March 10, 1953 D. W. SEIFERT 2,630,676

AXIAL FLOW JET MOTOR WITH ROTATING COMBUSTION PRODUCTS GENERATOR AND TURBINE

Filed Jan. 20, 1947 2 SHEETS—SHEET 1

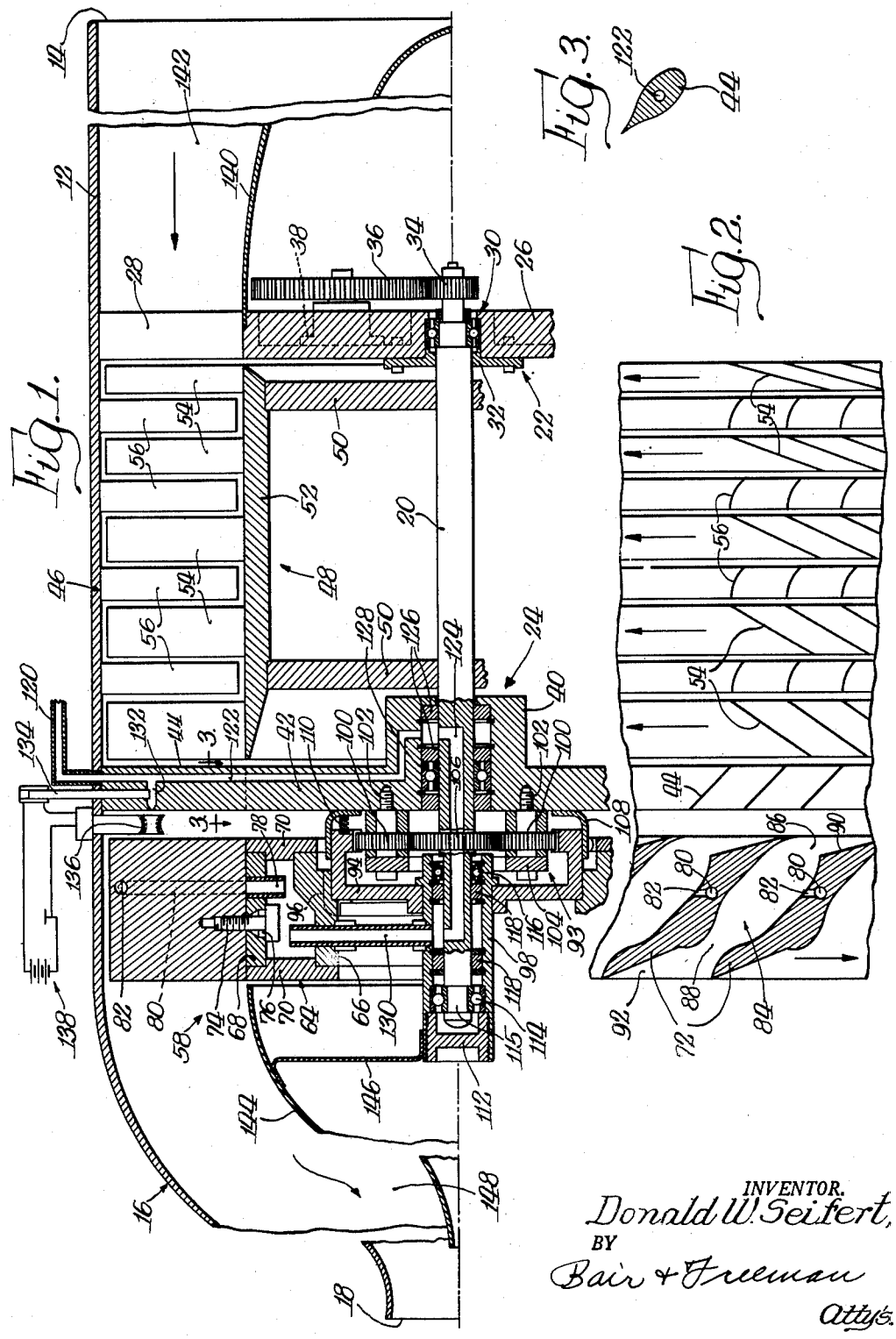


FIG. 1.



FIG. 2.



FIG. 3.

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Fig. 4.

