosive fuel combustion within the cylinder.

While I have described and illustrated embodiments which are only exemplary, it is apparent that various modifications can be made in the structure and arrange-75

ment within the scope of the invention as defined in the appended claims.

I claim:

1. A fluid operated engine, for use in conjunction with a fluid power stream initiated from a fluid power source, comprising:

- (a) a bistable fluid amplifier including a fluid input channel, left and right fluid output channels, and associated left and right control nozzle means for deflecting the power stream adapted to issue from the fluid input channel to one of said output channels, and wherein the fluid power stream locks onto a wall of one of the two output channels to which it is diverted;
- (b) oscillating means including a cylinder having a piston reciprocably disposed therein, and means coupled with said piston and extending through one end wall of the cylinder for transmitting mechanical energy from said piston;
- (c) said cylinder provided with first port means including left and right end fluid-receiving ports disposed at opposite ends of said cylinder, and second port means disposed intermediate the first port means and alternately covered and uncovered during reciprocating travel of the piston;
- (d) primary output conduit means including left and right conduits interconnecting said left and right output channels of the amplifier with said left and right first port means, respectively, for conducting a primary flow of the power stream to the piston;
- (e) feedback fluid conduit means interconnecting said second port means and said control nozzle means for switching said power stream to the other of said output channels when said second port means is uncovered;

wherein the improvement comprises fluid exhaust means including:

- (f) secondary output conduit means for conveying a secondary fluid flow interconnecting the left and right output channels of the amplifier with the opposite right and left primary output conduits, respectively, adjacent the juncture of the latter conduits with the respective right and left first port means; and
- (g) said right and left primary output conduits having exhaust port means provided near their juncture with said first port means and disposed opposite the respective junctures of the secondary output conduit means therewith;
- (h) whereby a portion of the power stream is diverted through the secondary output conduit means in the form of a secondary fluid flow to deflect residual fluid pressure issuing from said cylinder responsive to a power stroke of the piston in a manner to exhaust it through said exhaust port means to the ambient and to preclude the return of said exhaust fluid to the amplifier.

2. A fluid operated engine as defined in claim 1 wherein the secondary output conduit means includes conduits or channels of substantially smaller diameter than the primary output conduit means.

3. A fluid operated engine as defined in claim 1 wherein the secondary output conduit means includes conduits or channels of substantially smaller diameter than the primary output conduit means, and said secondary output conduits interconnect with said primary output conduits adjacent said first port means at substantially right angles.

4. A fluid operated engine as defined in claim 1, wherein the fluid exhaust means further includes a jet nozzle means disposed at the terminal ends of the secondary output conduit means opposite the exhaust outlet port means.

5. A fluid operated engine as defined in claim 1 further including:

- (a) movable valve means in association with and

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normally closing the exhaust port means and operable responsive to the aforesaid primary fluid flow, and

- (b) said valve means alternately blocking and opening the associated primary output conduit responsive to the secondary fluid flow to preclude return of the residual fluid pressure to the amplifier while simultaneously opening said exhaust outlet port means, responsive to reciprocation of the piston.

6. A fluid operated engine as defined in claim 1 wherein:

- (a) the secondary output conduit means includes conduits or channels of substantially smaller diameter than the primary output conduit means;

- (b) said secondary output conduits interconnect with said primary output conduits adjacent said first port means at substantially right angles;

- (c) movable valve means in association with and normally closing the exhaust port means and operable responsive to the aforesaid primary fluid flow and said valve means alternately blocking the associated primary output conduit responsive to the secondary fluid flow to preclude return of the residual fluid to the amplifier while simultaneously opening said exhaust outlet port means, responsive to reciprocation of the piston.

7. A fluid operated engine as defined in claim 6 wherein the movable valve means includes a pivotally mounted splitter valve blade.

8. Apparatus for use in conjunction with a fluid power source for converting fluid energy into mechanical reciprocating energy comprising:

- (a) a fluid amplifier having a power nozzle connectable with a fluid power source and issuing a primary power stream, a pair of opposed control nozzles positioned to direct fluid pulses against said power stream in a manner to cause angular displacement of said power stream, a pair of opposed primary output conduits positioned to receive said power stream as a result of displacement by fluid impulses issuing from said control nozzles, and feedback conduits communicating with said control nozzles;

- (b) oscillating means adapted to periodically direct fluid flow into a predetermined combination of ports formed in said oscillating means and including a cylinder having opposed ends, a double acting reciprocating piston within the cylinder where the opposed ends of the piston direct said power stream fluid ultimately into the proper control nozzle when said piston is properly positioned;

- (c) said output conduits, control nozzles and feedback conduits communicating with the aforesaid cylinder by means of said ports, with said ports being arranged such that fluid issuing from one output con-

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duit is directed to and fed back by said oscillating means into that control nozzle of the fluid amplifier which is positioned to deflect said power stream into the output conduit opposite the conduit issuing fluid;

wherein the improvement comprises fluid exhaust means including:

- (d) means for conveying a portion of the fluid power stream as a secondary power fluid stream between each of the given primary output conduits communicating with one end of the cylinder and the other primary output conduit communicating with the opposite end of the cylinder;

- (e) and exhaust conduit means connected with the aforesaid cylinder means and disposed for communication with the aforesaid means for conveying said secondary power fluid stream whereby the secondary power stream deflects residual exhaust fluid from the cylinder to the ambient and precludes its return to the amplifier.

9. The device as defined in claim 8 wherein the means for conveying a secondary fluid stream includes fluid conduits of substantially smaller cross-sectional area than the primary output conduits.

10. The device as defined in claim 9 wherein the exhaust conduit means include exhaust port means disposed within each primary output conduit adjacent its communicative juncture with the valving cylinder, and the secondary fluid output stream intersects the primary output conduits at approximately right angles opposite the exhaust port means therein.

11. The device as defined in claim 10 wherein the conduit means for conveying a secondary fluid stream have jet nozzles at the ends terminating opposite the exhaust port means.

12. The device as defined in claim 10 further including pivotal splitter valve means in association with and normally closing the exhaust port means responsive to the flow of the primary output stream, and alternately pivoted responsive to the flow of the secondary output stream to block the flow in the associated primary output conduit and to preclude the return of the residual exhaust fluid to the amplifier, while simultaneously opening said exhaust port means.

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PAUL E. MASLOUSKY, *Primary Examiner.*