PATENT SPECIFICATION

439,805

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(One Complete Specification Left under Section 91 (2) of the Patents and Designs Acts, 1907 to 1932.)

Specification Accepted: Dec. 6, 1935.

COMPLETE SPECIFICATION

Improvements in Jet Propulsion Apparatus for Aircraft, Projectiles and Turbine Apparatus

I, RENÉ LEDUC, of 3, Avenue Gabriel Dupont, Le Vesinet-Seine-et-Oise, France, French Nationality, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to a process for transmitting to a fluid a kinetic or potential energy without the help of a compressor or of mechanical means.

Said process consists in submitting a fluid, during its passage through a nozzle of convenient section, to variations of temperature and of velocity (and consequently of pressure and of volume) such as may be expressed in the diagram representing the evolution, by a cycle whose area corresponds to the thermal energy transformed into kinetic or potential energy.

Particularly, an expansion of the fluid heated up to a high temperature may be produced into the nozzle and followed by a compression at a low temperature, said compression being intended to bring the fluid back to the initial pressure.

When the device moves in a fluid, for example air, the latter—still cold—is first subjected to compression in consequence of the divergent form of the nozzle. At the end of said compression it receives an accession of heat units, especially by means of burners, which raise it to a high temperature, and is then expanded, owing to the convergent form of the nozzle; and is finally evacuated.

The hot gases, prior to expulsion, preferably pass into contact with a source of cold, in order to improve the yield; and the heat units thus recovered may be utilised over again, for pre-heating the fluid.

It has previously been proposed to construct a jet-propelled projectile provided with a passage therethrough having a section which diverges rearwardly to a combustion region and then converges steeply to a throat before discharge through a flared exit, the combustion region being maintained by a fuel nozzle.

In order to improve the efficiency of the nozzle of the present invention, the fluid streams are prevented from getting off from its walls by forcing a sheet of fluid under high speed and in a direction substantially tangential to said walls.

The present invention may be applied in various fields. When applied to aerial propelling purposes the cold source may be suppressed. In case of application to gas turbines, the hot sources are placed in the blading located at the periphery of the wheels revolving at high velocity, either in moving blades or in blades fixed with respect to the moving blades.

In order that the invention may be fully understood, it will now be described with reference to the accompanying drawings, in which:—

Figs. 1 and 2, 3 and 4, 5 and 6 are diagrammatic views illustrating respectively three examples of the thermal functioning of arrangements of the kind forming the subject of the invention.

Figs. 7, 8 and 9 are partial views of the inner wall according to the invention.

Figs. 10 and 11 represent views of a nozzle provided with supporting planes.

Fig. 12 shows a nozzle applied to aircraft wings or projectiles.

Figs. 13, 14 and 15 show various applications to gas turbines.

In order to facilitate the understanding of the invention, the example of the evolution of one kilogram of fluid into a nozzle constructed according to the invention will be first described with reference to Figs. 1 and 2.

Between 0 and 1 the hot source brings

an amount of heat Q_1, the pressure, the velocity and the temperature varying from p_0, V_0, T_0 to p_1, V_1, T_1; the diagram is based upon the assumption that $p_0=p_1$; the specific volume also varies from V_0 to v_1.

Between 1 and 2, the fluid will expand from p_1 to p_2 according to a polytropic law; the fluid then reaches the section 2—3 of the nozzle where an amount of heat Q_2 is removed by the cold source, thus causing the specific volume of the fluid to vary from v_2 to v_3, its temperature falling from T_2 to T_3 and its pressure from p_2 to p_3; the diagram is based on the assumption that $p_2=p_3$.

By reason of the form of the nozzle between 3 and 4, the fluid is compressed according to a polytropic law and the pressure raised from p_3 to p_4. The diagram is based on the assumption that $p_4=p_0$. The fluid is introduced into the nozzle at the velocity V_0 and leaves the same at the velocity V_4, carrying away an amount of heat such as Q_3.

The area formed by the cycle 1, 2, 3, 4 (Figure 2) represents the amount of energy available in the course of the evolution and it is shown that such energy is integrally transformed into kinetic or potential energy.