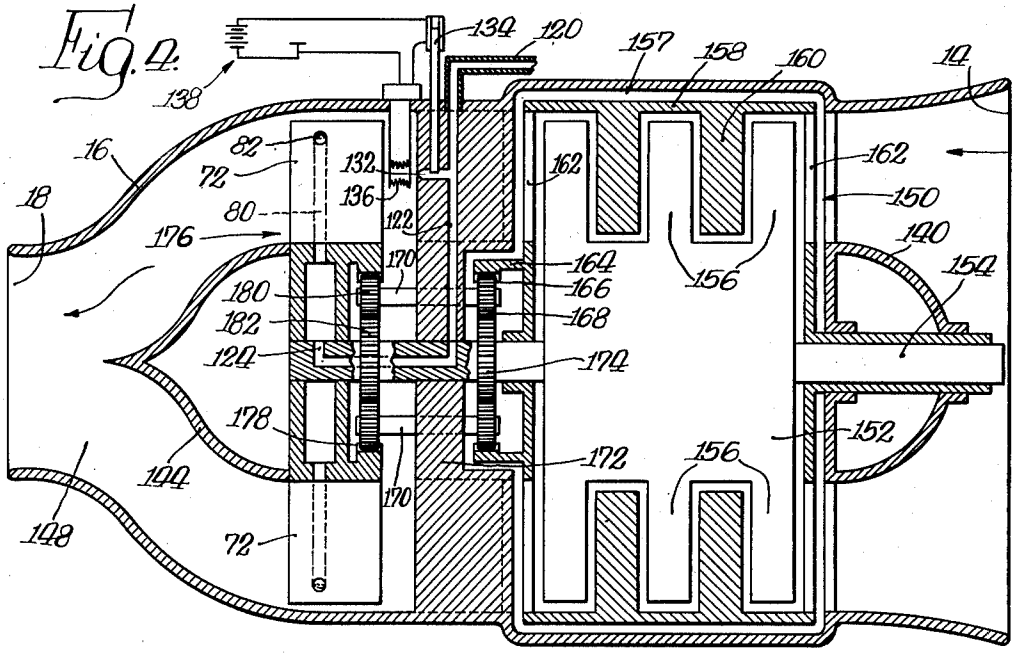
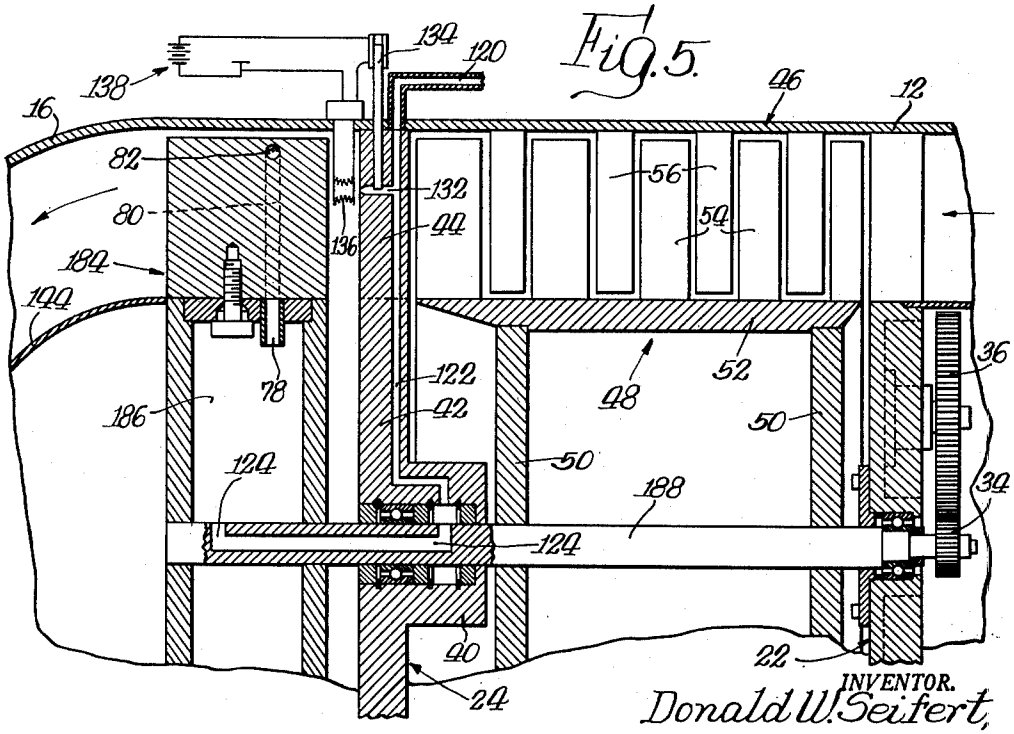



Fig. 5.




