

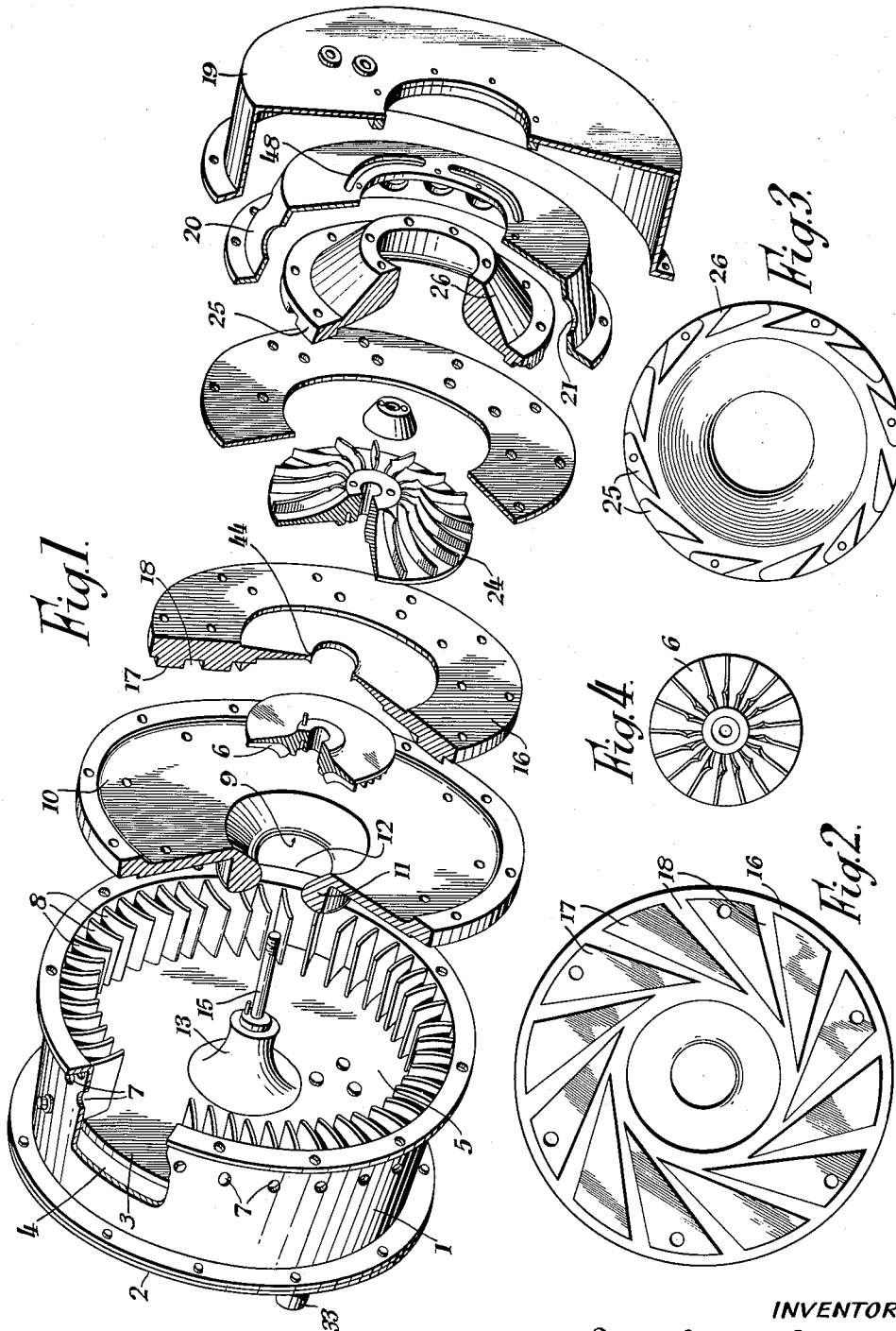
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FUEL INJECTION ARRANGEMENT IN VORTEX AIR STREAM
IN AN ANNULAR COMBUSTION CHAMBER
SURROUNDING A GAS TURBINE

