April 22, 1958 W. E. DUNCAN 2,831,320

EXTERNAL TURBINE JET ENGINE

Filed Oct. 9, 1953 3 Sheets-Sheet 1

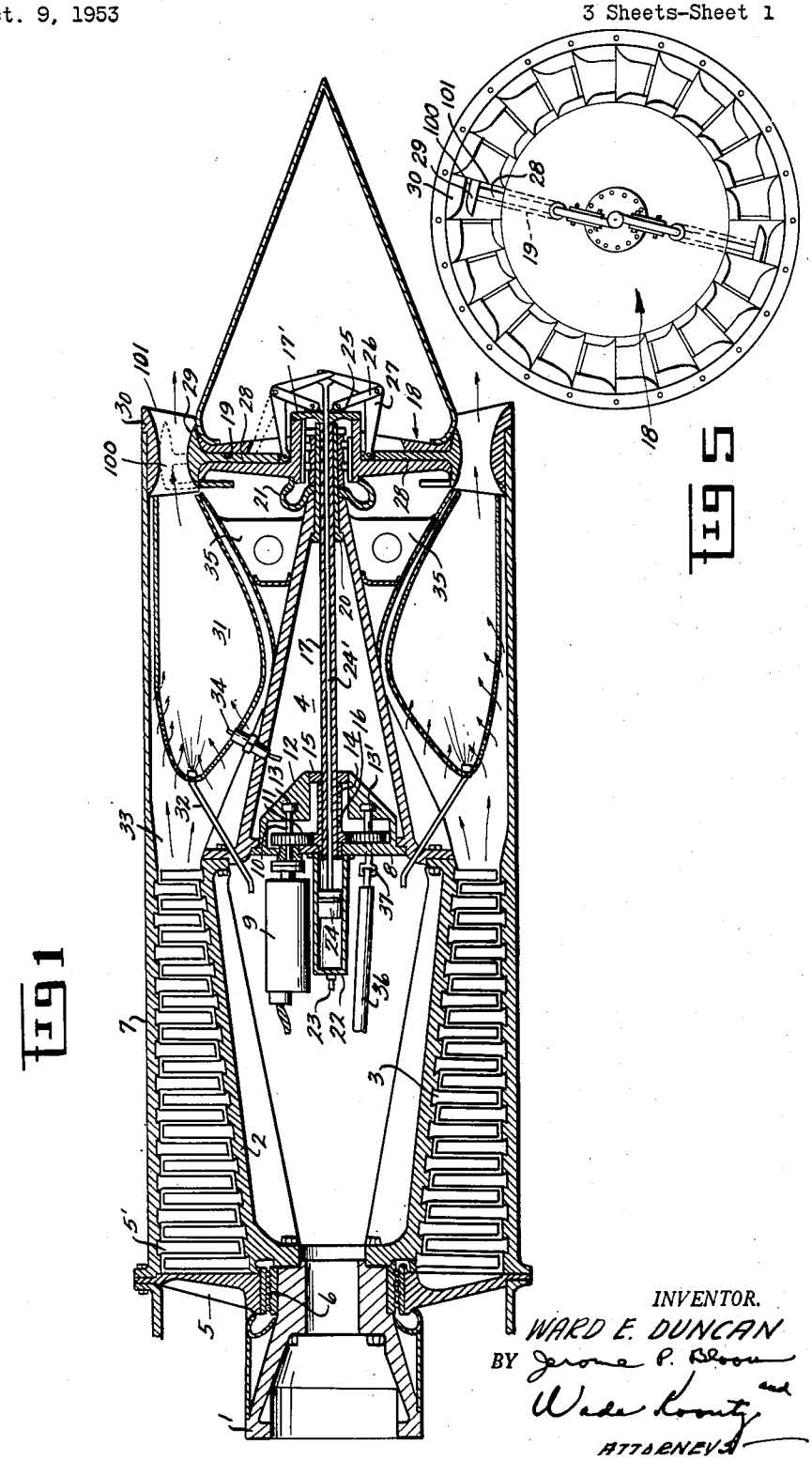


Fig 1

Fig 5

