

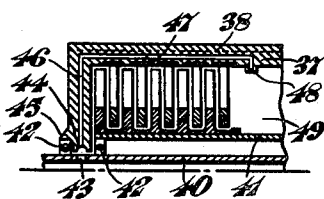
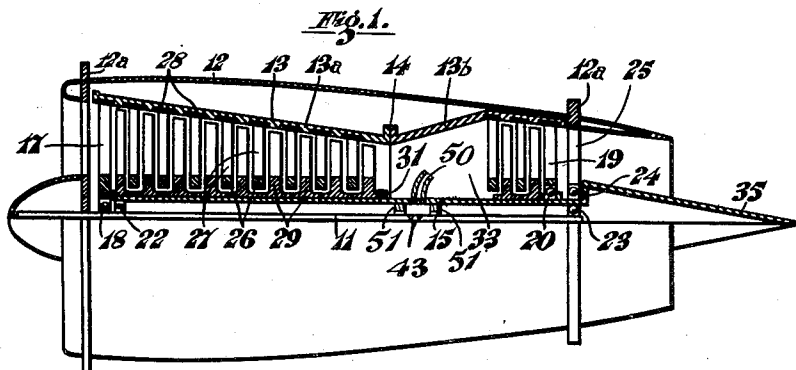
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HIGH SPEED PROPULSION PLANT

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HIGH-SPEED PROPULSION PLANT

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This invention relates to a high-speed propulsion plant, particularly for an aircraft, of the kind consisting of an axial-flow, contra-rotating compressor and internal-combustion turbine with a combustion chamber between them, the exhaust of the turbine giving a direct reaction drive. No mechanical energy need be taken from the plant, the turbine being of sufficient size merely to operate the compressor. Preferably the air flows continuously through the plant, the combustion chamber being an annular one arranged to interfere with the flow as little as possible.

My main object is to provide a more efficient plant of this kind.

A further object is to provide a single outer shell which carries the whole of the outer turbine blades and part at least of the outer compressor blades. The shell is preferably waisted along the compressor towards the combustion chamber in order to cope with the different volume of air being dealt with along the length of the compressor. As a matter of convenience, the shell is conveniently formed of two main parts joined to one another in a transverse plane, preferably in the vicinity of the combustion chamber.

A further object is to arrange a single inner rotor which provides substantially the whole of the inner rotary portion of the turbine and of the combustion chamber, and part at least of the inner rotary portion of the compressor. The two rotors, that is, the shell and the inner rotor, may be journaled through ball-bearings or other anti-friction means upon a stationary shaft.

In the accompanying sheet of diagrammatic drawings:

Figure 1 is a part-sectional elevation of one form of high-speed propulsion plant according to the invention;

Figure 2 is a fragmentary sectional view of a modified form of compressor showing one method by which fuel can be delivered to the combustion chamber; and

Figure 3 shows, to a larger scale, three blades in cross-section of the first row of turbine blades.

In the construction shown by Figure 1, there is a stationary shaft 11 supported from a stationary cowling 12 within the interior of which the plant is arranged. This consists of a single outer shell 13 built up in two parts 13a, 13b the adjacent edges of which are flanged, as shown at 14, and bolted or otherwise secured to one another, and of a single inner rotor 15 which is hollow. The outer shell 13 is supported, in this instance, through the front ring 17 of compressor blades from the shaft 11 by means of a ball-bearing 18,

and at its rear end from the rear row 19 of turbine blades through a ball-bearing 20 from the inner rotor 15. The latter is directly journaled upon the shaft 11 through ball-bearings 22, 23, and it is in addition journaled through ball-bearings 24 carried by a stationary row 25 of outlet blades which are fast with the rear end of the cowling 12. The latter is supported through flanges 12a fast therewith.

Each row of compressor blades carried by the shell 13 has a ring-portion 26 connected by the blades 27 to a shroud 28 located at the inner periphery of the shell. Each row of compressor blades on the inner rotor 15 is fast with a flanged ring 29, the flanges abutting one another and being secured on the periphery of the inner rotor as by a collar 31. Both sets of rings (26, 29) may be provided with labyrinths in known manner. In a similar way the sets of blades of the turbine are secured to the outer shell and inner rotor, respectively. Between the compressor and the turbine is the annular combustion chamber 33 which may be provided with fuel supply and ignition means of any well known or convenient construction.

It is preferred that the blades of the first row of the turbine (and possibly the blades of some of the next rows also) should be lipped on their leading edges 34 with a hard metallic alloy, as shown in Figure 3. A tapering stream-lined portion 35 is in this case fast with the inner rotor extending beyond the tapering outlet end of the cowling. Any convenient means may be made use of for supplying fuel to the combustion chamber 33, such for example as shown in Figure 2, at 46, 47 and 48, although obviously any well known means for supplying fuel and igniting it may be employed. In the construction shown in Figure 1, fuel may be introduced by the shaft 11 hollow and providing it with openings 43. Coacting with openings 43 are the openings of nozzles 50 which are provided with annular guiding rings 51 on opposite sides thereof. Any suitable ignition means may be provided to ignite the fuel thus introduced.

Preferably the outer shell and the inner rotor, which rotate in opposite directions, run at such differing speeds as to balance and therefore neutralise gyroscopic forces. Since the moment of inertia of the outer shell is the greater, its speed is the less, and this fits in with the limits imposed by centrifugal stresses. Moreover, with speeds of rotation of the inner rotor and outer shell within the limits so imposed, the working circumferential speed is very high (it may easily ex-

ceed the velocity of sound in air) so that blading of small deflection coefficient can be used. Since no torque is put into or taken out of the system (ignoring bearing friction) the exhaust gases must leave without torque and the relative speeds of the inner rotor and the outer shell can be determined by suitable blade design.