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Patented Mar. 10, 1953 2,630,676

# UNITED STATES PATENT OFFICE

2,630,676

## AXIAL FLOW JET MOTOR WITH ROTATING COMBUSTION PRODUCTS GENERATOR AND TURBINE

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Application January 20, 1947, Serial No. 722,987

17 Claims. (Cl. 60—39.35)

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This invention relates to jet motors.

The jet motor of the present invention is of the type which is propelled by expulsion of gases rearwardly out of the motor, and which picks up air for combustion when traveling. This is distinguished from rockets in which the air for combustion is contained in the fuel provided in the device.

By way of general explanation, the present invention applies to that type of fuel burning device in which the device is propelled forward by rearward expulsion of gases of combustion; the gases of combustion in the same propelling process rotate a driving element which in turn operates a compressor. The compressor then picks up air in the travel of the device, compresses it, and delivers it to the driving element where it supports combustion of the fuel.

An important advantage resides in this feature; in previous jet propelled devices, the combustion chamber was stationary, and the gases of combustion were then driven through a turbine which operated a compressor. In the device of the present invention, a plurality of combustion chambers are arranged in a rotating driving means, where the combustion takes place, so that the actual process of combustion produces a direct and immediate rotating force on the driving means.

The combustion driving means above referred to may also be referred to as an "athodyd" or "athodyd stage." "Athodyd" is a word recently coined from aero-thermo-dynamic-duct, and applies particularly to jet motors. This driving element may be referred to herein both as an athodyd driving means and a combustion driving means.

A portion of the power generated by the expulsion of gases out of the motor is utilized in driving the compressor but the air compressed by the compressor accomplishes more rapid combustion, resulting in higher speeds of the device.

Accordingly, the efficiency of such a device is increased as the speed of the motor is increased. This is a peculiarity of jet motors, and because of that condition, when the efficiency drops to a certain point, operation of the device ceases. As a correlative of this phenomenon, the device must be given an impulse by some auxiliary force to attain initial speed for the jet propulsion feature to become effective.

The present invention utilizes an elongated cylindrical casing; a shaft is rotatably mounted centrally of the casing, and the compressor and athodyd stage mentioned above are rotatably

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mounted on the shaft. The casing is open at both ends taking in air at one end and expelling it at the other end.

Fuel is supplied to the athodyd driving means, and an ignition device is provided for initial starting of the device. After the motor operates for a short time, the athodyd driving means becomes heated and the heat therefrom ignites the fuel; thereafter the ignition system is no longer required.

Another phenomenon peculiar to jet motors is that while both ends are open, the expulsion of gases is effected only in one direction, such expulsion being in the same direction as the influx of air which is brought in by the travel of the machine. The incoming air is compressed inside the motor and drives the gases of combustion out the opposite end.

An object of the present invention is the provision of a jet motor in which air compressed by the compressor is deflected in a direction to be forced into an athodyd driving means.

Another object is the formation of the athodyd combustion driving means for efficiently scooping up the compressed air deflected into it.

A further object of the invention is that the injection of fuel into the combustion driving means is assisted by the rotation of the driving means.

Still another object is the provision of a shape of combustion spaces in the driving means to render the propulsion effect of the device and the turning force on the driving means, by the gases of combustion, more efficient.

With these and other objects in view, my invention consists in the construction, arrangement and combination of the various parts of my device whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims and illustrated in the accompanying drawings, wherein:

Figure 1 is a longitudinal sectional view of a portion of the jet motor of my invention;

Figure 2 is a developed partial view of the compressor and combustion driving means of the jet motor, as viewed from immediately inside the casing of the motor;

Figure 3 is a sectional view taken on line 3—3 of Figure 1;

Figure 4 is a longitudinal sectional view of a modified form of jet motor; and

Figure 5 is a longitudinal sectional view of a third type of jet motor.

*The device of Figures 1 to 3*

Referring now in detail to the drawings, the jet motor shown in Figures 1 and 2 includes a cylindrical casing 12 having a leading open end 14, and a trailing open end 16. The trailing end 16 is developed along airflow lines and terminates at a reduced cylindrical outlet 18. If desired, the shape of the casing 12 may be tapered along air flow lines to produce more efficient air flow, and the working parts designed to conform to the shape of the casing.