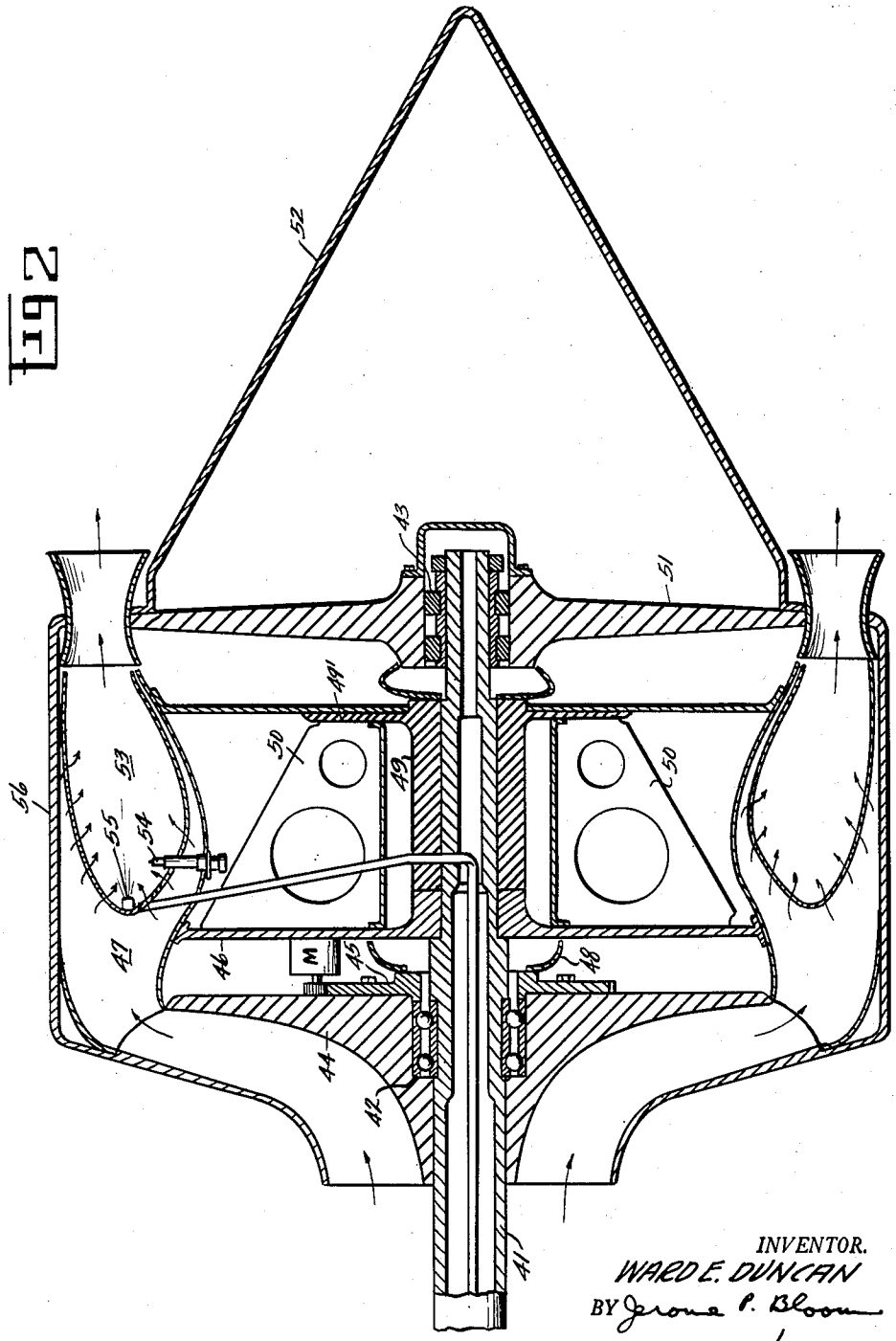
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Fig 2



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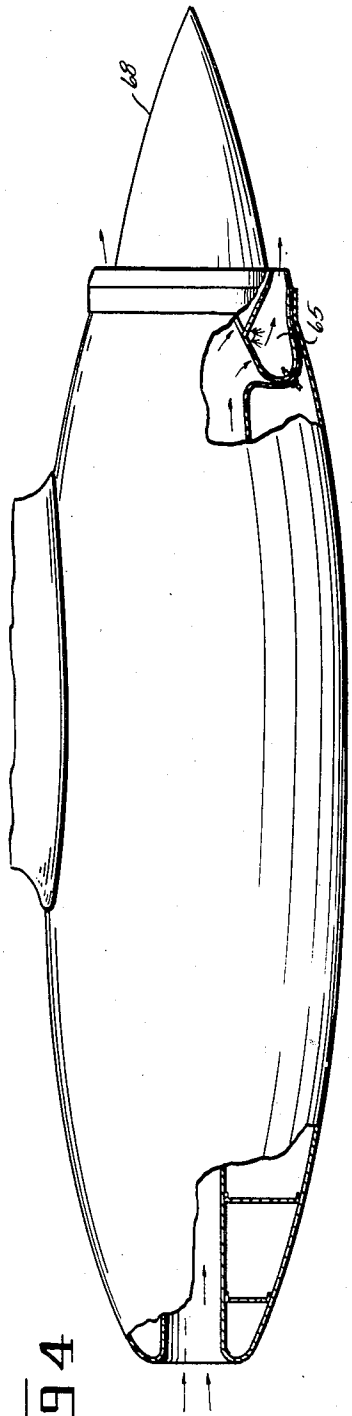


