

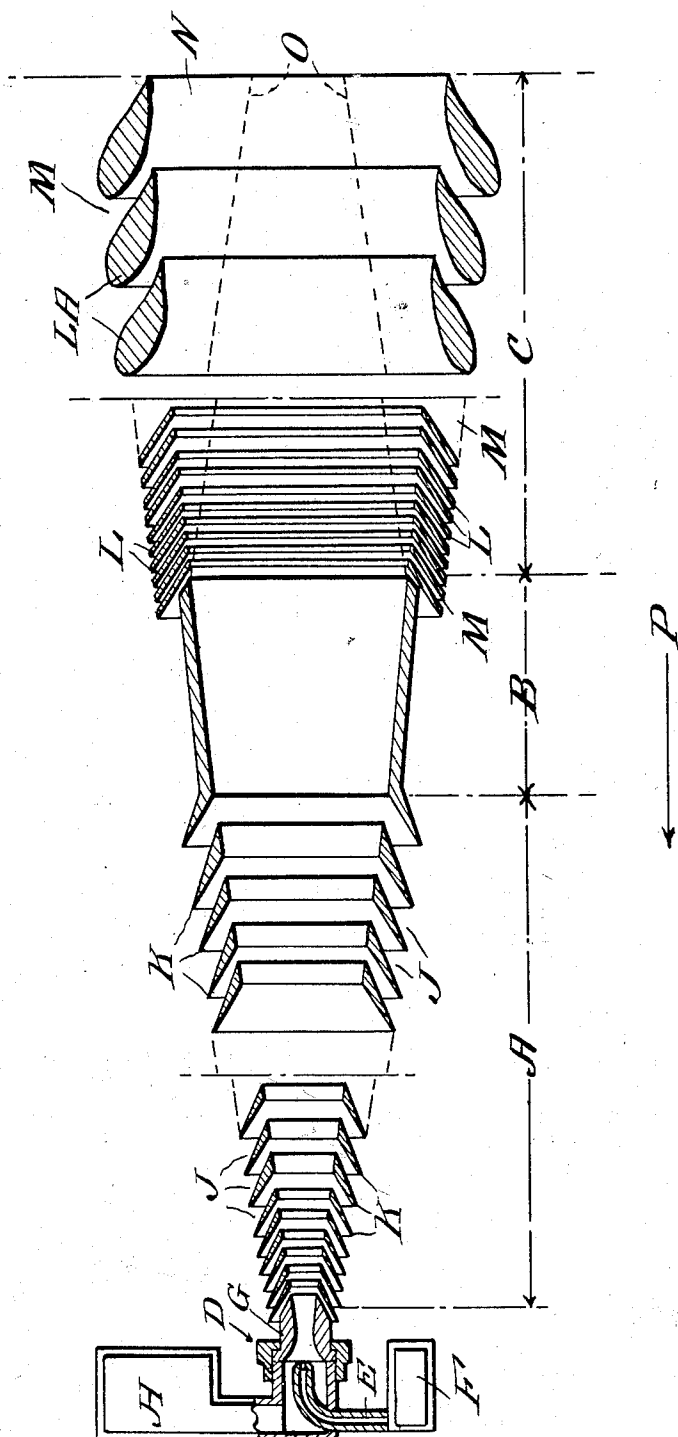
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REACTION PROPULSION ENGINE

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REACTION PROPULSION ENGINE

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1 Claim. (Cl. 60—35.6)

This invention relates to engines of the class wherein the work performed is manifested as a reactive response to the expansion of a gas within an open chamber forming a part of the engine. Examples of engines of the class referred to are the common rocket and the gas turbine, and the present invention has been devised with the object of providing such an engine wherein the operative cycle (and hence the thermal efficiency) more nearly approaches that of an ideal heat engine cycle, such as that due to Carnot, than is the case with known engines of like kind.

According to this invention, efficiency is gained by the provision, in a reaction propulsion engine handling a working fluid other than steam, of means whereby the working fluid is enabled to expand substantially adiabatically to a pressure and temperature below those of the surrounding atmospheric medium, and then be compressed substantially isothermally to a pressure not less than that of the medium in order that it may discharge thereinto.

The isothermally compressing means which mainly form the subject hereof consist of a trunk having one end opening to the exhaust end or port of an engine, and the other end open to the atmosphere in which the engine is operating. The compression is accomplished by the admission of relatively cool "atmosphere" into the trunk through inlet apertures therein thus reducing the high velocity of the working fluid, produced by the preceding expansion and counteracting the temperature rise due to the compression of the medium, thus keeping the compression substantially isothermal.

The single figure of the accompanying drawing is a purely diagrammatic sectional representation of a preferred form of an engine incorporating the present invention. The figure is divided into three main portions as indicated by spans A, B and C. Portion C, by itself, illustrates an isothermal compression trunk which is applicable to an adiabatic zone which may consist of an open ended sleeve or rocket-like casing such as B.

Portions B and C together illustrate a rocket-like application of the invention in which the small end of the sleeve may receive its isothermally expanded working fluid from any convenient source.

