Sept. 26, 1950 P. KOLLSMAN 2,523,378

WING-MOUNTED JET REACTION ENGINE FOR AIRCRAFT

Filed Nov. 28, 1945 2 Sheets-Sheet 1

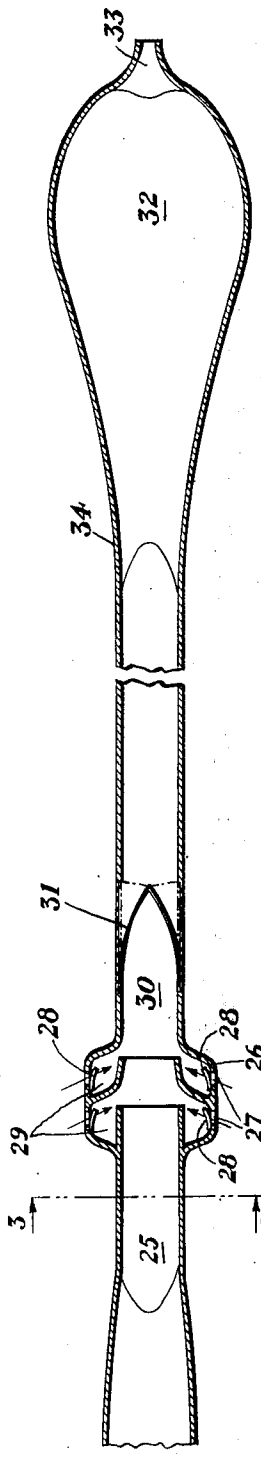


Fig. 2

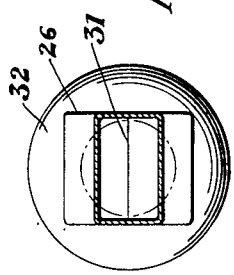


Fig. 3

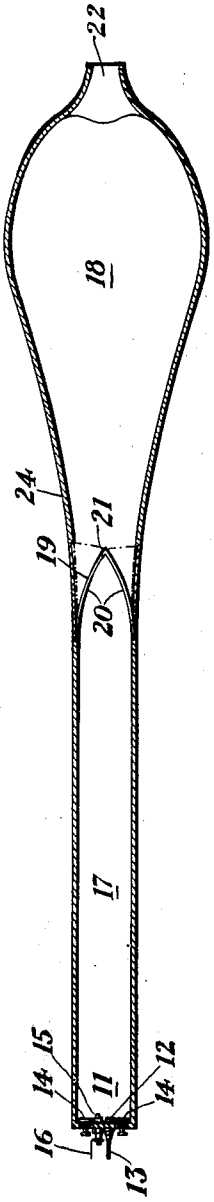


Fig. 1

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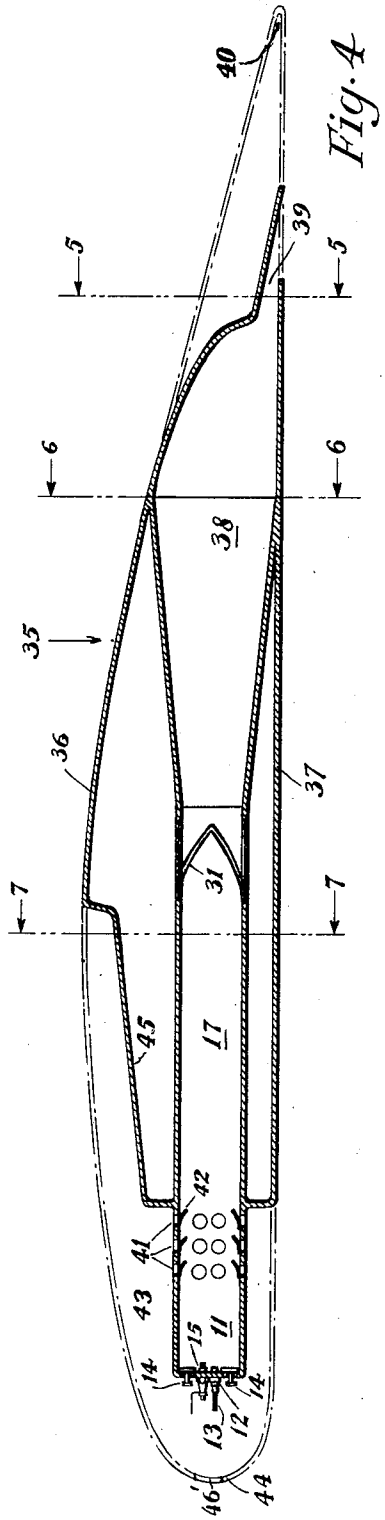