Fig 4

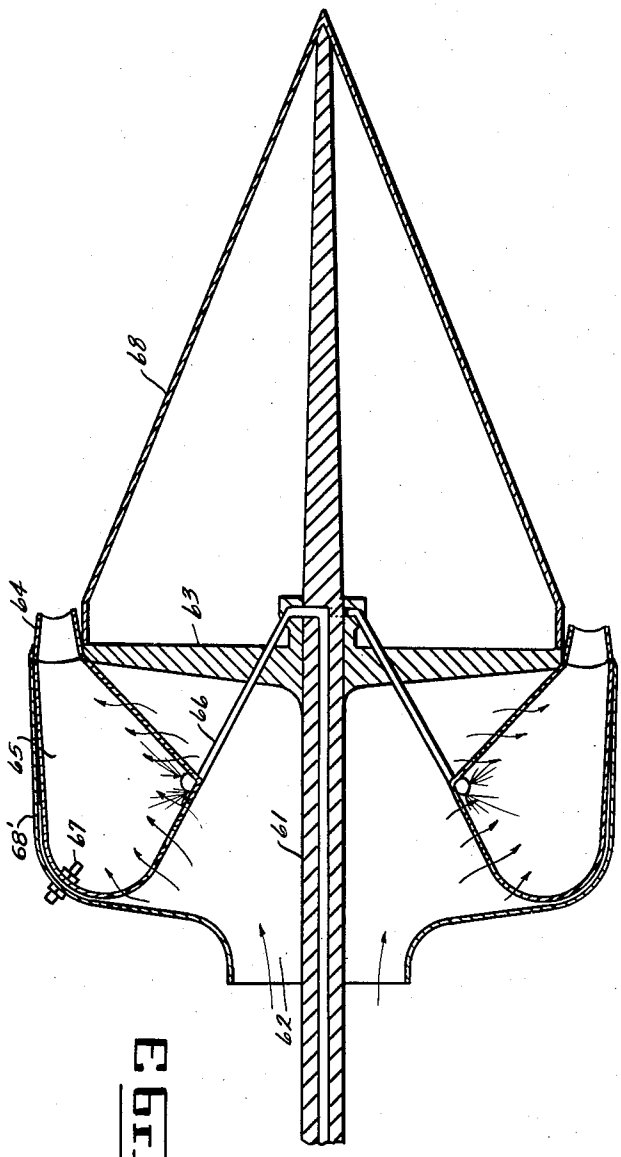


Fig 3

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EXTERNAL TURBINE JET ENGINE

Ward E. Duncan, Miami, Fla.

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3 Claims. (Cl. 60—35.6)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention is directed in application to a new and improved jet engine having a rotating casing and presenting a highly simplified construction with a resulting economy of production. The engine in its practical form utilizes a rotating outer shell having connected therewith the rotor blades of the compressor section of the engine, the shell being also connected to a nozzle discharge wheel or turbine which is integral with the casing and which is rotated by jet discharge to drive the compressor rotor providing a compact efficient engine structure with a minimum of parts as compared to jet engines now being utilized. This type of structure presented by the invention, moreover, reduces the maintenance problems consequent in the use of present jet engines. The improved engine also reduces the problem of controlling the engine temperature, the nozzle discharge wheel being in effect the turbine wheel which as arranged is exposed to additional air flow with a consequent reduction in operating temperature permitting a higher R. P. M. to be obtained within a desirable temperature range.

An object of this invention is to provide a new and improved rotary jet engine.

A further object of the invention is to provide an improved jet engine with a rotatable outer casing driven by jet discharge whereby the R. P. M. is controlled by the discharge.

Another object of the invention is to provide a highly simplified jet engine wherein the turbine wheel serves as a discharge nozzle wheel enabling greater engine efficiency.