Mounted centrally, axially of the casing 12 is a rotatable shaft 20 supported at one end by a bearing support indicated generally at 22 and at the other end by another support indicated generally at 24. The bearing support 22 consists of a solid central portion 26 and outwardly of the portion 26 are a plurality of blades 28 having their outer ends fixedly secured in the casing 12. The shape and disposition of these blades 28 will be referred to later. A central opening is formed in the central portion 26 of the bearing support 22, for supporting an anti-friction bearing 30 in which the respective end of the shaft 20 is supported. The bearing 30 may be secured in place by a plate 32 secured to the bearing support 22.

Secured to the leading end of the shaft 20 is a gear 34 meshing with another gear 36 which is mounted on a trunnion 38 which in turn is mounted on the bearing support 22.

The bearing support 24 includes a central hub 40 of enlarged dimensions and a central portion 42. Outwardly of the central portion 42 are a plurality of blades or fins 44, shown in Figure 2, secured in their extremities to the casing 12.

A turbocompressor is indicated generally at 46, and includes a rotary element 48. The rotary element includes a pair of end plates or discs 50 secured to the shaft 20 in a conventional manner, and a cylindrical member 52 fitted on the end plates 50. Secured to the outer surface of the cylindrical member 52 are a plurality of sets of blades 54 spaced axially along the member 52. The blades 54 are placed around the member 52 as will be understood by those familiar with turbines.

Spaced between adjacent sets of blades 54 are sets of fixed stationary buckets 56. The buckets 56 are fixed to the inner surface of the casing 12 and extend between the blades 54 down to a point adjacent the member 52.

The athodyd driving means is indicated generally at 58. The driving element includes a hub 64 in the form of a hollow drum and is made up of an inner tubular member 66 and an outer tubular member 68 secured together and sealed by side plates 70.

Secured to the outer surface of the outer tubular member 68 are a plurality of blocks or blades 72. The blades 72 are secured to the tubular member 68, by means of bolts 74 extending through openings in the tubular member 68 and threaded into tapped holes in the blades 72. Several such bolts 74 may be employed in each blade 72. A copper compression ring 76 surrounds each bolt 74 and fits in an annular seat in the tubular member 68, and is adapted to be wedged therein by the bolt head. This copper ring forms a seal as well as a means for retaining the bolt 74 in tightened condition. A tube 78 extends through the outer tubular member 68 adjacent each blade 72, and connects with an opening or passage 80 leading from the tube 78 radially outwardly through the respective blade 72. The passages 80 terminate in jets 82 which extend and open in a direction opposite of and tangential to the direction of rotation of the blades 72.

Between adjacent blades 72 are spaces 84 in which combustion of the fuel takes place. The shape of these spaces 84 is determined by the shape of the blades 72, and each space 84 includes a restriction 86 at the right end, or inlet, and a restriction 88 at the left end, or outlet. Beyond the restrictions 86 and 88 are diverging spaces 90 and 92.

The blades 72 are positioned on the drum 64 at an angle thereto, that is, each blade is turned on its own radial axis and positioned at an angle to the axis of the driving means 58, and shaft 20.

The driving means 58 is supported on the shaft 20 by means of a planetary gearing indicated generally at 93, and which includes a ring gear 94 on the periphery of which the tubular member 66 is splined as indicated at 96. Certain of the splines 96 may be enlarged for the passage of air therethrough. The web or central portion of the ring gear structure is supported on a sleeve 98 secured to and rotatable on the shaft 20. A plurality of planetary gears 100 mesh with the ring gear 94 and are supported on trunnions 102 secured in the bearing support 24. The outer ends of the trunnions 102 are fitted with a ring 104 to prevent cantilever action, and consequent binding, on the trunnion supports 102. The planetary gears 100 mesh with a sun gear 106 mounted directly on the shaft 20.

A shield 108, having a central opening for surrounding the trunnion supports 102, has an axial flange for locating it on the ring gear 94. The shield 108 may be secured to the ring gear 94 in such a manner as to slide axially thereon and is biased toward the bearing support 24 by means of compression springs 110. The shield 108 serves as a grease retainer for the planetary gearing 93.