It is consequently possible, without compressor, to communicate kinetic energy to a fluid.

The section of the nozzle may be such as shown in Figure 3, in the case in which the said nozzle moves into a fluid with a sufficiently high velocity V_0; the evolution of the fluid is then as follows (see Figure 4): between 0 and 1, the fluid is compressed from p_0 to p_1; between 1 and 2, the hot source brings the amount of heat Q_1 thus causing the specific volume of the fluid to vary from v_1 to v_2, while its temperature rises from T_1 to T_2; between 2 and 3 the fluid expands from p_2 to p_3; the diagram is based on the assumption that $p_3=p_0$.

It will be understood that the nozzle shown in Figure 3 may be combined with the nozzle shown in Figure 1; a composite device is thus obtained which is shown in Figure 5 and which may be used when the nozzle moves into the fluid under a reduced velocity V_0. For this case, the diagram (pv) is shown in Figure 6.

The invention is particularly intended for the cases of flight at high altitudes and high velocities, since it enables to avoid the use of any of the motor driven compressors which have hitherto been used in order to make up for the low pressure of the air at such high altitudes.

According to the present process, the propulsion is obtained by means of the nozzle; the thrust corresponds to the variation in the quantity of motion between the inlet and the outlet.

The hot source may be constituted by a hot radiator or more advantageously, when air is the operating fluid, by burners placed into the nozzle.

A cold radiator may be used as a cold source, the heat being removed outside either directly or by means of an intermediate fluid.

The sections of the nozzle in which expansion takes place generally have a very high efficiency so that it may be assumed that its value is equal to unit. In the sections of the nozzle corresponding to a compression, the efficiency is generally lower. The losses are especially due to the fact that the fluid does no more follow the walls of the diffuser, but is detached from them, thus producing whirling motions.

The fluid may be contrived to follow the walls of the diffuser by blowing at high speed very thin sheets of fluid tangentially with respect to the walls. In order to obtain the said result, the fluid is taken in the section where the pressure is higher and carried by means of conduits of proper size to the place in which a sheet of fluid has to be blown. In this way the layer which is nearest to the nozzle is not detached from its walls neither in the place in which blowing is accomplished nor where suction takes place. Blowing will be performed in a fore and aft direction, so that the potential energy contained in the fluid may be recovered.

In Figure 7 is shown the construction of a nozzle intended to prevent the detachment of the nearest inside layer. The air intake openings 8, which are for instance of circular section, draw the above mentioned layer in the section of the nozzle where the pressure is highest and by means of conduits such as 9, the fluid flows into circular nozzles 10 provided in a lower pressure zone where the energy of the fluid sucked at 8 is recovered while the nearest layer is blown.

In Figure 8 such layer is everywhere prevented from detaching from the walls by suction through intakes or nozzles such as 11: in order to recover the energy of the fluid, the same is thrown backwards and outside through circular openings 12 placed in lower pressure regions, the suction and the blowing actions being both performed through said openings.

In the case of Figure 9, referring to the section of the nozzle in which the fluid is subjected to a pressure which is lower than the outdoor pressure, the scope of the invention is attained by providing a suction through circular openings taking the fluid at the outer surface and leading said fluid to the inner surface by means of openings or nozzles 14 and thus recovering the energy of the fluid.

The blowing holes preferably consist in annular slots extending over all or part of the periphery of the nozzle.

In Figure 10 a nozzle 1*a* is provided at the rear part of a gas tight cock-pit 2*a* containing the passengers, the equipment and the freight. Such cock-pit may be fed with air at the normal pressure, either by means of compressed air stored in containers, or by a small volumetric or centrifugal compressor driven by a turbine or a motor connected to the diffuser. Other means may still be used, such as oxygen or liquid air or any chemical reaction evolving oxygen. The burners 3*a* constitute the hot source, they are fed with fuel forced by means of air pressure or by a volumetric or centrifugal pump driven by a turbine or a motor which may be the same as the driving means provided for the air compressor. The fuel flows first in the radiator 4*a* acting as the cold source and is vaporized in order to facilitate combustion. The landing carriage consists of a skid bar 5*a*.