An additional object of the invention is to provide an improved rotary jet engine incorporating variable area jet discharge nozzles.

Another object of the invention is to provide an improved rotary jet engine having a rotatable outer casing incorporating the rotor blades of the compressor section which casing is driven by jet discharge.

A further object of the invention is to provide an improved rotary jet engine that can operate at higher gas temperatures than prior jet engines.

Other objects and advantages of the invention will become readily apparent to those versed in the art from the following description taken in conjunction with the accompanying drawings wherein:

Fig. 1 shows a cross-section of the preferred form of the invention;

Figs. 2 and 3 present modifications of the preferred form of the invention;

Fig. 4 shows how the modification of Fig. 3 of the drawings may be incorporated in a fuel tank suspended from an air-craft; and

Fig. 5 is an end view of the engine of Fig. 1 disclosing details of the end wall and nozzle openings.

The preferred practical embodiment of the invention comprises a stationary engine support, an outer tubular substantially cylindrical casing rotatably mounted on the support, and fluid accelerating means including a compressor section and a combustion chamber secured to the stationary support. The stationary engine support including an adapter section 1 to be fixed to the aircraft structure. A conical section 2 fixed to the adapter 1 and extending longitudinally therefrom constitutes a fixed support for the stator blades 3 of the compressor section of the engine. A tail support section 4 of the engine is bolted to the section 2 and forms a continuation thereof, being conical in longitudinal cross-section and forming a bearing at its rear. The compressor section of the engine is formed to have several stages. The first stage is in the form of a wheel with rotor blades 5 and rotatable on a bearing 6 mounted on the adapter 1. The outer extremities of the first stage rotor blades are bolted to the engine outer casing 7 which is arranged for rotation relative to the fixed engine support. The rotor blades 5' of the successive stages of the compressor section are fixed to the outer casing of the engine and extend inwardly intermediate the stator blades. A plate 8 separates the compressor fixed section 2 and the tail support section 4. A starter unit 9 is bolted to the compressor side of the plate and has a drive shaft 10 extending therethrough to which is fixed a drive gear 11. Connected integrally to the plate on the tail side is a support 12 and the drive shaft is journalled in a bearing 13 fixed in the support. A tubular section 14 extends axially and centrally from the plate in a rearward direction. The rear end of the tubular section 14 is journalled in a bearing 15 in the support 12. A gear 16 integral with the tubular section adjacent the plate meshes with the gear 11 on the drive shaft. A tubular shaft 17 concentric with the tubular section 14 is fixed thereto in any suitable manner and extends rearwardly and axially through the tail section support 4 to a circular plate 17' extending transversely thereof and integral therewith at the rear end of the shaft. Bolted to the plate 17' is a nozzle wheel turbine or circular end wall 18 having a plurality of fluid guiding passages 100 spaced uniformly along the periphery of the end wall 18 and having at least two radial passages or spokes 19 with each communicating with one of the peripheral passages 100. It will be understood that the number of passages 19 may be increased, if desired.

A bearing tube 20 for the tubular shaft 17 is fixed in the end opening of the tail section support 4 and extends rearwardly therefrom. Bearings are maintained between the end wall 18 and the tail support section 4 in any suitable fashion. A scavenging line (not shown) is provided leading into the housing formed by the nozzle wheel turbine hub and enclosure 21 to provide lubrication for the nozzle wheel bearings.

Secured to the compressor side of the plate 8 axially and centrally thereof is a cylinder 22 to the front end of which leads a line 23 delivering hydraulic fluid from a supply. Mounted for movement in the cylinder 22 is a piston 24 having an elongated stem or rod 24' extending rearwardly through the tubular shaft 17 and beyond the plate 17' fixed thereto. Fixed to the circular plate 17' are brackets 25 (two shown) equally spaced from the center of the plate and radially disposed about the axis of the rotation of the engine. A link 26 is secured to each bracket 25 and extends outwardly in diverging relation. On the end of each link is a bell crank lever 27, each lever having its inner arm connected to the end of the piston rod 24'. The outer arm of each lever is pivotally connected to the inner end of a rod 28 (two shown). Each of the rods 28 is slidably mounted in one of the radial passages 19 in the end wall 18. These