2,748,568

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2 Sheets-Sheet 1

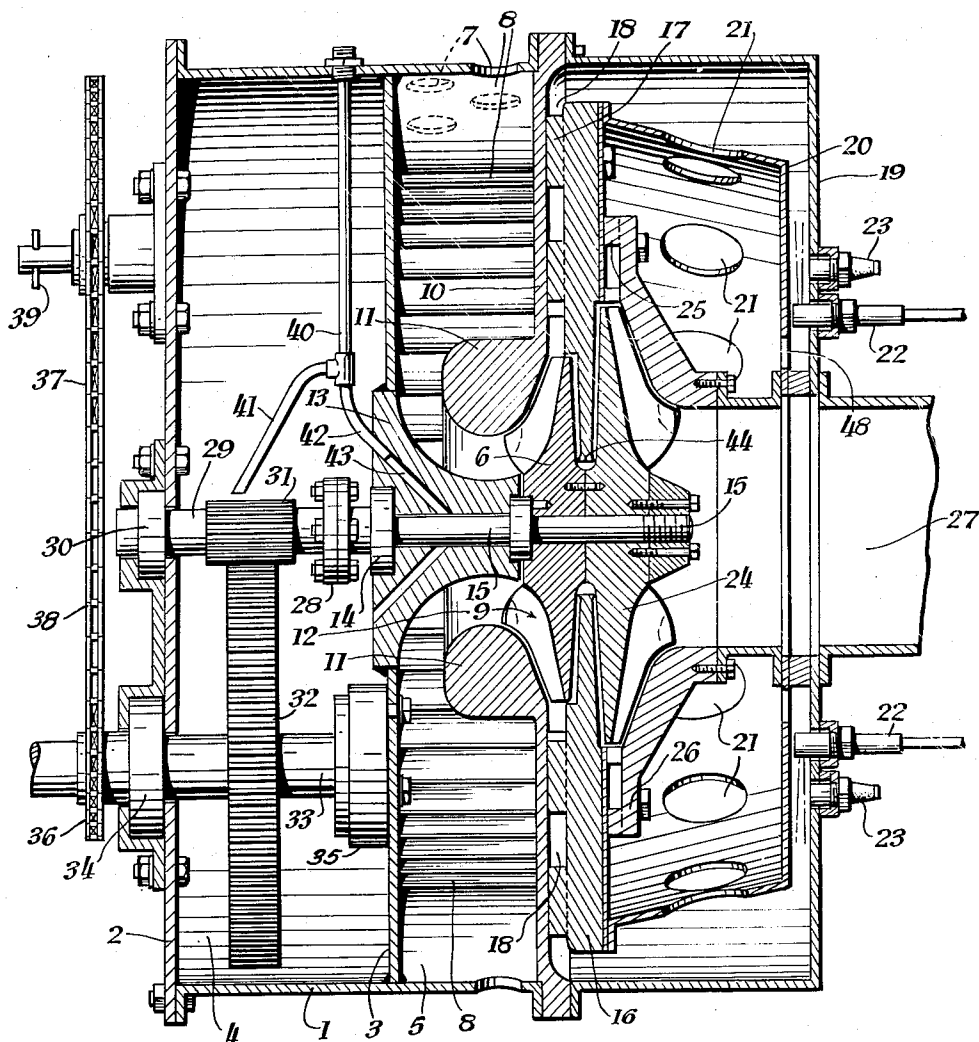


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Fig.5.



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FUEL INJECTION ARRANGEMENT IN VORTEX AIR STREAM IN AN ANNULAR COMBUSTION CHAMBER SURROUNDING A GAS TURBINE

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9 Claims. (Cl. 60—39.36)

The gas turbine forming the subject of the present invention has been designed primarily for industrial use, but is also suitable for use in the propulsion of road or rail vehicles, ships or other craft where its comparatively large frontal area would not be a disadvantage.

It is not proposed with this construction of turbine to make use of the reaction effect of the issuing burnt gases, but to connect the turbine by means of a suitable system of reduction gearing to an output shaft from which a drive can be taken to the machinery which it is intended to operate.

A gas turbine in accordance with the present invention includes an annular combustion chamber, a centrifugal impeller for supplying air under pressure to said combustion chamber, a turbine wheel in direct driving connection with said impeller and partly or wholly contained within said combustion chamber, means for injecting fuel into said combustion chamber, mixture igniting means and gearing connecting said turbine wheel with an output shaft.

It is preferred that the impeller and turbine wheel shall be directly associated together so that they, in fact, form a single unit, the parts being formed either separately or as an integral casting or other component. It is within the scope of the invention, however, to separate these components and to fixly associate them with a common shaft.

One advantage of combining the centrifugal impeller and turbine wheel so that they form a single unit is that the construction of the machine is simplified and consequently it can be manufactured more cheaply, a point of considerable importance when intended for industrial use. Furthermore, it will be appreciated that the flow of entering air will be directed radially outwards over the impeller, while the burnt gases will be directed radially inwards over the turbine blades.