Figure 11 shows at 6*a* the inlet section of the nozzle 1*a*, the wings 7*a*, supported by the stays 8*a*, and the skid bar 5*a*.

Circular blades such as 9*a*, intended to guide the fluid streams and to improve efficiency, may be placed in any convenient part of the nozzle.

A turbine or motor driven propeller, which will be described below, may be provided only for starting purposes and not to act as a compressor. Said propeller may be placed in the nozzle directly upstream with respect to the hot source and will be stopped for the ordinary flight of the aircraft.

Starting may also be performed by other means such as catapult process or by means of a trailing aircraft.

In Figure 12 which concerns an air-craft wing or a projectile, the spindle shaped body 26 is provided with a nozzle 27 and with a hot source 28. The fluid is fed into the nozzle by the slots 29 and is discharged at 30. The shape of the nozzle 27 and of the rear part of the spindle-shaped body 26 are determined in such a way that the slot 29 will be maintained below the external pressure, the fluid being consequently sucked in the front part of the body 26 and thus preventing the impact waves to be generated.

Another very interesting embodiment of the invention consists in transforming the thermal energy of gas turbines, with continuous output, and without cooling, operating at low temperature (below 932° F. in the combustion chamber).

In some cases, particularly for boats and aeroplanes propelling, or for the aircraft starting device which is the object of the invention, the overall efficiency is not as important as is weight, simplicity of construction and of assembly. In such cases the overall thermal efficiency may be as low as 17%, and this value is easily obtained through a further feature of the invention, by providing (Figures 13 and 14) a plurality of nozzles such as 31, without cold source, said nozzles being placed side by side and inclined upon the axis of rotation, at the periphery of a high speed revolving wheel 32. The diffuser 33 may be placed radially, so that the air inlet is preferably accomplished on a radius R_1 smaller than R_2, thus decreasing the losses. The hot source is constituted by the burners 34, supplied with fuel through the conduits 35 connected to the hollow shaft 36. The fuel may be sprayed in the radiator 37 which is swept by the exhaust gases. The heat removed by the gases may be recovered, for instance for heating boilers.

In another embodiment of the invention shown in Figure 15, the burners 38 are stationary, and the fuel vapour is projected at the peripheral speed of the wheel. In this case the construction of the wheel is simpler.

The present invention differs from those hitherto known in that:

1°) the nozzles are placed upon the whole periphery of the wheel.

2°) the air is heated by fixed or moving burners, both compression and expansion taking place upon the same wheel.

3°) the temperature of the combustion chamber is below 500° C. there is consequently no cooling to provide.

The invention comprises as new industrial products the aircrafts, turbines, projectiles and like devices constructed according to the present invention.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Apparatus for transforming calorific energy into kinetic energy, comprising a nozzle and means for varying the temperature and velocity in said nozzle in accordance with a cycle, the nozzle having rearwardly divergent sections immediately upstream from a source of heat and convergent directly afterwards, and comprising passages in the walls of the nozzle between zones in which different pressures exist, with the object of preventing separation of the streams of fluid.

2. Apparatus according to Claim 1, in

which the nozzle is associated with supporting means such as wings.

3. Apparatus according to Claim 1, in which the nozzle comprises a compression zone, a source of heat, and an expansion zone, a source of cold and a compression zone.

4. Apparatus according to Claim 1, in which circular blades intended to guide the fluid streams are provided inside the nozzle.

5. Apparatus according to Claims 1 and 2 comprising a nozzle and means for varying the temperature and velocity in said nozzle in accordance with a cycle, the nozzle having rearwardly divergent sections immediately upstream from a source of heat and convergent directly afterwards, the variations of section in the nozzle being obtained by combination of the inner wall of same and the outer wall of a central streamlined body such, for example, as a pilot's cabin.

6. Apparatus according to Claim 1, in which the source of heat is constituted by burners.

7. Apparatus according to Claim 1, in which the nozzle is provided with a compression zone, a hot source and an expansion zone comprising radiators for cooling.