passages, as seen in Figs. 1 and 5, radiate from a common point on the axis of rotation of the engine. Each of the radial passages **19** in the end wall **18** has one end communicating with one of the passages **100** disposed along the periphery of the end wall. Each of the outer ends **29** of the rods **28** is shaped to cooperate with an outer wall of one of the end wall passages **100** to form a convergent-divergent nozzle. Except where the outer ends **29** of the rods **28** extend therefrom, the end wall **18** has an abutment portion secured thereto and shaped, similar to the outer end **29** of the rod **28**, to cooperate with outer walls **30** of the remaining passages **100** to form convergent-divergent nozzles. Radial plates or vanes **101** form the nozzle walls and fix the nozzles at an angle to the hot gas chamber so the deflection of the gas by the vanes imparts a rotational motion to the casing **7**. These vanes **101**, which are secured to the end wall **18** and the outer casing **7**, extend beyond the end wall far enough (see Fig. 1) so that the heat imparted to them by the exhaust gas stream is dissipated into the outer air to enable the end wall **18** to withstand high operating temperatures and resulting in greater engine efficiency.

As is apparent, by control of the hydraulic fluid to the cylinder **22**, the piston rod **24'** can move longitudinally of the tubular shaft **17** to control the bell crank levers **27** to move the rods **28** including the outer ends **29**, which form the inner walls of some of the nozzles **100**, radially to uniformly vary the cross sectional area of these nozzles. It will be understood that the remainder of the nozzle **100** do not have a varying area since they do not have outer ends **29** of the rods **28** disposed therein but have the abutment portions as previously set forth. However, all of the passages **100** could have varying areas through the use of outer ends **29** of the rods **28** extending therein to and forming an inner wall thereof, if desired. An annular combustion chamber **31** adjacent the end wall **18** is positioned to discharge the hot exhaust gas stream against the periphery of the end wall **18** and through the fluid guiding passages **100**. The combustion chamber **31** has fuel injectors **32** at the forward end thereof to which is led an appropriate fuel mixture. The outer wall of the annular combustion chamber has openings therein for compressed air to enter from the diffuser passage **33** following the compressor section. An igniter **34** extends into the chamber to ignite the air fuel mixture. Brace plates **35** extend between the combustion chamber and the tail support section.

In addition an auxiliary accessory drive shaft **36** is connected by a universal joint to a shaft **37** extending through the plate, to which shaft is fixed a gear meshing with the tubular section gear for driving purposes. The other end of the shaft bears in a bearing **13'** secured in the support.

To start the engine, the starter is energized to rotate the drive shaft **17** and connected nozzle wheel to which is secured the outer engine casing by its connection to the outer nozzle walls to drive the case with its connected compressor vanes inducing an axial air flow which is compressed through the various stages of the compressor and flows into the air diffuser passage where there is a further pressure increase. The air then enters the combustion chamber through the openings in the outer wall thereof where it is mixed with fuel from the fuel injectors. The mixture is then ignited and discharged through the nozzles which have the cross-sectional areas properly adjusted. The air flow being slightly deflected by the nozzle vanes causes the engine casing to rotate, as well as providing a forward thrust. The rotation of the engine casing drives the compressor so the energy withdrawn from the exhaust gas stream to produce the rotational motion is substantially returned to the system.

After combustion has started, the igniter may be turned off since incoming fuel air mixture is ignited by the previous ignited mixture giving a continuous combustion process.

The cross-sectional area of the nozzles is increased by pumping hydraulic fluid into the cylinder **22** while the decrease in cross-sectional area is accomplished by bleeding fluid from the cylinder and centrifugal force moves the inner walls of the nozzles outwardly.

This construction provides high efficiency with fewer moving parts and lighter weight than contemporary jet engines. It also eliminates the conventional nozzle diaphragm and the conventional arrangement of the turbine wheel with its accompanying temperature control problems. The particular nozzle control arrangement provides also immediate and positive control of engine output.

A modification of the invention, shown in Fig. 2 of the drawings, consists of a support shaft **41** hollow in nature and having spaced bearings **42** and **43** thereon. Mounted on the first bearing **42** is a compressor **44** of the centrifugal flow type. The rotor is fixed against movement longitudinally of the bearing by a circular plate **45** bolted thereto having gear teeth about its periphery and a central aperture with a flange thereabout abutting the bearing **42**. A radial support **46** for the air diffuser assembly **47** mounted on shaft **41** also serves to have a bearing seal **48** secured thereto. A second support **49** mounted on the shaft **41** abutting the hub of the first support has a radial transverse plate **49'** integral therewith and spaced rearwardly of the first support. Braced support elements **50** connect the supports **46** and **49** and therewith serve to mount the annular diffuser element. Mounted on the rear end of the support shaft **41** is a nozzle wheel or circular end wall **51** having a plurality of passages **200** mounted on bearings **43**. A housing **52** secured to the nozzle wheel provides a tail cone. A combustion chamber **53** annular in form is supported by the brace structure and an igniter **54** extends through the wall thereof at a position spaced from the fuel injector **55** connected thereto. The stationary hollow shaft **41** serves to house the fuel and oil lines extending to the fuel injector and front and rear bearings respectively. The engine outer casing **56** is connected to the outer periphery of the nozzle wheel and to the compressor.

