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Tompkins

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[54] **COUNTER-WAVE PULSE JET ENGINE**

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[52] **U.S. Cl.** **60/248,** 60/39.77, 60/39.8

[51] **Int. Cl.** **F02k 7/04**

[58] **Field of Search** 60/247, 248, 249, 39.77, 60/39.7, 39.8, 39.78

[56] **References Cited**

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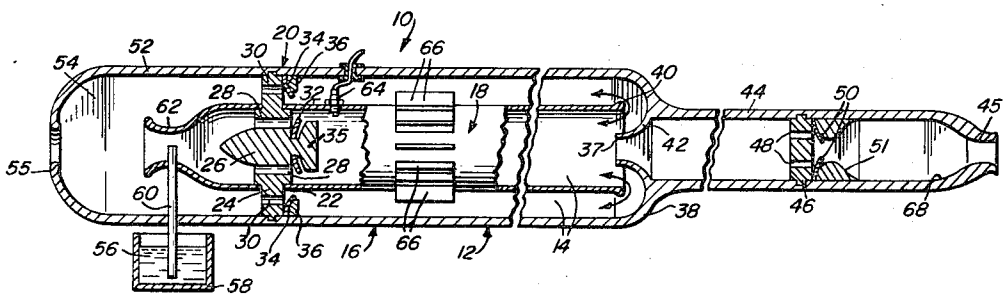
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[57] **ABSTRACT**

A pulse jet engine having a housing forming a longitudinal, enclosed resonance chamber with spaced end walls functioning as reflecting walls and an exit port arranged substantially midway between the end walls. Ports are provided in the end walls for permitting a gas, such as air, to pass into the chamber. Flap valves are associated with these ports for closing same during intermittent combustions occurring in the chamber. The housing may include concentrically arranged inner and outer tubes, with adjacent ends of these tubes provided with the intake ports. The end of the outer tube spaced from its one end extends beyond the curves toward the adjacent end of the inner tube to form an annulus arranged for deflecting gases passing between the inner and outer tubes. This annulus has a concentric opening forming the exit port. A tailpipe may be connected concentrically to the annulus and arranged extending coaxially from the inner and outer tubes. Further, a reflecting wall having a port and an associated flap valve is arranged in the tailpipe for making the tailpipe a further resonance chamber.