8. Apparatus according to Claim 1, in which the nozzle is provided with a compression zone, a hot source, an expansion zone provided with radiators and means for reutilizing the heat recovered in said radiators, for preheating upstream with respect to the hot source.

9. A turbine incorporating nozzles, each of which has means for cyclically varying the temperature and velocity of flow in said nozzle comprising a rearwardly divergent section immediately upstream from a source of heat followed directly by a convergent section.

10. Apparatus as claimed in Claim 9 in which the nozzles are fixed.

11. Apparatus as claimed in Claim 9 in which the nozzles are carried on the turbine rotor.

Dated this 6th day of June, 1934.

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London, W.C. 1,
Agents for the Applicant.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1936.

Fig_1

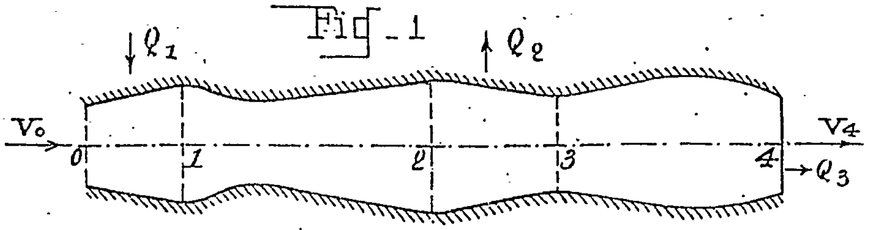


Fig_2

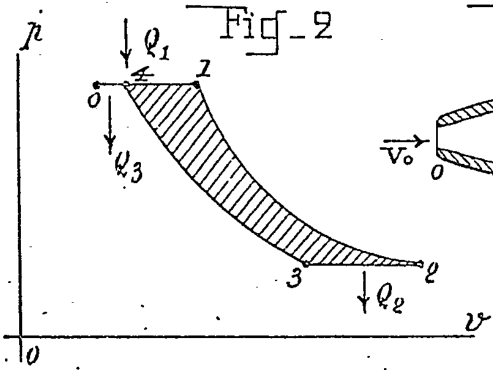


Fig_3

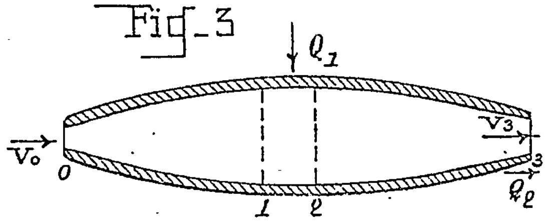


Fig_4

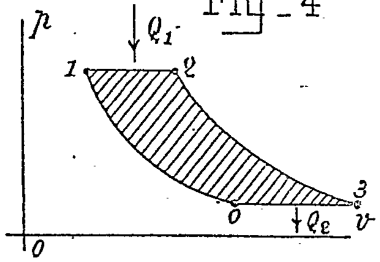


Fig_5

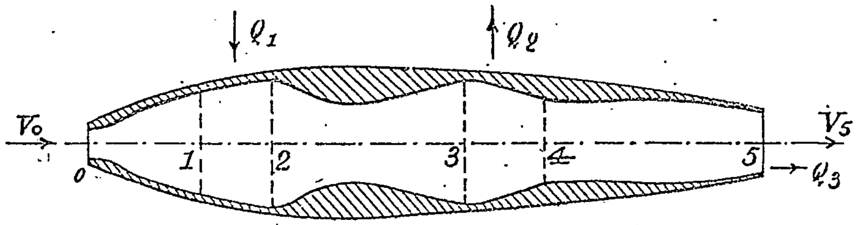
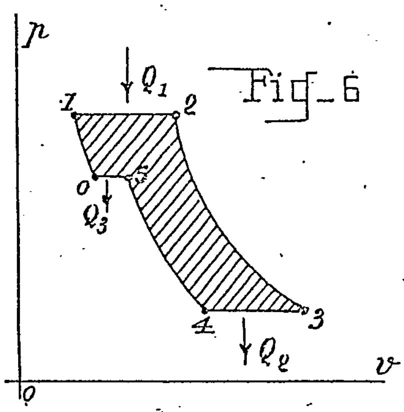