The sleeve 98 is secured onto the shaft 20 by means of a block 112, threaded in the rear end of the sleeve; the block 112 seats against the interior shoulder in the sleeve 98 and against anti-friction bearing 114 which fits in an annular recess 115 in the rear end of the shaft 20. Another anti-friction bearing 116 is provided between the sleeve 98 and the shaft 20 ahead of the bearing 114. Seals 118 are provided between the sleeve 98 and shaft 20 at spaced points therein for a purpose to be shown later, and are held in place therein by the usual retaining rings. Fuel is supplied by means of an exterior fuel line 120 which leads to a passage 122 in one of the fins 44 and through the central portion 42 of the bearing support 24. The passage 122 then leads through the enlarged hub 40 of the interior thereof and into a passage 124 in the shaft 20. The interior of the hub 40 may be sealed by seals 126. An additonal anti-friction bearing 128 is provided between the shaft 20 and the hub 40. The passage in the shaft 20 leads rearwardly and opens into the sleeve 98 between the seals 118. The seals 118 therefore act as retainers for the fuel passing through passage 124. From this space a tube 130 leads to the interior of the hollow drum 64 from there through the passages 78 and 80 to the jets 82.

In the fin 44 in which the fuel passage 122 is formed, an auxiliary outlet 132 opens rearwardly adjacent the blades 72 in the athodyd driving means 58. A solenoid operated closure 134 extends into the outlet 132 for controlling the same. An ignition glow plug 136 is positioned adjacent the outlet 132, and in surrounding rela-

tion thereto. The solenoid operated closure 134 and the ignition means 136 may be operated by a convenient electric circuit 138 which can be either manually or automatically controlled. The ignition glow plug means 136 is Venturi-shaped, so that when the fuel from the outlet 132 passes therethrough it will be more readily ignited.

An inner shield 140 encloses the forward end of the central area of the interior of the motor leaving an annular passage 142 therearound. This passage 142 corresponds with the radial area occupied by the blades 54 and buckets 56 of the turbocompressor, and the blades 72 of the driving means 58. A similar shield 144 is provided at the rear and may be fixed to the rear end of the sleeve 98 by means of a plate 146. The shield 144 is similar in outline to the rear end 16 of the casing and forms therewith an outlet passage 148.

*Operation of the device of Figs. 1 to 3*

A motor generator may be coupled with the gear 36 for starting purposes. To start the jet motor the starting motor is started which rotates the compressor and athodyd driving means up to a certain speed. The device, when operated up to the speed possible by the starting motor, produces compressed air by the compressor, which is forced rearwardly to the athodyd driving means 58, and ultimately out of the motor rearwardly.

Fuel emerges out of the outlet 132, and out of the jets 82; the auxiliary ignition means 136 is connected, which ignites the fuel leaving the outlet 132, which then ignites the fuel leaving the jets 82 in the athodyd spaces between the blades 72.

Both the propelling effect of the motor, and the rotary force on the athodyd driving means 58 is caused by the combustion of gases in the spaces 84 after compressed air is built up therein. The gases of combustion are forced rearwardly by the compressed air, and the reaction of the expulsion of gases of combustion forces the device forward; at the same time the reaction of the expulsion of the gases of combustion out of the spaces 84 produces a turning effect on the driving means 58 due to the angular disposition of the latter with respect to the axis of the shaft 20.

The combustion thus produced rotates the athodyd driving means 58 faster, which in turn rotates the compressor faster, and builds up greater pressure of air. The fuel emerging out of the jets 82 enters into the spaces 84 and burns therein. The combustion heats the blades 72 to such a degree that after initial starting by auxiliary means, the heat from the blades 72 causes the ignition of the fuel. After the driving means 58 is thus rotated for a time and becomes heated, the ignition means 136 can be cut out and the solenoid operated closure 134 closed. At the same time the starting motor may be automatically cut out.

By the time the fuel emerges from the jets 82 it is fully vaporized. The centrifugal force of the athodyd driving means throws the fuel in the drum 64 against the tubular member 68, outwardly beyond the inner ends of tubes 78, and heat conducted from the blades 72 vaporizes it. Such vaporized fuel then passes through the passages 78 and 80, and out the jets 82.

However, when the device is being started, fuel in liquid form may emerge from the jets. Fuel is pumped into the drum 64 until it is deep enough to cover the inner ends of tubes 78 and flow therethrough, and out the passages 80 and jets 82.

The tangential disposition of the jets 82 produces an added turning force on the athodyd driving means. The reaction against the blades 72 from the pumped fuel emerging from the jets 82 adds to the force of combustion in rotating the driving means similar to the action of a lawn sprinkler.