A motor M is used for starting. It may be incorporated in any suitable manner as in the stationary portion and geared to the compressor, for example, as shown in Fig. 2 of the drawings.

In this modification air is compressed and accelerated by the compressor vanes, flowing through the radial passages and leaving in a spiral path, then entering the diffuser section **47** of a spiral type with diverging passages, raising the air pressure. The air passes then through openings in the combustion chamber where it is mixed with fuel and ignited. The discharge of the products of combustion through the nozzles which are of the convergent-divergent type and angled as in the preferred modification described herein produces the rotational as well as forward thrust. The nozzle wheel or end wall of this modification disclosed in Fig. 2 of the drawing, of the invention may utilize the fixed convergent-divergent type nozzle or may utilize the variable area type as in the preferred form of the invention. The manner of inclusion of the hydraulic control through hollow shaft **41** to the nozzle wheel being obvious and repetitious is unnecessary. The principles employed in this modification, as in the first, involve the connection of the nozzle wheel to the outer casing of the engine which is connected to the compressor to drive the compressor providing a simple, economical, efficient engine.

A second modification, see Fig. 3, of the invention comprises a hollow shaft **61** rotatably supported. Connected to the shaft for rotation therewith is a centrifugal compressor unit **62** connected to the outer casing **68'**. At the rear of the casing and connected to the shaft **61**

is a nozzle wheel or end wall 63 having a plurality of passages 300 defining nozzles 64. The nozzles extend rearwardly and are inclined away from the direction of rotation of the wheel. The nozzle wheel is connected to the casing 68' in any suitable manner for rotation therewith. A tail cone 68 is fixed to the nozzle wheel. An annular combustion chamber 65 within the outer casing has fuel lines 66 leading thereto from the hollow shaft 61 for fuel injection. Igniters 67 also extend into the combustion chamber to ignite the fuel introduced into the chamber. Openings in the combustion chamber admit air from the compressor unit for mixture with the fuel and ignition. The ejection of the products of combustion through the nozzles produces forward thrust as well as the rotational force necessary to rotate the outer casing to drive the compressor. Here also the variable area convergent-divergent nozzles may be employed in a manner as shown in the preferred embodiment of the invention. Fig. 4 shows how the modification of Fig. 3 may be employed in a pod suspended from an aircraft.

As can be readily seen, the principles employed in the various modifications of the invention are simple in nature and lend themselves to many variations and applications which may readily be contemplated by those versed in the art and such is within the scope of the invention.

What is claimed is:

1. An engine comprising a stationary support, a casing rotatably mounted on the support, said casing integral with an end wall, said end wall having a plurality of spaced fluid guiding passages disposed closely adjacent the end wall periphery, fluid accelerating means in the engine positioned to direct a fluid stream against the periphery of the end wall and through the fluid guiding passages, said fluid guiding passages interacting with the fluid stream to impart rotational energy to the casing, means connected to the engine for simultaneously and uniformly varying the cross sectional area of at least two of the passages in the end wall.

2. The invention set forth in claim 1 wherein the means for simultaneously and uniformly varying the cross sectional area of at least two of the passages on the periphery of the end wall includes at least two passages in the end wall which radiate from a common point, an elongated element slidably mounted in each of the radiating passages, one end of each of said elongated elements positioned in one of said passages on the periphery of the end wall and shaped to cooperate with the outer peripheral surface of these passages to form adjustable convergent divergent nozzles, and means connected to said elongated elements for actuating them to simultaneously and uniformly vary the cross sectional area of at least two of the convergent divergent nozzles.

3. The invention set forth in claim 2 wherein the means for simultaneously and uniformly actuating the elongated elements includes an actuating shaft extending along the axis of the casing and means connecting the actuating shaft to the slidable elongated elements.

References Cited in the file of this patent

UNITED STATES PATENTS

2,410,538	Walton	Nov. 5, 1946
2,641,105	Drake	June 9, 1953
2,679,725	Sharma	June 1, 1954

FOREIGN PATENTS

587,528	Great Britain	Apr. 29, 1947