Portions A, B and C together illustrate a rocket-like application of the invention which includes an isothermal expansion zone A constituted by a combustion chamber which is furnished with means for the establishment there-

in of a continuous stream of working fluid, and which is shaped and arranged to enable substantially isothermal expansion of said fluid up to the point where it enters the adiabatic expansion sleeve B.

In the illustrated arrangement the portion A has a "closed" small end D which is furnished with liquid fuel jet E fed by any known form of fuel pump indicated at F. Air or other oxidising agent for combustion is supplied to nozzle G by a known form of compressor indicated by H. Portion A has a multiplicity of ports J for entrance of compressed air or atmosphere, extra air being sucked through said ports by injector effect due to the velocity of the throughgoing working fluid. The ports J are preferably completely circumjacent to the chamber as indicated in the drawing, and in such case the chamber consists of a plurality of ring-like bodies K which are held in fixed relative positions by any suitable mechanical expedient.

The divergent sleeve B, apart from its open ends, is completely closed. Working fluid fed to the small end of sleeve B may be delivered thereto from any convenient pressure source, but for preference it arrives at the sleeve as the exhaust of an isothermal expansion zone such as A. The sleeve B extends into the trunk portion C which is constructed as a series of ring-like bodies L, in like manner to portion A. The rings L, between them define annular inlet apertures or ports M through which cool atmospheric air may enter the trunk incrementally along the full length thereof and thus effect a gradual pressure rise of the throughgoing working fluid. An ideal condition would obtain if the incremental atmospheric air additions were infinitely small in volume and infinitely large in number; in practice this condition can only be approached with more or less rough approximation by admitting atmospheric medium to the trunk at one or more points intermediate of the ends thereof. The rings K and L are preferably of streamlined or aero-foil cross-sectional shape as indicated by rings LA in order to minimise power losses due to skin friction, eddies, turbulences and the like.

Air is compressed by the compressor H to an extent such that its temperature exceeds the ignition temperature of the fuel to be used. This compression is adiabatic or as nearly so as is practically attainable; alternatively, and less preferably, the compression is at constant pressure or constant volume or otherwise.

The compressed air meets the fuel at the entrance to the nozzle G. The rate of fuel delivery

to nozzle G is greater than that which would just furnish sufficient fuel to completely react with the incoming air, and consequently combustion continues within zone A, being supported by air which enters the trunk by way of ports J.

The working fluid resulting from incomplete combustion commences expansion within the nozzle G and gains velocity as it passes into the zone A. Air is thus drawn into the zone through the ports J by injector effect and the augmented working fluid loses velocity in so doing. The newly entered air reacts with the unused fuel and thus effects a further expansion. This expansion is controlled by the inlet area of the ports J and the variation of the cross-sectional area of the zone A so that the expansion is performed approximately as an isothermal expansion along the zone A. In this manner the velocity that would be lost by the addition of the entering air is regained in the isothermal expansion and the augmented or second working fluid is formed.

The second working fluid continues expansion within the zone B. The variation of the cross-sectional area of this zone B is such that the expansion therein is substantially adiabatic and the second working fluid gains further velocity accompanied by loss of pressure. This expansion is carried to a degree such that the second working fluid in the vicinity of the large end of the zone B is at a pressure below that of the surrounding atmosphere.

The second working fluid enters the trunk C and by injector action draws atmosphere through the ports M thus creating a third working fluid which loses velocity and gains pressure as it proceeds along the trunk towards the open end N. The variation of the cross-sectional area in the trunk, and the atmospheric additions through ports M, are such that compression of the second working fluid (which is now a dispersed ingredient of the third fluid) occurs approximately isothermally. This isothermal compression of the second working fluid progresses the cycle through the next sequential stage of the Carnot cycle, and the compression may be represented by the dotted lines O.

The reactive thrust due to the expansion in zone B plus the pressure rarefaction about the frontal surfaces of the rings L causes motion of the apparatus in the direction of arrow P relative to its surrounding medium.

Although the invention subject hereof has been described with respect to an engine intended to operate in substantial conformity with the Carnot cycle, it will be appreciated that the engine may be designed to operate in accordance with other heat engine cycles. For example the transverse area variations of the first zone may be so arranged that the working fluid expands approximately at constant pressure in that zone.

What I claim is:

A reaction propulsion engine comprising a chamber defining a divergent first zone having its small end closed and its large end open and having side openings for admission of a fluid fuel ingredient thereinto, means for directing an axial stream of working fluid ingredients into said first zone from the closed end thereof, said means and said side openings and the divergence of said first zone being such that working fluid formed in said first zone and passing towards the open end thereof expands isothermally; an expansion zone consisting of a divergent open ended sleeve having its small end open to the large end of said first zone, and in which the divergence is such that working fluid passing through said sleeve from said first zone and towards the large end of said sleeve expands substantially adiabatically to an extent such that its pressure on arrival at the large end of said sleeve is less than that of the atmosphere externally of the engine; and a divergent trunk having its small end open to the large end of said sleeve and its large end open to atmosphere, said trunk having side openings therein for admission of atmosphere increments thereto, the side openings in said trunk and the divergence of said trunk being such as to enable entering atmosphere increments to effect a substantially isothermal pressure rise in working fluid passing from said sleeve and through said trunk towards the large end thereof.

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