The turbocompressor 46 is similar in construction to a steam turbine, but of course in the present instance the operation is reversed for accomplishing the results of a compressor. Fins 28, buckets 56 and fins 44 operate to direct air in certain given directions through the compressor. The blades 54 are arranged at different angles successively through the motor from the leading end to the trailing end as indicated in Figure 2. Finally the fins 44 are directed in a direction for deflecting the compressed air in a particular direction into the combustion driving element 58. Each set of buckets 56 deflects air between successive sets of blades 54 so that the succeeding set of blades 54 produces a maximum compression effect. The fins 44 are positioned at nearly the same angle relative to the axis of the shaft 20 as the angle of the blades 72 of the driving means 58. The air is thereby deflected as nearly directly into the spaces 84 as is possible. The diverging spaces 90 at the leading ends of the spaces 84 are adapted to scoop up the entering air more readily, and the trailing diverging spaces 92 accomodates the exhaust gases more readily.

The expulsion of gases of combustion reacts against such compressed air and the blades 72 to rotate the blades in the direction indicated by the arrow in Figure 2. The planetary gearing 93 through which the driving means 58 is connected with the shaft 20 reverses the direction of rotation between the driving means and the compressor.

The expulsion of gases of combustion at the rear opening 148 drives the motor ahead and in such forward travel air is scooped up in the leading open end 14 where it is compressed by the compressor. The greater the compressed air built up by the compressor, the greater is the expulsion of gases out of the rear end and vice versa, thus resulting in an arrangement whereby the faster the motor travels the more efficient it becomes.

One of the fins 44 may be enlarged to accommodate the fuel line 122, as shown in Figure 3, and certain others of the fins may be formed similarly for symmetry. Figure 2 shows the fins 44 diagrammatically, to show their angular disposition, and to illustrate their function in directing air into the spaces 84 of the driving means 58.

The gearing 34—36 may be utilized for driving auxiliary equipment such as lighting on a ship in which the device is used.

As an alternative, jets may be provided in only alternate blades 72, leaving dead athodyd spaces, for passage of air therethrough for cooling the driving means.

*The device of Figure 4*

The essential difference between the device of Figure 4 and that of Figure 1 is that the turbocompressor is made up of counter rotating elements. The differences in detail between the

two figures will be pointed out hereinafter, and the similarities will not be dwelt upon.

The turbocompressor in Figure 4 is indicated generally at 150 and comprises a central rotary element 152 secured on the shaft 154. The rotary element 152 is provided with a plurality of sets of curved blades 156 inclined successively toward the axial from the inlet 14 to the rear, similarly to those of Figure 1. Although the blades 156 are inclined similarly to the blades 54 of Figure 1, they are also curved similarly to the buckets 56 of Figure 1, to produce more efficient action of the compressor.

An outer rotary element indicated generally at 157, surrounds the central rotary element and includes a drum or cylindrical member 158 having a plurality of sets of inwardly extending buckets 160 positioned between adjacent sets of blades 156. The outer rotary element 157 is freely rotatable on the shaft 154. Fins 162 are formed radially around the forward and rearward ends of the outer rotary element 157, in line with the blades 156 and buckets 160.

The trailing side of the outer rotary element 157 is provided with a cylindrical extension 164 on which is formed a ring gear 166. Planetary gears 168 are mounted on shafts 170 supported in bearing support 172. The bearing support 172 is constructed similarly to the bearing support 24 of Figure 1. A sun gear 174, fixedly secured on the shaft 154, meshes with the planetary gears 168.

The combustion driving means of Figure 4 is indicated generally at 176 and is supported on the trailing end of the shaft 154 to rotate freely thereon.

Formed in the leading side of the driving means 176 is a ring gear 178 with which mesh planetary gears 180 on the rear ends of the shaft 170. A sun gear 182 is fixedly secured on the shaft 154 in position to mesh with the planetary gears 180.

The remaining features of the device of Figure 4 are the same or similar to corresponding features of the device of Figure 1 and in part are illustrated diagrammatically in Figure 3.

*Operation of the device in Figure 4*

Upon rotation of the driving means 176 the outer rotary element 157 of the compressor rotates in the same direction as the driving means. Since both are connected to corresponding parts of similar planetary gearing, the central rotary element 152 of the compressor rotates in a direction opposite to that of the driving means and therefore in the opposite direction of the outer rotary element 158.

The effect of such counter-rotation therefore between the two rotary elements of the compressor is to produce greater compression results. Thus greater efficiency is accomplished due to greater compression of air.