In order that the invention may be clearly understood and readily carried into effect the invention is hereinafter described with reference to the accompanying drawings in which:

Figure 1 is an exploded view of the gas turbine, some of the components being shown in section or broken away to illustrate their construction more clearly;

Figure 2 is an end view of the diffuser;

Figure 3 is a view showing the fixed guide vanes which direct the burnt gases tangentially with respect to the blades of the turbine wheel;

Figure 4 is a front elevation of the centrifugal impeller;

Figure 5 is a longitudinal vertical section of the gas turbine.

The gas turbine is intended primarily for industrial use and comprises a main casing 1 of annular form closed at the rear end by an end plate 2 and incorporating a partition 3 which divides the casing into two compartments, namely, compartment 4 for gearing and a compartment 5 which partly contains the centrifugal impeller 6 into which compartment air enters on its way to the impeller.

The casing 1 is formed in its periphery with air inlet holes 7 and with inwardly directed fixed guide vanes 8

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over which the entering air must necessarily pass on its way to the impeller, the guide vanes causing the air to be directed inwardly to the air entry point 9 of the impeller. As will be seen clearly from Figure 5 the casing is closed at its outer end by an end plate 10, this end plate being formed with an annular protrusion 11 which is shaped to provide a passageway 12 leading to the inlet 9 of the centrifugal impeller. The partition 3 carries a centrally arranged boss 13 carrying bearings 14 for a shaft 15 to which the impeller is secured.

It will be appreciated, therefore, that the entering air passes radially inward through holes 7 in the peripheral wall of the casing and thence over the fixed guide vanes 8 and thence through passage 12 to the entry point of the impeller, the air being drawn between the blades of the impeller and forced radially outwards being at the same time compressed in the process of being directed outwardly between the end plate 10 and a further plate 16 between which plates is mounted a diffuser 17 of the form shown in Figure 2, the diffuser having a number of tangentially arranged air ducts 18 through which the air under pressure has to pass radially outwards on its way to the combustion chamber.

The combustion chamber includes the outer casing 19 and an inner casing or combustion chamber proper 20, the latter being formed with holes 21 around its periphery through which air under pressure which has entered the interior of the casing 19 can pass ready for combustion. Fuel injectors 22 are associated with the outer casing 19 and are offset with respect to kidney shaped holes 48 so that liquid fuel can be injected under pressure to mix with the entering air, the mixture being fired by suitable spark plugs or other igniting devices 23, combustion taking place in the space separating the end walls of the combustion chamber proper and casing 19, the fuel being directed radially outward from the injectors, i. e., in a direction opposite to the direction of air flow of the primary air.

The burnt gases are thence directed on to the blades of turbine wheel 24 which in the construction shown is directly connected with the centrifugal impeller, both components being secured in position on the shaft 15 and pinned or otherwise connected together so that they rotate jointly with their associated shaft 15.

The turbine wheel is similar in construction to the impeller, but is of larger diameter, the burnt gases being directed tangentially by means of fixed blades 25, the disposition of these blades being diagrammatically shown in Figure 3. The arrangement is such that the burnt gases will be directed tangentially on to the tips of the blades of the turbine wheel and will cause it to rotate at high speed. The blades 25 are sandwiched in position between plate 16 and a further plate 26 which is shaped to lie closely adjacent the blades of the turbine wheel and provide between the blades a series of passages through which the burnt gases must necessarily flow radially inwardly and finally enter an exhaust pipe or like 27.

The shaft 15 is connected by means of a coupling 28 with a further shaft 29 revoluble in a bearing 30 in the end plate 2, the shaft 29 carrying a pinion 31 meshing with a gear wheel 32, the latter being secured to a shaft 33 revolubly mounted in bearings 34 and 35 associated with the end plate 2 and partition 3 respectively.

The shaft 33 constitutes an output shaft of the gas turbine and is driven at considerably reduced speed from the shaft 29 which is, of course, driven at the same speed as the turbine wheel.

For starting purposes a sprocket 36 is associated with the shaft 33 through the medium of a free wheel or like connection, the sprocket 36 being coupled with a sprocket 37 by a roller chain 38, the sprocket 37 being secured

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to a shaft carrying a starting dog or the like 39 which can be engaged by a starting handle.