10 Claims, 2 Drawing Figures



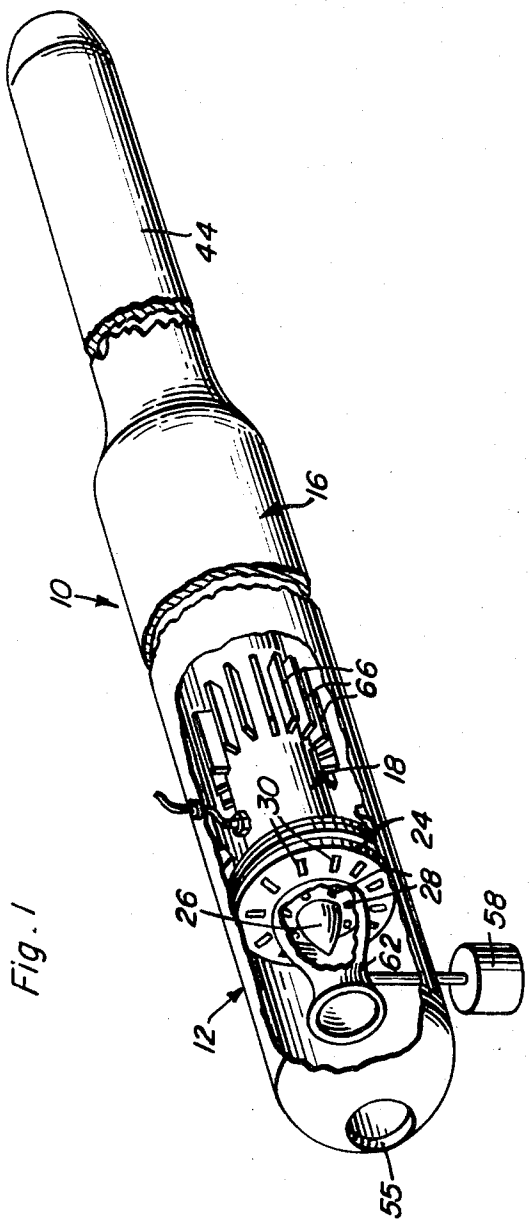

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Fig. 1

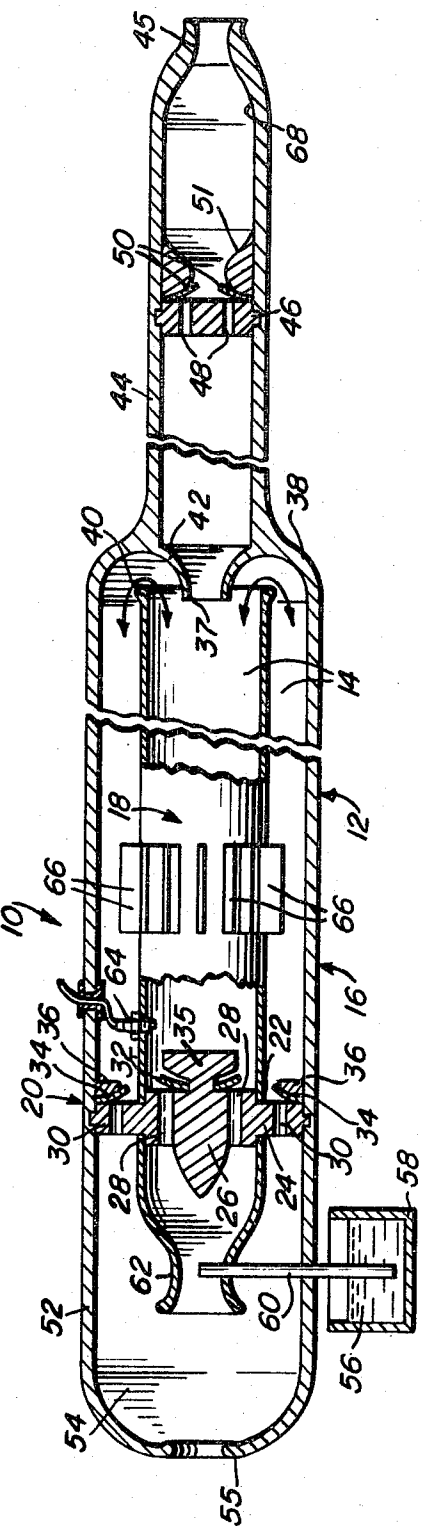

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Fig. 2

COUNTER-WAVE PULSE JET ENGINE

BACKGROUND OF THE INVENTION

1. Field of the invention

This invention relates generally to a combustion engine, and particularly to a counter-wave pulse jet engine.

2. Description of the Prior Art

The intermittent duct, or pulse jet engine has been long known, and was used to power the V-1 buzz-bombs directed against London during World War II. Development of the pulse jet engine since that time, however, has been slight due to inherent noise problems. Accordingly, attention has been directed to the thermal or turbo-jet and continuous duct or ram engines.

The loud noise in a conventional pulse jet engine is due to a pulsed wave passing out of the open, exhaust end of the combustion chamber, overshooting due to inertia after the driving pressure on the wave has dissipated, coming to a stop, and being drawn back into the chamber by the suction which was created by the wave initially passing out of the chamber. The wave will travel back toward the intake end of the chamber until the suction is balanced, and will again overshoot and cause a pressure wave to start to build-up in the tube. As this pressure wave reaches the intake end of the tube, a combustible mixture, which was drawn into the tube when the suction wave reached the intake, is forced into the ever narrowing space between the intake port and the igniter plate. Heat from the last burning is stored in the adjacent igniter plate, and high pressure from the effect of ramming the wave into the narrow space acts, once the engine is operating, together with the stored heat to ignite the mixture. Gases being forced out of the exhaust opening produce thrust which can be used in any suitable, known manner as motive power. The input suction wave, however, is 90° out of phase with the exhaust wave — that is, the suction is 90° away in space from the exhaust at the frequency of operation — therefore, the sound from the engine is extremely loud.

