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PLURAL COMBUSTION PRODUCT GENERATOR IN RING COAXIAL WITH TURBINE

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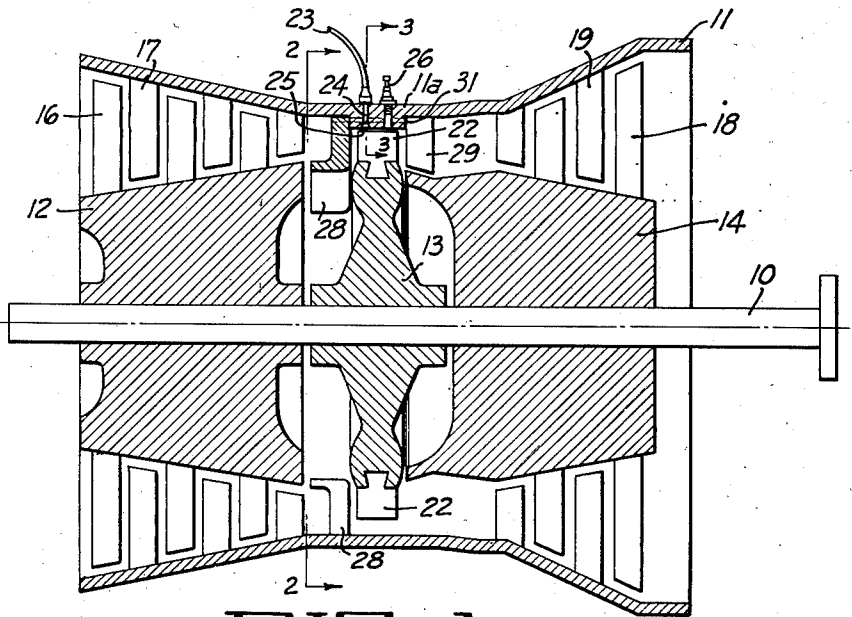


FIG. 1

FIG. 2

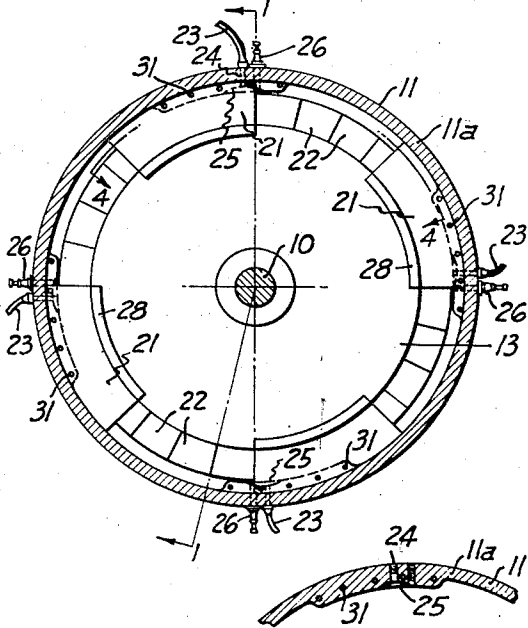
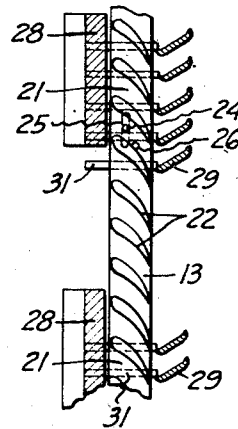


FIG. 3

FIG. 4



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## UNITED STATES PATENT OFFICE

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## PLURAL COMBUSTION PRODUCT GENERATOR IN RING COAXIAL WITH TURBINE

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6 Claims. (Cl. 60—39.37)

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This invention relates generally to prime movers of the gas turbine type such as are suitable for use on aircraft or other applications where it is desired to generate power from liquid or gaseous fuels.

It is an object of the invention to provide a prime mover of the above type with an overall efficiency considerably better than has been obtained in the past from gas turbines of conventional design.

Another object of the invention is to provide a gas turbine which for a given size will be capable of relatively high power output.

A further object of the invention is to provide a gas turbine having provision for self starting of the same.

Additional objects of the invention will appear from the following description in which the preferred embodiment of the invention has been set forth in detail in conjunction with the accompanying diagrammatic drawing.

Referring to the drawing:

Figure 1 is a side elevational view in section taken along the line 1—1 of Figure 2, illustrating diagrammatically a gas turbine incorporating the present invention.

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1.

Figure 3 is an enlarged sectional view taken along the line 3—3 of Figure 1.

Figure 4 is a sectional lay-out serving to illustrate the arrangement of parts in conjunction with the spaced combustion zones.