It will be understood that the gear ratio between the driving means 176 and the compressor 150 may be varied from that illustrated, if desired, to obtain different relative speeds of rotation between the two.

*The device of Figure 5*

The device shown in Figure 5 is similar to that of Figure 1, but the gearing between the combustion driving means and the shaft is eliminated. In such a construction, fuel may proceed directly from the passage 124 into the hollow drum 186, and through the passages 78 and 80, and jets 82.



In the present instance (Figure 5) the combustion driving means 184 is shown connected directly with the central axial shaft 188. The turbocompressor in this instance is indicated at 56, and similar to the device of Figure 1, the central rotary element 48 thereof is fixedly secured to the shaft 188. In such a device the rotary element of the compressor and the driving means rotate in the same direction. Efficiency is gained by the elimination of the gearing between the driving means and the shaft. However, it may be desirable to provide a gearing just mentioned, instead of eliminating it, to cause greater rotation of the compressor element than of the driving element. If it should happen that the speed of the driving element would be limited due to the presence of intensive heat, or other causes, it should not be necessary to limit the speed of the rotary element of the compressor, for the same reasons. The rotary element of the compressor is relatively cold and may attain greater speed and centrifugal force for building up greater pressures.

The efficiency of the device is improved due to the fact that combustion takes place directly in the rotary driving means. This is distinguished from previous types of jet motors where gases passed from a stationary combustion space to a turbine driving element with consequent loss of efficiency. In the present device such loss of efficiency is eliminated.

While I have herein shown preferred embodiments of my invention, it will be understood of course that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the claims appended hereto to cover any such modifications or substitutions of equivalents as fall within the true spirit and scope of my invention.

I claim:

1. In a jet motor, a casing having open ends, a rotatable combustion driving means in said casing having a plurality of radial blades, each pair of adjacent radial blades bounding a combustion chamber therebetween, a fuel passage adapted for connection with a source of fuel, said fuel passage extending through said combustion driving means, and a plurality of passages leading from said fuel passage and extending through said blades and terminating in jets opening into the combustion chambers between the blades.

2. In a jet motor, a casing having open ends, a rotatable combustion driving means in said casing having a plurality of radial blades, each pair of adjacent radial blades bounding a combustion chamber therebetween, a fuel passage adapted for connection with a source of fuel, said fuel passage extending through said combustion driving means, and a plurality of passages leading from said fuel passage and extending through said blades and terminating in jets, said jets being positioned at the outer tips of said blades and opening into the combustion chambers between the blades in a direction opposite to the direction of rotation of said combustion driving means.

3. In a jet motor, a casing having open ends, a rotatable combustion driving means in said casing having a plurality of radial blades, each pair of adjacent radial blades bounding a combustion chamber therebetween, said blades being disposed at an angle with respect to the axis of the combustion driving element, about their respective radial axes, a fuel passage adapted for

connection with a source of fuel, said fuel passage extending through said combustion driving means, a plurality of passages leading from said fuel passage and extending through said blades and terminating in jets opening into the combustion chambers between the blades, said jets opening in a direction having a component tangent to the blades.

4. In a jet motor, a casing having open ends, a rotatable combustion driving means in said casing having a plurality of radial blades, said radial blades forming combustion chambers therebetween, said combustion chambers being of reduced dimension toward the leading end of said casing, and means including passages through said blades terminating tangentially thereof for injecting fuel into said combustion chambers.

5. In a jet motor, a casing having open ends, a shaft rotatable in said casing, a bearing support in said casing, said bearing support having radial fins secured to said casing, and combustion driving means mounted on said shaft downstream of said bearing support, and a fuel passage adapted for connection with a source of fuel, said fuel passage extending through one of said fins in said bearing support, through said shaft, and through said combustion driving means and having an outlet therein.

6. In a jet motor, a casing having open ends, a shaft rotatable in said casing, a bearing support in said casing, said bearing support having radial fins secured to said casing, and a combustion driving means mounted on said shaft, said combustion driving means having blades at its outer portion, thereby forming an annular air passage through said casing, and a fuel passage adapted for connection with a source of fuel, said fuel passage extending through one of said fins in said bearing support, through said shaft, and through the blades of said combustion driving means and having tangential outlets therein, said fuel passage having a second outlet opening out of said fin of said bearing support into said annular air passage and into said combustion driving means, and ignition means in said annular air passage adjacent said second outlet.