A recent attempt to improve the operation of the pulse jet engine is set out, for example, in U.S. Pat. No. 3,486,331, wherein a reflecting wall is inserted in the conbustion chamber towards the exit end thereof for forming a closed-tube resonance chamber. The pressure waves formed by the intermittent combustion in the combustion chamber will be reflected off this reflecting wall and off the wall formed by closed valves at the intake end of the chamber, which causes a more rapid build-up of pressure and initial explosive force in the chamber. Ports provided in the reflecting wall permit high pressure periods to force combustion gases down a tailpipe. Since, by proper design, a plane of substantially equal pressure will exist at the reflecting wall, a continuous flow of air will pass through the ports provided in the reflecting wall and exit from the engine. In this manner, noise from the engine will be at a continuous, reduced level, and operating efficiency of the engine will be increased.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a pulse jet engine having an improved closed resonance chamber arrangement providing an even further reduced noise level and increased efficiency as compared to known arrangements.

It is another object of the present invention to provide a pulse jet engine which uses some of the sound energy emitted by the engine to pump additional air, thereby lowering sound output, increasing engine efficiency by increasing the volume exhausted and allowing the exhaust port to be so restricted as to increase the pressure and speed of the gases exhausted, and providing internal engine cooling.

It is yet another object of the present invention to provide a pulse jet engine having one or more closed resonance chambers in which the total length of these chambers is greatly increased without a substantial increase in the overall size of a unit of, for example, a given thrust.

These and other objects are achieved according to the present invention by providing a combustion engine, comprising: a housing forming an enclosed resonance chamber; a port provided in the housing for permitting a fluid to pass into the chamber; valve means associated with the port for closing same during intermittent combustion occurring in the chamber; and means provided on the housing and arranged between the port and a reflecting wall of the chamber spaced from the port for permitting combustion gases to exit the chamber. Advantageously, the exit port is arranged substantially midway between the inlet port and the reflecting wall.

According to an advantageous feature of the present invention, the reflecting wall is also provided with an intake port and an associated valve means for admitting air into the resonance chamber when a condition of low pressure is present in a portion of the chamber adjacent the valve means.

The housing of a preferred embodiment of the present invention includes concentrically arranged inner and outer tubes, with adjacent one ends of the tubes provided with the intake ports, and port provided blocking members arranged in the tubes at the one ends for blocking same.

The inner and outer tubes also have other ends spaced from the one ends. The other end of the outer tube extends beyond and curves toward the other end of the inner tube and forms an annulus arranged for deflecting gases passing between the inner and outer tubes. This annulus forms the exit port with an opening arranged concentrically with respect to the tubes.

A tailpipe may be connected to and arranged concentric with the annulus, and arranged extending coaxially from the inner and outer tubes. A further blocking member having a port may be arranged in the tailpipe together with an associated valve element for making the tailpipe a further resonance chamber.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, partly cutaway and in section, showing a counter-wave pulse jet engine according to the present invention.

FIG. 2 is a vertical, longitudinal sectional view showing the engine of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1 and 2 of the drawings show a counter-wave pulse jet engine 10 according to the present invention. This engine 10 has a housing 12 forming an enclosed resonance chamber 14.

Chamber 14 is advantageously formed by constructing housing 12 from a pair of concentrically arranged inner and outer tubes 16 and 18. The adjacent ends 20 and 22 of tubes 16, 18 are provided with blocking members 24 and 26 arranged for blocking the associated tube ends.