Fig. 4

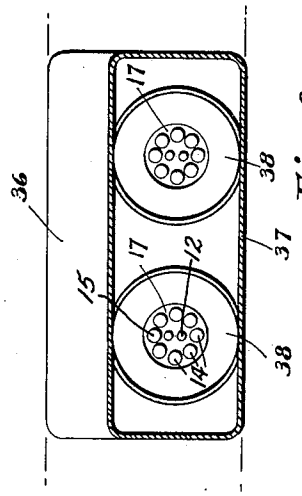


Fig. 6

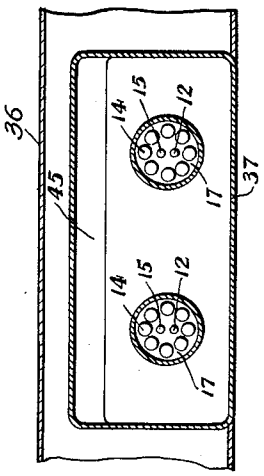


Fig. 7

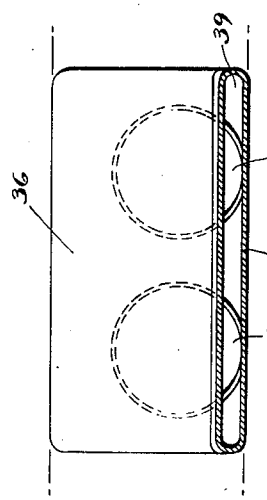


Fig. 5

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WING-MOUNTED JET REACTION ENGINE FOR AIRCRAFT

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Application November 28, 1945, Serial No. 631,363

3 Claims. (Cl. 244—15)

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This invention relates to devices for producing a reactive thrust by pressure fluid discharged at substantial velocities and pressure from a discharge port and has particular application to duct-engines comprising basically a combustion chamber and an adjoining discharge duct through which slugs of pressure fluid are moved by explosions taking place in the combustion chamber.

The efficiency of engines furnishing fluid under pressure for producing reactive thrust depends on the rate of speed at which the pressure fluid is discharged. Under the most favorable operating conditions the rate of discharge of the pressure fluid is equal to or slightly greater than the speed at which the engine moves with respect to the surrounding medium, for example, the surrounding air, into which the discharge jet is directed. If the rate of discharge of the pressure fluid is considerably greater than the speed of the engine, a substantial loss of energy is incurred, generally referred to as loss due to slip. Duct engines or other pressure fluid generators generally produce slugs of pressure fluid travelling at too high a rate for efficient operation. It is therefore desirable to reduce the rate to a figure at which efficient operation is obtained.

It is further desirable to eject a constant flow of pressure fluid from a propulsion nozzle or port rather than individual slugs or bursts in order to obtain a substantially constant propulsion force and to reduce the noise incident to the discharge of individual slugs.

The invention provides means for reducing the rate of speed of slugs of pressure fluid in engines of the above character to a figure at which the pressure fluid is most advantageously discharged and provides in addition means for storing the volume of pressure fluid contained in the plurality of slugs in order to produce a continuous even flow of fluid of equalized pressure adapted to be discharged from a reaction port or nozzle under the most favorable condition.

The objects, features and advantages of this invention will appear more fully from the detailed description which follows accompanied by drawings showing for the purpose of illustration preferred embodiments of the invention.

The invention also consists in certain new and original features of construction and combination of parts hereinafter set forth and claimed.