Fig_6



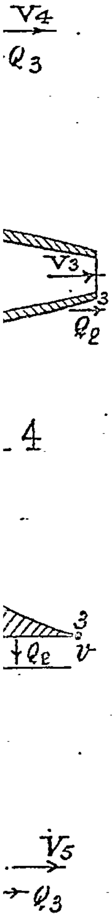


Fig. 7

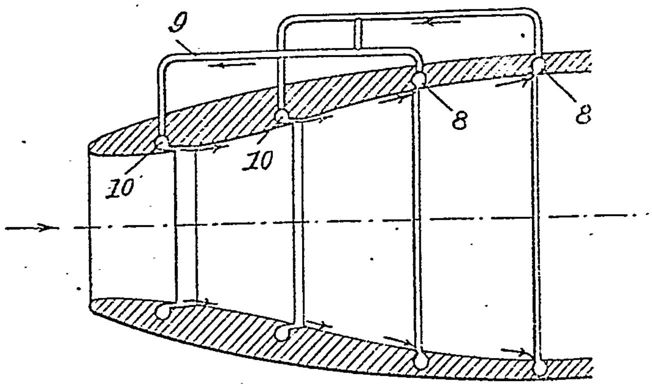


Fig. 8

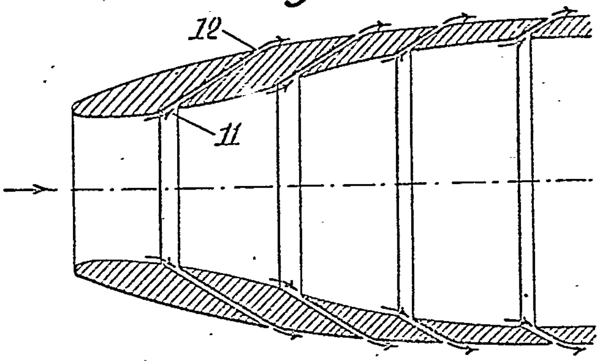


Fig. 9

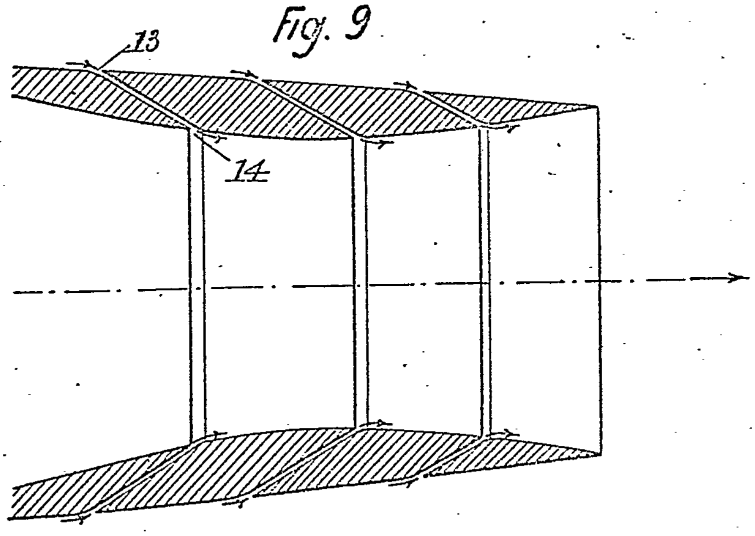


Fig_1

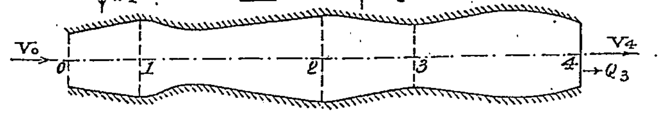


Fig_2

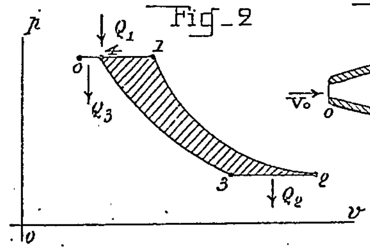


Fig_3

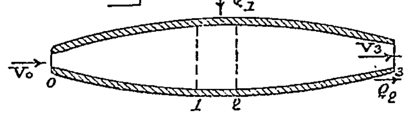