A plurality of ports 28 and 30 are provided in blocking members 24, 26 and conventional flap valves 32 and 34 are associated with ports 28, 30, for closing same during intermittent combustions occurring in chamber 14. During periods when a condition of low pressure is present in at least a portion of the chamber adjacent the valves 32, 34, ports 28, 30 admit air into the resonance chamber 14. Valve supports 35 and 36 are arranged for mounting flap valves 32, 34 in any known manner. An exit port 37 is provided on the housing, and is arranged between intake ports 28 and 30 for permitting combustion gases to exit chamber 14. This exit port 37 is advantageously arranged substantially midway between ports 28 and 30.

Tubes 16, 18 have ends 38 and 40 spaced from ends 20, 22. End 38 of tube 16 extends beyond and curves toward end 40 of tube 18, and forms an annulus 42 arranged for deflecting gases passing between tubes 16, 18. Annulus 42 forms exit port 37 with an opening arranged concentrically with respect to tubes 16, 18.

A tailpipe 44 terminating in a converging-diverging nozzle 45 may be connected to and arranged concentric with annulus 42. This tailpipe 44 extends coaxially from tubes 16, 18. A further blocking member 46 having a plurality of ports 48 is arranged in tailpipe 44 together with a plurality of flap valves 50 associated with ports 48 for making tailpipe 44 a further resonance chamber. Abutments forming a converging-diverging nozzle 51 may be provided to also serve as supports for flap valves 50.

Tube 16 is advantageously provided with a canopy portion 52 arranged extending from end 38 of tube 18 and away from tubes 16, 18 for forming a chamber 54 having a volume larger than a fluid volume passed through ports 28, 30. This canopy portion 52 terminates in an opening 55 allowing gases, such as air, to flow into chamber 54.

A conventional jet engine fuel 56, such as gasoline or kerosene, may be fed from a conventional container 58 through a hose 60 into a converging-diverging nozzle 62 extending from end 22 of tube 18. Blocking member 26 may be given a substantially bullet-shape to act as a pressure increasing air-ram. A spark plug 64 is shown as arranged in tube 18 for initially firing a mixture of air and gas passing into the combustion chamber. Valve supports 35, 36 also function as igniter plates which heat upon the initial or first few combustions in engine 10 such that subsequent combustions will be spontaneous and it will not be necessary to further actuate spark plug 64.

Other suitable elements, such as a glow plug, may be used in place of spark plug 64. Heat radiating vanes or fins 66 may be arranged about tube 18 to help pass heat from the hotest spots in tube 18 to the gases in the counter-wave space, or resonance chamber portion, between tubes 16, 18. Further, conventional heat and sound insulation (not shown) may be arranged in a known manner around the forward portion of engine 10.

An engine 10 according to the present invention operates by initially having air from an external source (not shown) blown through opening 55 into nozzle 62. This air, and more to be drawn in by aspiration, passes through nozzle 62, where the pressure is low due to high velocity, and kerosene, gasoline, or other fuel 56 is passed from container 58 through hose 60 and mixed with the air in the venturi formed by nozzle 62. As the mixture is expanded at the downstream side of nozzle 62, the velocity head of the incoming air is converted to pressure, and the mixture is forced through flap valves 28, 30.