Although the characteristic features of the invention which are believed to be novel will be particularly pointed out in the claims appended hereto, the invention itself, its objects and advantages, and the manner in which it may be carried out may be better understood by referring to the following description taken in connection with the accompanying partially diagrammatic drawings forming a part thereof, in which:

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Fig. 1 is a longitudinal section of a duct-engine embodying the invention;

Fig. 2 is a longitudinal section of a portion of a pressure fluid generator embodying the invention;

Fig. 3 is a cross section taken on line 3—3 of Fig. 2;

Fig. 4 is a longitudinal section of a multiple duct engine embodying the invention;

Fig. 5 is a section taken on line 5—5 of Fig. 4;

Fig. 6 is a section taken on line 6—6 of Fig. 4; and

Fig. 7 is a section taken on line 7—7 of Fig. 4.

In the following description and in the claims various details will be identified by specific names for convenience. The names, however, are intended to be as generic in their application as the art will permit. In the specification the term "pressure fluid" or "fluid" is used as a generic term comprising both gases and liquid, or, in other words, media of compressible as well as non-compressible character.

Like reference characters refer to like parts in the several figures of the drawings. In the drawings accompanying, and forming part of, this specification, certain specific disclosure of the invention is made for the purpose of explanation of broader aspects of the invention, but it is understood that the details may be modified in various respects without departure from the principles of the invention and that the invention may be applied to other structures than the ones specifically shown.

The duct engine shown in Fig. 1 comprises a combustion chamber 11 provided with a fuel injector nozzle 12 supplied with fuel through a line 13. Automatic inlet valves 14 admit a combustion supporting compressible fluid into the combustion chamber at suitable intervals where it mixes with the fuel injected by the nozzle 12 to form an explosive mixture. The combustion supporting fluid may be supplied to the inlet valves from a suitable source, not shown, and may be precompressed gas or air admitted through the valves from a supply chamber surrounding or adjoining the outside wall or walls of the combustion chamber 11, as shown, for example, in Figure 4, hereinafter described. These details are omitted from the drawing for the sake of clarity. Suffice it to say that the inlet valves 14 automatically operate to admit combustion supporting fluid to the combustion chamber previous to an explosion therein and that the valves automatically close when the pressure inside the combustion chamber exceeds the pressure outside.

The explosive charges in the combustion chamber are ignited by a spark plug 15 supplied with electrical energy from a suitable source not shown through a supply lead 16.

A duct 17 extends from the combustion chamber 11 and leads into an enlarged chamber 18 separated from the duct 17 proper by a check valve 19 shown in the illustrated embodiment as comprising flexible valve members or vanes 20 adapted to separate at 21 when the pressure in the duct 17 exceeds the pressure in the enlarged chamber 18 and to close when the pressure in the chamber 18 exceeds that in the duct 17 to prevent a back flow of fluid from the chamber 18 into the duct 17.

The chamber 18 has a discharge port 22 in one of the walls through which a jet of pressure fluid may be discharged from the chamber 18. The discharge port may be coaxially arranged with respect to the duct 17 as at 22 or may be provided in the side wall at any desired location.

The walls 24 of the enlarged chamber 18 immediately adjoining the end of the duct 17 gradually enlarge in diameter, without abrupt changes, to permit transformation of kinetic energy of slugs of pressure fluid entering the chamber into pressure without causing energy consuming turbulence.

The operation of the engine shown in Fig. 1 is as follows: After an explosive charge has been formed in the combustion chamber 11 the charge is ignited. The explosion causes a slug of pressure fluid to move through the duct 17 at high velocity towards the enlarged chamber and the discharge nozzle 22. The pressure of the slug causes the check valve 19 to open, admitting the slug of pressure fluid into the enlarged chamber. A return or back flow of pressure fluid from the chamber 18 into the duct 17 is prevented by the check valve 19 which closes as soon as the pressure in the duct 17 drops below the pressure in the chamber 18. The tapered walls 24 of the chamber 18 causes a reduction of the rate of travel of the slug while simultaneously permitting an increase in pressure.

The discharge of successive slugs of pressure fluid into the chamber 18 builds up a volume of fluid of high pressure therein. The velocity of the pressure fluid inside the enlarged chamber 18 is relatively low while its pressure is high.