Fig_4

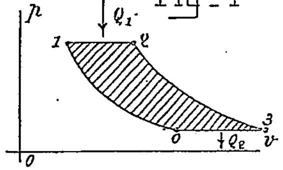


Fig_5

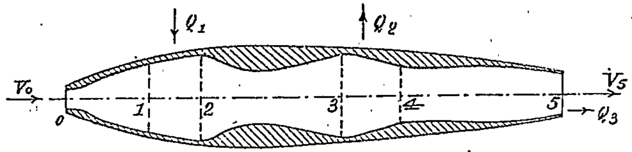


Fig_6

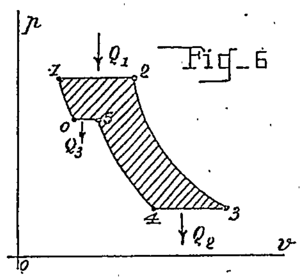


Fig. 7

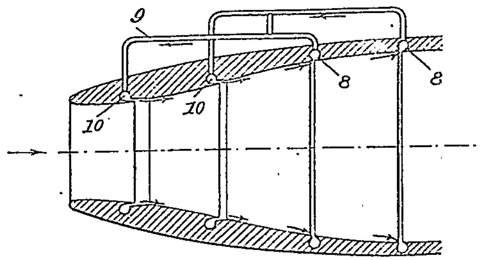


Fig. 8

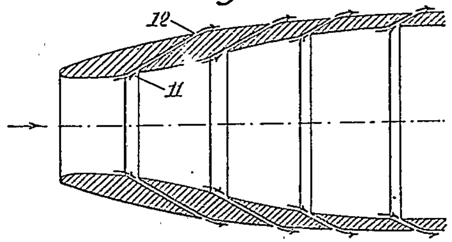


Fig. 9

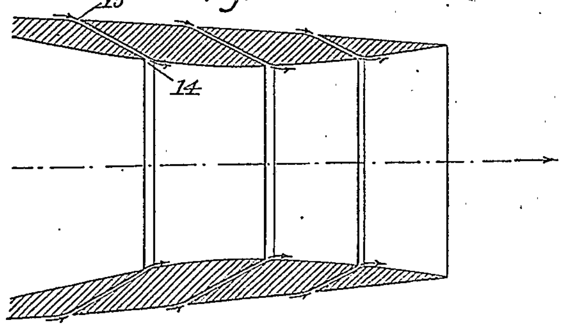