A spark is applied at the inside end of spark plugs 64 by, for example, high voltage electricity from a conventional source (not shown). Combustion will start when the mixture is right, it will reach explosion velocity as the pressure rises, the valves 28, 30 will be closed, and a sound wave will be started out of tube 18 toward its open end 40. Some of the gases being pushed out of tube 18 by this sound, or pressure wave are turned back or deflected by annulus 42 and become part of a counter-wave in the space between tubes 16 and 18. This counter-wave will cause air to be drawn into the resonance chamber 14 through ports 30, and valves 34. Not all of the combustion gases, however, are deflected by annulus 42, the remainder flowing through exit port 37. This undeflected portion of gases passes into tailpipe 44, which is advantageously the same length as the counter-wave space — that is, the same length as one-half the length of resonance chamber 14 — and, therefore, will return the wave in phase with the return from the counter-wave. The counter-wave return will pass into tube 18, overshoot, and cause a mixture igniting, pressure buildup at the intake end of tube 18. Additional aspiration is achieved by alternate suctions at valves 32 and 34. The sound wave in tailpipe 44 bounces off that portion of blocking member 24 which cooperates with flap valves 34 to reflectively block end 20 of tube 16, but when the pressure in tailpipe 44 is higher than in downstream smoothing chamber 68, some of the gases pass through ports 48 and valves 50 into smoothing chamber 68. Pressure is stored at near peak sound pressure in smoothing chamber 68 until it can pass out through nozzle 45. It is this air passing out of nozzle 45 which causes a suction inside of chamber 14 and draws additional air into engine 10. Once engine 10 is started, the external air pressure source may be shut down.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to thsoe skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed as new is as follows:

1. A combustion engine, comprising, in combination:

a. a housing forming an enclosed, resonance chamber having a pair of adjacent end portions;

b. a port provided in one of the housing end portions for permitting a fluid to pass into the chamber;
c. valve means associated with the port for closing same during intermittent combustions occurring in the chamber;
d. a further port arranged at the other of the housing end portions and being also provided with an associated further valve means for admitting air into the resonance chamber when a condition of low pressure is present in a portion of the chamber adjacent the further valve means;
e. deflection means provided on the housing and arranged between the chamber end portions for deflecting fluid passing between the chamber end portions; and
f. exit means provided on the housing and arranged between the chamber end portions for permitting combustion gases to exit the chamber.

2. A structure as defined in claim **1,** wherein the exit permitting means is arranged substantially midway between the chamber end portions.

3. A combustion engine, comprising, in combination:

a. a housing forming an enclosed, resonance chamber;
b. an intake port provided in the housing for permitting a fluid to pass into the chamber;
c. valve means associated with the intake port for closing same during intermittent combustions occurring in the chamber;
d. an exit port provided in the housing for permitting a fluid to pass from the chamber;
e. valve means associated with the exit port for permitting a predetermined pressure to open the associated valve means and pass a fluid from the chamber;
f. a tailpipe connected to and surrounding the exit port, and arranged extending from the housing; and

g. a blocking member having a further port and arranged in the tailpipe, and a valve element associated with the further port for making the tailpipe a further resonance chamber.

4. A structure as defined in claim **3,** wherein the housing includes concentrically arranged inner and outer tubes, with adjacent one ends of the tubes provided with ports, and means having the ports arranged in the tubes at the one ends for blocking same.

5. A structure as defined in claim **4,** wherein the tubes have other ends spaced from the one ends, and the other end of the outer tube extends beyond and curves toward the other end of the inner tube and forms an annulus arranged for deflecting gases passing between the inner and outer tubes, the annulus forming the exit permitting means as an opening arranged concentrically with respect to the tubes.

6. A structure as defined in claim **1,** wherein the housing includes concentrically arranged inner and outer tubes, with adjacent one ends of the tubes provided with the ports, and means having the ports arranged in the tubes at the one ends for blocking same.

7. A structure as defined in claim **6,** wherein the tubes have other ends spaced from the one ends, and the other end of the outer tube extends beyond and curves toward the other end of the inner tube and forms an annulus arranged for deflecting gases passing between the inner and outer tubes, the annulus forming the exit permitting means as an opening arranged concentrically with respect to the tubes.

8. A structure as defined in claim **7,** wherein the outer tube is provided with a canopy portion arranged extending from the one end of the outer tube and away from the tubes for forming a chamber having volume larger than a fluid volume passed through the blocking means ports in an engine cycle.

9. A structure as defined in claim **7,** further including a tailpipe connected to a concentric with the annulus, and arranged extending coaxially from the inner and outer tubes.

10. A structure as defined in claim **9,** further including a blocking member having a port and arranged in the tailpipe, and a valve element associated with the port for making the tailpipe a further resonance chamber.

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