Pressure fluid inside the chamber 18 is continuously discharged through the discharge port 22 in the form of one continuous jet passing through the nozzle at a velocity lower than the average velocity of the individual slugs in the duct 17. The discharge velocity depends on the size of the discharge port or orifice 22, the frequency at which individual slugs enter the chamber 18, and the volume of each slug taken at a certain pressure, the volume depending, in turn, on the volume of the charge exploded in the combustion chamber 11. This is evident that by suitable dimensioning and timing a predetermined rate of discharge of the pressure fluid can be obtained at the nozzle 22 which is most favorable for the condition under which the device is to operate.

Fig. 2 illustrates an application of the invention to a pressure fluid generator provided with means for introducing a volume of a second pressure fluid, such as air, between individual slugs passing through the duct of the generator. The duct 25 through which individual slugs of pressure fluid pass from the generator (not shown) leads to an enlarged valve housing 26 having a plurality of relief ports 27 controlled by valve flaps 28. Pressure fluid entering from the outside through the relief ports 27 enters chambers 29 in the valve housing 26 and thence pass into a continuation duct 30 containing a check valve 31. The check

valve 31 admits pressure fluid from the continuation duct 30 into an enlarged chamber 32 having a discharge port 33. The walls 34 of the chamber gradually diverge to permit gradual reduction of the speed at which the gas goes into the chamber 31 from the continuation duct 30 while simultaneously permitting transformation of kinetic energy of the gas into pressure.

The device shown in Fig. 2 operates substantially as follows: Individual slugs of pressure fluid passing through the duct 25 at relatively high speed tend to lower the pressure in the space behind them which, in turn, causes a reduction in the rate of travel of the slugs and a loss. To prevent such reduction in pressure and in order simultaneously to increase the total volume of pressure fluid traveling through the continuation duct, additional pressure fluid is admitted through the relief valves 27, 28 after each slug. The valve flaps 28 of the relief valves open automatically to admit pressure fluid from the space surrounding the valve housing 26, for example, air, when the pressure inside the valve housing drops to a predetermined point after passing of each slug. Additional pressure fluid is thus admitted into and travels through the continuation duct 30 to enter the enlarged chamber 32 where equalization of pressure, reduction of speed and transformation of energy takes place as described in connection with the engine shown in Fig. 1. Return of fluid from the chamber 32 into the continuation duct 30 is prevented by the check valve 31. A continuous jet of pressure fluid is discharged through the nozzle of port 33 and furnishes motive power by reactive thrust.

A multiple duct-engine embodying the present invention is shown in Figs. 4 to 7. Within the structure of an airplane wing 35 having a top surface 36 and a bottom surface 37 two duct-engines are mounted, one engine being visible in Fig. 4. Each engine comprises a combustion chamber 11 from which a duct 17 leads into a chamber 38, of gradually increasing cross section common to both ducts having a discharge port 39 in the bottom surface of the airfoil near its trailing edge 40. Check valves 31 may be provided in each duct 17.

The combustion chamber is equipped with a fuel injector nozzle 12, automatic inlet valves 14 and a spark plug 15 similar to the engine shown in Fig. 1. The ignition in the two combustion chambers is preferably so timed that explosions take place alternately.

At the end of the combustion chamber 11 proper, or at the end of the combustion area of the chamber 11, relief ports 41 are provided in the wall of the chamber or of the duct 17 controlled by check valve flaps 42. Air is admitted through the inlet valve 14 and the relief ports 41 from a supply chamber 43 in the leading portions of the airfoil, the supply chamber formed by the top and bottom surfaces and the leading edge surface 44 of the airfoil and a back wall 45 in the interior of the airfoil. Air is admitted into the supply chamber 43 through a suitable port 46 which may be located in the leading edge at 46' or elsewhere.

The operation of the embodiment shown in Figs. 4 to 7 is as follows: An explosive charge is formed in one of the combustion chambers 11 from fuel injected by the nozzle 12 and air admitted through the inlet valves from the air supply chamber 43. The charge is ignited causing a slug of pressure fluid to travel through the duct 17 tending to create a suction area in its wake. The reduced pressure following the path of the

slug causes the relief check valves 42 to open to admit an additional volume of air into the duct to prevent or reduce retardation of the slug of pressure fluid by reduced pressure and also cooling the check valve 31. The slug and the additional air admitted through the relief check valves 42 pass through the check valve 31 into the common chamber 38 where a reduction of the speed of the slugs and an increase of pressure takes place as mentioned in connection with the previously described embodiments. In the meantime an explosive charge is formed and exploded in the second unit which likewise discharges fluid into the common chamber 38, the two duct-engine units operating alternately. A continuous jet of fluid of predetermined pressure is discharged from the common chamber 38 through the discharge port 39 and propels the air foil by reactive force.