In the construction of Figure 2, the fuel is supplied along the outer shell 37 at one or more places. Thus, the fuel is delivered under pressure along the interior of the stationary shaft 40 (which in this instance is made hollow and supports, as before, the outer shell 37 and the inner rotor 41 through ball-bearings 42) and through openings 43 into an annular groove 44 at the radially-inner edge of the annulus 45 supporting the front row of compressor blades, and thence it travels by centrifugal action along radial passages 46 and longitudinal passages 47 to be delivered through radially-extending nozzles 48 into the combustion chamber 49.

The construction above described lends itself particularly well to mounting beneath the wing of an aircraft in the case of land planes, and since there is no propeller, air flow over the top surface of the wing is uninterrupted and also the landing gear design is simplified. Reaction propulsion is at its maximum efficiency when the vehicle speed is about half the gas discharge speed; but it also has the advantage that at starting, though the efficiency also starts at zero, the actual thrust is doubled.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

1. A high-speed propulsion plant, particularly for an aircraft, comprising an axial-flow contra-rotating compressor and internal-combustion turbine with a combustion chamber between them, the exhaust of said turbine giving a direct reaction drive, said plant having a single outer shell which carries the whole of the outer turbine blades and part at least of the outer compressor blades, and also provides the outer portion of the combustion chamber, said outer shell comprising a frusto-conical compressor portion, a frusto-conical combustion chamber portion, said frusto-conical portions having their apices confronting each other, and a rear frusto-conical portion having the base thereof confronting the base of said combustion chamber and forming a reaction nozzle.

2. A high-speed propulsion plant, particularly for an aircraft, comprising an axial-flow contra-rotating compressor and internal-combustion turbine with a combustion chamber between them, the exhaust of said turbine giving a direct reaction drive, said plant having a single outer shell which carries the whole of the outer turbine blades and part at least of the outer compressor blades, and also provides the outer portion of the combustion chamber, said outer shell being formed of two main parts joined to one another in a transverse plane, preferably in the vicinity of the combustion chamber, said outer shell comprising a frusto-conical compressor portion, a frusto-conical combustion chamber portion, said frusto-conical portions having their apices confronting each other, and a rear frusto-conical portion having the base thereof confronting the base of said combustion chamber and forming a reaction nozzle.

3. A high-speed propulsion plant, particularly for an aircraft, consisting of an axial-flow rotary compressor and internal-combustion turbine with

a combustion chamber between them, the exhaust of said turbine giving a direct reaction drive, said plant having a single outer shell which provides substantially the whole of the outer rotary portion of the turbine and of the combustion chamber, and part at least of the outer rotary portion of the compressor, and said plant also having a single inner rotor which provides substantially the whole of the inner rotary portion of the turbine and of the combustion chamber, and part at least of the inner rotary portion of the compressor, said outer shell and inner rotor revolving in opposite directions, said outer shell comprising a frusto-conical compressor portion, a frusto-conical combustion chamber portion, said frusto-conical portions having their apices confronting each other, and a rear frusto-conical portion having the base thereof confronting the base of said combustion chamber and forming a reaction nozzle.

4. A high-speed propulsion plant, particularly for an aircraft, consisting of an axial-flow rotary compressor and internal-combustion turbine with a combustion chamber between them, the exhaust of said turbine giving a direct reaction drive, said plant having a single outer shell which provides substantially the whole of the outer rotary portion of the turbine and of the combustion chamber, and part at least of the outer rotary portion of the compressor, and said plant also having a single inner rotor which provides substantially the whole of the inner rotary portion of the turbine and of the combustion chamber, and part at least of the inner rotary portion of the compressor, said outer shell and inner rotor revolving in opposite directions and being journaled through anti-friction means upon a stationary shaft, said outer shell comprising a frusto-conical compressor portion, a frusto-conical combustion chamber portion, said frusto-conical portions having their apices confronting each other, and a rear frusto-conical portion having the base thereof confronting the base of said combustion chamber and forming a reaction nozzle.

5. A propulsion plant, according to claim 4, in which an axial streamline tail is carried by the inner rotor and in which said outer shell tapers to provide a nozzle cross-section decreasing towards the outlet end, so as to direct the gases, substantially without eddies or vacuum being formed, over the axial streamline tail carried by said inner rotor.

6. A propulsion plant, according to claim 4, in which an axial streamline tail is carried by the inner rotor to rotate therewith and in which said outer shell tapers to provide a nozzle cross-section decreasing towards the outlet end, so as to direct the gases, substantially without eddies or vacuum being formed, over the axial streamline tail carried by said inner rotor, in combination with a stationary cowling which, with the tapering outlet part of said outer shell, gives a smooth streamline profile.

7. A propulsion plant, according to claim 3, in which fuel is supplied to the combustion chamber along a passage formed in said outer shell.

8. A high speed propulsion plant comprising an axial flow rotary compressor and internal combustion turbine with a combustion chamber between them, said plant having an outer shell which provides the rotary portion of the compressor, combustion chamber and turbine, and an inner rotor providing the inner rotary portion of the compressor, combustion chamber and tur-

bine, said outer shell and inner rotor being journaled for rotation in opposite directions, said outer shell being of substantially circular cross-section and tapering from the inlet end of the compressor to the outlet end thereof and from the inlet end of the turbine to its outlet end, the portion of the shell connecting the compression and turbine

forming the combustion chamber and being oppositely tapered from the inlet end of the turbine to the outlet end of the compressor the outlet end of said turbine being of smaller diameter than the inlet end thereof and constituting a reaction nozzle.

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