Gas turbines such as are now in use consist of a suitable compressor which delivers air to a combustion chamber, within which a suitable fuel is burned. The products of combustion are delivered to a turbine unit for generation of power. Generally the rotors of the compressor and turbine units are mounted upon a single shaft.

Gas turbines of the type described above are subject to certain limitations with respect to efficiency and power output for an installation of a given size. Generally the gases contacting the blades of the turbine can not be at a temperature in excess of about 1100° F. without mechanical failure. Thus the high temperature gaseous products of combustion produced in the primary combustion chamber must be cooled to a temperature level of not more than about 1100° F. before contacting the blades of the turbine. This cooling of the gaseous products of combustion is accomplished by utilizing a relatively large amount of air supplied by the compressor, in order to dilute and thus cool the products of

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combustion, and also by expansion of the products of combustion before contact of the same with the turbine blades.

My invention involves reducing the temperature of the gaseous products of combustion by a method making possible a substantial increase in overall efficiency, and at the same time making possible an increase in power output for an installation of a given size. Briefly my invention involves the extraction of mechanical work directly from the primary combustion chamber or chambers, concurrently with combustion of the fuel. At the same time parts of the combustion chamber are cooled to thereby operate within safe temperature limits. By this method it is possible to reduce the temperature of the gases being delivered to the blades of the turbine without utilizing excessive quantities of intake air, and at the same time the work extracted in the primary combustion chambers is applied as useful work to the output of the machine.

Referring to the drawing, the particular form of the invention illustrated diagrammatically consists of a shaft 10 provided with suitable bearing supports (not shown), and mounted axially within the housing 11. Mounted upon the shaft are the rotors 12, 13 and 14. Rotor 12 forms a part of a suitable compressor unit, and it is provided with conventional vanes 16 cooperating with the stationary vanes 17. Rotor 14 forms a part of a turbine unit for the generation of power, and is provided with conventional blades 18 cooperating with the stationary blades 19. Rotor 13 mounted between the rotors 12 and 14 forms a part of the means for extracting mechanical work in the primary combustion chamber or chambers, as will be presently explained.

Within the annular portion 11a of the housing a plurality of circumferentially spaced combustion chambers 21 are established. The blades 22 on the rotor 13 pass directly through these primary combustion chambers. Fuel such as a suitable liquid hydrocarbon is introduced into each combustion chamber through the fuel line 23 which discharges through a suitable nozzle 24 into a pocket 25. Alongside each pocket or slot 25 there is an ignition device 26 (such as a common spark plug), supplied with suitable energizing current for insuring sustained combustion.

In order to cause the gaseous products of combustion to have velocity components capable of imparting torque to the rotor 13, a series of barriers 28 are provided, with each barrier ex-

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tending alongside a particular combustion chamber and in close juxtaposition with one side of the path of movement of the blades 22. Adjacent the other side of the path of movement of blades 22 are spaced groups of stationary reactor blades 29, which are also positioned to extend along the primary combustion chambers. By virtue of the barriers 28 the bulk of the products of combustion generated in the primary combustion chambers are caused to expand in a direction generally away from the barriers 28, and because of such expansion and reaction upon reactor blades 29, considerable torque is applied to the blades 22. Upon leaving the blades 29 the expanding products of combustion pass to the turbine unit to apply useful torque to the turbine rotor 14.

As an aid in preventing excessive heating of the blades 29, a plurality of air ducts 31 are shown extending through each barrier 28, across and outside the path of movement of the blades 22, to discharge relatively cool air upon the bases of the blades 29.

Operation of the prime mover described above can be explained as follows; Assuming that the shaft 10 is in rotation, atmospheric air is drawn in and compressed to a suitable pressure such as of the order of from 50 to 120 p. s. i., and finally delivered to the general zone of operation of the rotor blades 22. Flow of air between the blades 22 in the spaced zones located between the primary combustion chambers serves to scavenge out remaining products of combustion, to supply combustion supporting air for the combustion chambers and to cool blades 22 whereby these blades are maintained within safe temperature limits. As the blades 22 enter a primary combustion chamber the air between them is intermixed with atomized fuel and this combustion mixture continuously ignited. Thus combustion within the chambers 21 takes place continuously, and simultaneously with the combustion of fuel within these chambers a considerable amount of mechanical work is extracted by virtue of torque applied to the moving blades 22. Such extraction of work simultaneously with combustion of the fuel necessarily considerably reduces the temperature of the products of combustion, which are finally discharged between the reactor blades 29. Thereafter the gases discharged from between blades 29, diluted with air passing directly through the regions between the barriers 28 and the air discharged through ducts 31, are delivered to the turbine at a safe temperature level for further generation of power in the same manner as is done in a conventional gas turbine power generation section. The manner in which gases and cooling air are thoroughly intermixed serves to eliminate hot spots in the delivery of the gases to the turbine.