The invention thus provides an effective means for increasing the efficiency of duct-engines by appropriate reduction of the rate of discharge of pressure fluid from the engine resulting in corresponding reduction of losses due to slip. In addition it provides equalized continuous propulsion thrust and reduction of noise due to elimination of individual discharges or bursts of pressure fluid from the engine nozzle. The invention also provides a multiple duct-engine supplying jointly one or several discharge ports with pressure fluid.

Obviously the invention is not restricted to the particular specific embodiment herein shown and described. It is susceptible of various modifications and adaptations. The invention is of course applicable to duct-engines in which the succession of explosions is timed by periodic controlled admission of fuel or controlled formation of combustible charges, in distinction from the illustrated forms of engines in which the combustions are controlled by the ignition system. More than two engine duct units may of course be combined to cooperate with one joint chamber or the chambers of several individual units be interconnected to produce the same result as accomplished by the invention. Various additions and modifications may be made according to specific requirements, for example, check valves may be omitted from the ducts or other forms of relief valves or relief means used than the ones shown.

All such and other modifications, changes, additions, omissions and substitutions may be made by persons skilled in the art without departure from the essence of this invention.

What is claimed is:

1. An intermittent duct engine for aircraft comprising, in combination, a plurality of combustion chambers; a common air supply chamber in heat exchanging relationship with said combustion chambers, surrounding said combustion chambers, and forming the leading portion of an airfoil, said air supply chamber communicating with the atmospheric air through an intake port in the leading edge of said airfoil portion; admission valves in the head of said combustion chamber for controlling the admission of combustion air under dynamic pressure from said supply chamber into said combustion chambers; means for introducing and igniting in said combustion chamber fuel charges in timed relationship; a duct associated with and rearwardly extending from, the head of each of said combustion chambers through which duct slugs of pressure fluid are moved by the explosion of said charges; a common storage chamber into which said ducts

open, and walls of said storage chamber adjoining the ends of said ducts being divergent with respect to said ducts to provide a path of gradually increasing cross section to slugs of fluid entering from said ducts; and a discharge port directed towards the trailing portion of said airfoil through which fluid is discharged from said common storage chamber.

2. An intermittent duct engine for aircraft comprising, in combination, a plurality of combustion chambers; a common air supply chamber in heat exchanging relationship with said combustion chambers, surrounding said combustion chambers and forming the leading portion of an airfoil, said air supply chamber communicating with the atmospheric air through an intake port in the leading edge of said airfoil portion; admission valves in the head of said combustion chamber for controlling the admission of combustion air under dynamic pressure from said supply chamber into said combustion chambers; means for introducing and igniting in said combustion chambers fuel charges in timed relationship; a duct associated with each and rearwardly extending from, the head of each of said combustion chambers through which slugs of pressure fluid are moved by the explosion of said charges; relief check valves in said ducts rearwardly with respect to said admission valves, said relief check valves being responsive to the difference in pressure between said supply chamber and said ducts for automatically admitting air into said ducts if the pressure in the supply chamber exceeds the pressure in the respective duct; a common storage chamber into which said ducts open, said storage chamber being in the trailing portion of said airfoil, the walls of said storage chamber adjoining said ducts being divergent with respect to said ducts to provide a path of gradually increasing cross section to slugs of fluid entering from said ducts; and a discharge port directed towards the trailing portion of said airfoil through which fluid is discharged from said common storage chamber.

3. An intermittent duct engine as set forth in claim 2 in which a further check valve is provided in each of said ducts, said further check valve being responsive to the difference in pressure between the respective duct and said common storage chamber for preventing back flow of fluid from the storage chamber into the duct if the pressure in the duct drops below the pressure of the storage chamber.

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