7. In a jet motor having a rotatable shaft and combustion driving means rotatable on said shaft, said driving means comprising, in combination, a hub adapted for mounting on said shaft, a plurality of blades extending radially from said hub, there being passages in said blades leading from said hub outwardly and terminating in jets opening out of said blades tangentially thereof, said blades being disposed at an angle, with respect to the axis of said hub, about their respective radial axes, said blades being restricted between their edges so that the spaces between adjacent blades have restricted dimensions at opposite ends in a direction axially of said driving means, and means for supplying fuel through said passages.

8. In a jet motor, a casing having open ends adapted for flow of air therethrough, a shaft in said casing, an axial flow rotor on said shaft, a plurality of radial blades on said rotor, each blade having a leading edge and a trailing edge, the leading edge being offset from the trailing edge in the direction of rotation of said rotor, each blade having a leading face and a trailing face, the leading face of each blade and the opposite facing trailing face of the previous blade being shaped to form therebetween a flow passageway having an enlarged combustion chamber formed intermediate the ends thereof, and fuel passages in said blades opening to the combustion chambers.

9. A jet motor as set forth in claim 8, wherein said fuel passages extend radially through said blades and terminate in jets positioned adjacent the outer tips of the blades.

10. A jet motor as set forth in claim 8, wherein the fuel passages open to the combustion chamber through the trailing face of the blade.

11. A jet motor as set forth in claim 8, wherein the fuel passages open in a diretcion opposite to the direction of rotation of the rotor.

12. A jet motor as set forth in claim 8, wherein the fuel passages open through the trailing face of the blade in a direction having a component tangent to the trailing face of the blade.

13. A jet motor as set forth in claim 8, wherein said faces of the blades form a throat in said flow passageway downstream of said combustion chamber and also form an expansion nozzle downstream of said throat.

14. In a jet motor, a casing having open ends adapted for flow of air therethrough, a shaft in said casing, an axial flow rotor on said shaft, a plurality of radial blades on said rotor, each blade having a leading edge and a trailing edge, the leading edge being offset from the trailing edge in the direction of rotation of said rotor, each blade having a leading face and a trailing face, the leading face of each blade and the opposite facing trailing face of the previous blade being shaped to form therebetween a flow passageway having an enlarged combustion chamber formed intermediate the ends thereof, a plurality of axially spaced sets of fins upstream of the rotor, the last set of fins through which the air passes before it enters said rotor being disposed at an angle to the axis of the motor, and the axes of said combustion chambers being straight and extending parallel to said last set of fins.

15. In a jet motor, a casing having open ends adapted for flow of air therethrough, a shaft in said casing, an axial flow rotor on said shaft, and a plurality of radial blades on said rotor, each blade having a leading edge and a trailing edge, the leading edge being offset from the trailing edge in the direction of rotation of said rotor, each blade having a leading face and a trailing face, the leading face of each blade and the opposite facing trailing face of the previous blade being shaped to form therebetween an axial flow passageway comprising, in order passing downstream, a first throat, a combustion chamber of enlarged width, a second throat, and an expansion nozzle.

16. In a jet motor, a casing having open ends adapted for flow of air therethrough, a shaft in said casing, an axial flow rotor on said shaft, a plurality of radial blades on said rotor, each blade having a leading edge and a trailing edge, the leading edge being offset from the trailing edge in the direction of rotation of said rotor, each blade having a leading face and a trailing face, the leading face of each blade and the opposite facing trailing face of the previous blade being shaped to form therebetween a flow passageway having an enlarged combustion chamber formed intermediate the ends thereof, the axes of said combustion chambers being straight and disposed at an angle to the axis of the motor, a throat in each said flow passageway downstream of said combustion chamber and an expansion nozzle downstream of said throat, and the portion of the blade leading face downstream of the expansion nozzle extending axially of the com-

bustion chamber axis further than the portion of the blade trailing face downstream of the expansion nozzle, whereby the flow issuing from the flow passageway is turned toward a direction parallel to said motor axis.

17. In a jet motor, a casing having open ends, a shaft in said casing, radial fins between said shaft and said casing, a combustion driving means on said shaft downstream of said radial fins, a fuel passage adapted for connection with a source of fuel, said fuel passage extending through one of said fins, through said shaft, and through said combustion driving means and having an outlet therein, said fuel passage having a second outlet opening in said fin, said second opening facing in a direction downstream of the fin, and ignition means between said fin and said combustion drive means adjacent said second outlet.

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