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Fig. 10

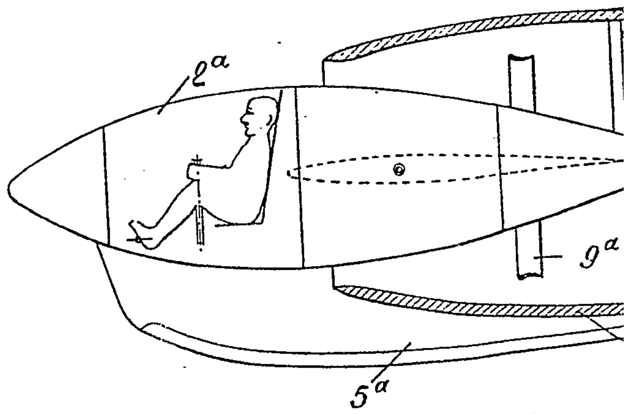


Fig. 11

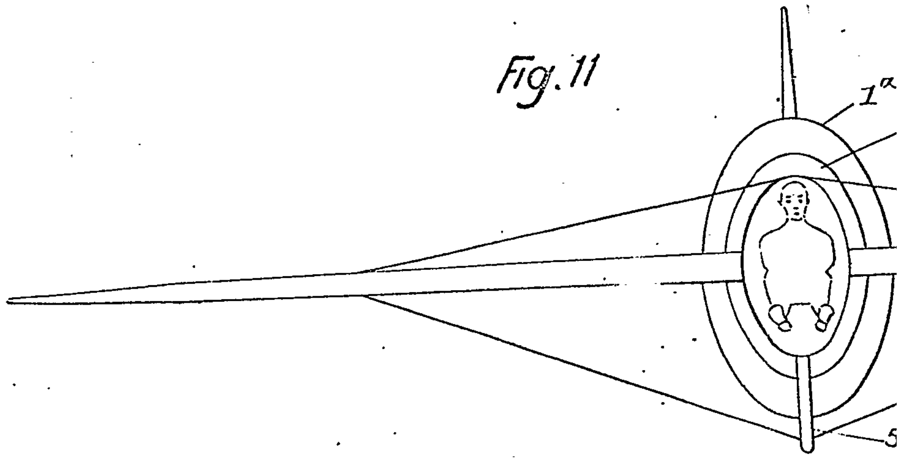
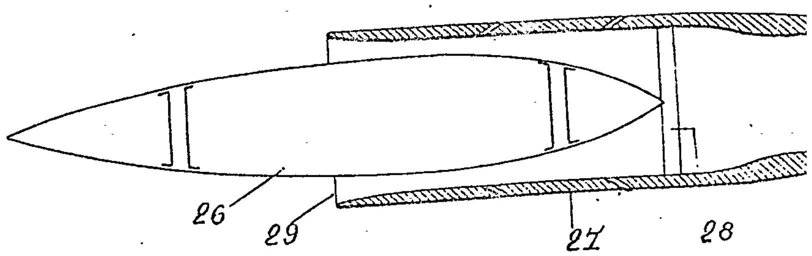
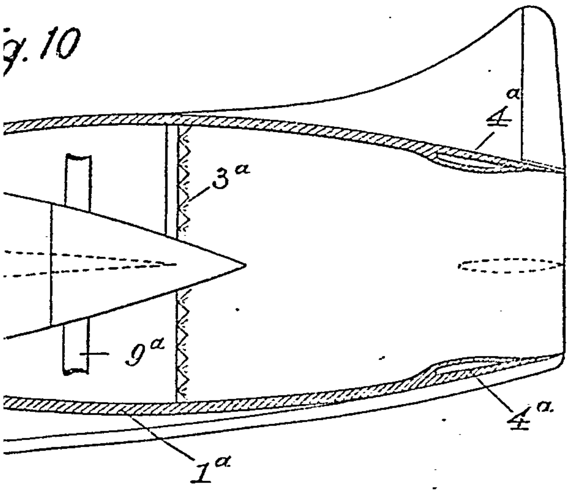


Fig. 12.



g. 10



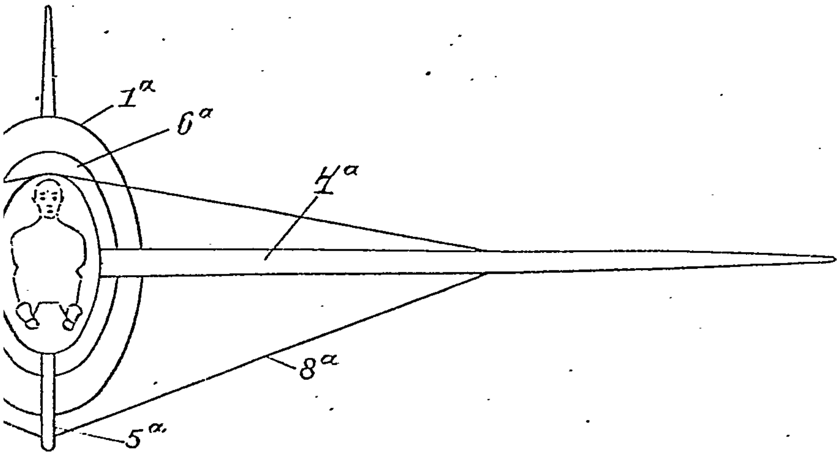
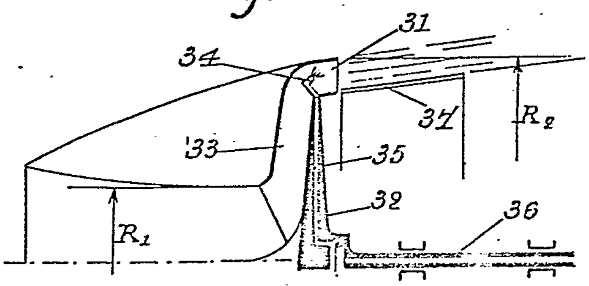


Fig. 13.