A number of novel results are accomplished by virtue of the above described features of the invention. The amount of air required for a given amount of fuel consumption can be greatly reduced over conventional practice, because of the manner in which I extract work and thus reduce the temperature of gases in conjunction with combustion. Thus the power absorption occasioned by compression of air is greatly reduced, aside from the fact that the compressor itself need not be of excessive size and capacity. In addition the thermal loss occasioned in conventional practice by virtue of the discharge of excessive quantities of gas at temper-

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atures still high above ambient, is substantially reduced in proportion to the reduction in air intake. In addition to such results, which enable a theoretical betterment in efficiency over conventional practice of 100% or more, considerable power gain is obtained by virtue of torque applied to the rotor 13. Furthermore it will be apparent that with the features described it is possible to construct a unit of given power output with considerable saving in overall size and cost of manufacture. To compare a prime mover incorporating my invention with a machine of the same size of conventional construction, the net mechanical power available from my prime mover is theoretically more than twice that obtained from the conventional machine.

It will be noted that in operation of my machine the combustion chambers are continuously supplied with fresh air, and products of combustion are continuously scavenged from the blades as the blades pass from one combustion chamber to another. Furthermore as the blades pass from one combustion chamber to another, they are subjected to relatively cool compressed air, thus tending to avoid overheating.

Conventional gas turbines must be started by applying an electric motor or like device to initially rotate the main shaft up to near full rated speed. My construction makes possible self starting on fuel, as for example by initially supplying a suitable highly volatile fuel to the nozzles 24 or to supplemental nozzles which may be provided for this purpose.

I claim:

1. In a prime mover, a turbine rotor provided with circumferentially spaced blades, a housing surrounding the rotor, means for igniting and burning a combustible mixture of fuel and air in a plurality of localized circumferentially spaced combustion chambers through which the blades pass, means adjacent each combustion chamber for directing the velocity components of the expanding gaseous products of combustion to apply torque to the rotor within said combustion chambers, means for supplying air under pressure to the rotor and in a direction to flow between the blades in the areas intervening between the combustion chambers, and means for introducing fuel directly into the spaces between the blades as the blades enter the combustion chambers to thereby form combustible mixtures for ignition.

2. A prime mover as in claim 1 in which a turbine unit is provided and in which gaseous products of combustion leaving the primary chambers pass to said turbine unit for generation of power.

3. In a prime mover, a turbine rotor provided with circumferentially spaced blades, a housing surrounding the rotor, means for igniting and burning a combustible mixture of fuel and air in a plurality of circumferentially spaced localized primary combustion chambers through which the blades successively pass, a plurality of circumferentially spaced barriers located adjacent one side of the path of movement of the blades and adjacent said combustion chambers, stationary reactor blades adjacent the combustion chambers and adjacent the other side of the path of movement of the rotor blades, said barriers and said stationary blades comprising means causing expanding gaseous products of combustion in the combustion chambers to apply torque to the rotor blade to thereby extract mechanical work simultaneously

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with burning of fuel, and a compressor unit adapted to supply air under pressure to said rotor, the flow of compressed air being through the areas between the barriers and between the blades of the rotor passing from one combustion chamber to the next whereby combustion supporting air is supplied to the combustion chambers and whereby remaining products of combustion from a preceding combustion chamber are scavenged from the spaces between the blades, and means for introducing fuel directly into the spaces between the blades as the blades enter the combustion chambers to thereby form combustible mixtures for ignition.

4. A prime mover as in claim 3 together with a turbine unit adapted to receive gaseous products of combustion leaving the combustion chambers and intermixed with air delivered through the plates of the rotor.

5. A prime mover as in claim 3 together with means for delivering cooling air to the bases of the stationary blades to cool the same.

6. In a prime mover, a turbine rotor provided with circumferentially spaced blades, a housing surrounding the rotor, a plurality of stationary and circumferentially spaced barriers carried by the housing and disposed in close proximity with one side of the path of movement of the blades, stationary circumferentially spaced reactor blades carried by the housing and disposed in proximity with the other side of the path of movement of the rotor blades and in spaced opposed relation with said barriers, whereby the spaces between the blades are enclosed while the rotor blades

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pass in proximity to the barriers except for that side of the spaces which face toward the reactor blades, means for continuously delivering a stream of air through the housing and through the spaces between the turbine blades which are traversing the spaces between the barriers, thereby scavenging the spaces between the turbine blades and cooling the same, means for introducing fuel directly into the spaces between the turbine plates which are entering the regions of the barriers, and means for igniting the resulting combustion supporting mixture within said spaces.

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