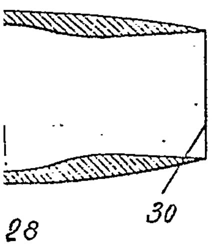


Fig. 15.

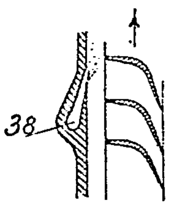
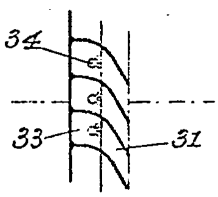


Fig. 14.



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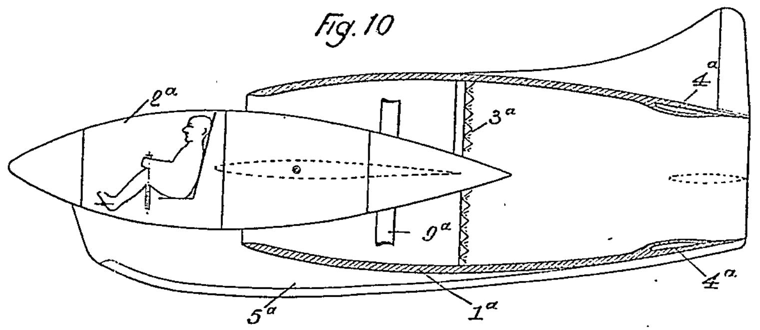


Fig. 11

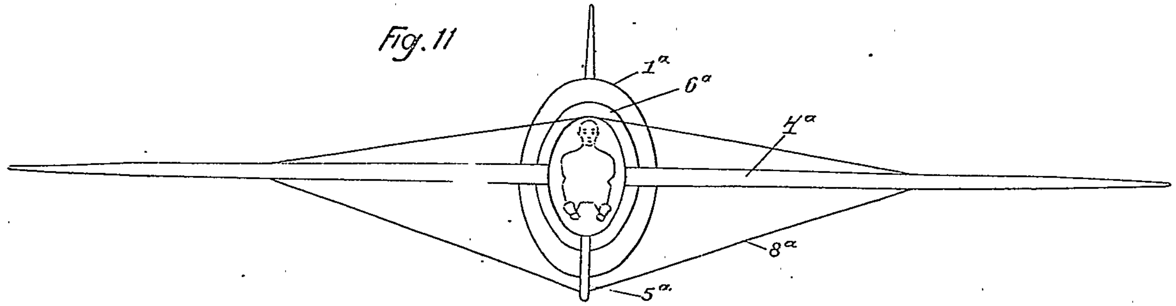


Fig. 12.

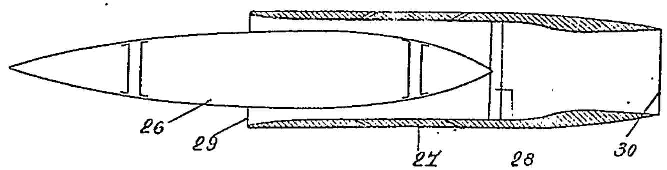
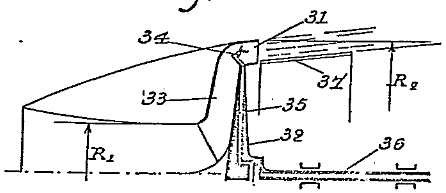


Fig. 13.



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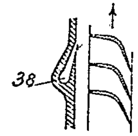

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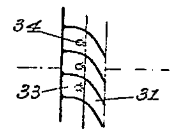

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