For lubrication purposes the compartment 4 may take the form of an oil bath, oil entering by way of a pipe 40 leading to branch pipes 41 and 42, branch pipe 41 serving to lubricate the gearing, while branch pipe 42 leads to an oil duct 43 through which oil can pass to the shaft 15 and its associated bearings.

To provide a good seal between the centrifugal impeller and the turbine wheel the inner periphery of the plate 16 is shaped to a knife edge 44.

It will be appreciated that the diffuser 17 and plate 16 will be cooled by the entering air.

The end wall of the combustion chamber proper and the end wall of the outer casing are in fairly close proximity and by arranging the components in this fairly close relationship part of the air which has entered the combustion chamber proper with a swirling motion will pass radially inwardly between the walls where it constitutes primary air and is burnt along with the droplets of liquid fuel injected into the air from the fuel injectors. The correct quantity of primary air reaching the injectors to ensure efficient combustion will depend on the correct proportioning of the holes 48 and 21, whilst the holes in the end of the combustion chamber are kept as near the center of the vortex as practicable together with the fuel injectors, thus ensuring a high whirl velocity of air past the sprayers and good atomization of the fuel. This relative positioning of the holes in the end wall of the combustion chamber and the fuel injectors respectively also ensures stability of the flame. The inward radial velocity of the primary air, the direction of air flow being opposite to the direction of the droplets of fuel from the fuel injectors ensures complete combustion and it is thought will prevent entry of unburnt fuel into the combustion chamber proper.

It will be appreciated that such a construction of gas turbine will by virtue of the annular form of the combustion chamber necessarily have a comparatively large frontal area in relation to the diameter of the combined impeller and turbine wheel, but it is thought that this will not be a disadvantage in the application of the turbine for industrial use or for use in connection with the propulsion of land or water borne vehicles or ships.

I claim:

1. In a gas turbine, in combination, a turbine rotor; a stationary annular casing forming an annular combustion chamber arranged coaxial with said turbine rotor, said annular casing including two opposite annular lateral walls arranged spaced from each other in axial direction of said turbine rotor, and outer and inner annular peripheral walls extending between said annular lateral walls; air inlet means for introducing compressed air into said combustion chamber located in the region of the edge formed by one of said lateral walls and said outer peripheral wall for directing a stream of compressed air along the latter, said stream of compressed air forming in said combustion chamber a vortex forcing air toward said inner peripheral wall; fuel supply means for introducing fuel into said combustion chamber located nearer to said inner peripheral wall than to said outer peripheral wall so that the fuel is injected in said whirling air stream at a point of high velocity thereof whereby high velocity fuel-air mixture will burn in the region adjacent said inner peripheral wall of said combustion chamber; and guide blade means passing inwardly to said turbine rotor through the wall of the annular casing and connecting the combustion chamber with said turbine rotor and guiding the combustion gases to said rotor.

2. In a gas turbine, in combination, a turbine rotor; a stationary annular casing forming an annular combustion chamber arranged coaxial with said turbine rotor, said annular casing including two opposite annular lateral walls arranged spaced from each other in axial direction of said turbine rotor, and outer and inner annular pe-

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ripheral walls extending between said annular lateral walls; air inlet means for introducing compressed air into said combustion chamber located in the region of the edge formed by one of said lateral walls and said outer peripheral wall for directing a stream of compressed air along the latter, said stream of compressed air forming in said combustion chamber a vortex about the chamber axis forcing air toward said inner peripheral wall; fuel supply means for introducing fuel into said combustion chamber located near the other of said lateral walls and nearer to said inner peripheral wall than to said outer peripheral wall so that the fuel is injected in said whirling air stream at a point of high velocity thereof whereby high velocity fuel-air mixture will burn in the region adjacent said inner peripheral wall of said combustion chamber; and guide blade means passing inwardly to said turbine rotor through the inner peripheral wall of the annular casing in the region of the edge between said one of said lateral walls and said inner peripheral wall and connecting the combustion chamber with said turbine rotor and guiding the combustion gases to said rotor.

3. In a gas turbine, in combination, a turbine rotor; a stationary annular casing arranged coaxial with said turbine rotor, said annular casing including two opposite annular lateral walls arranged spaced from each other in axial direction of said turbine rotor, and outer and inner annular peripheral walls extending between said lateral walls; a partitioning wall member located within said annular casing and having an annular peripheral wall portion coaxial with said annular casing connected to one of said lateral walls of said annular casing, and a lateral wall portion extending substantially parallel and spaced a short distance from the other lateral wall of said annular casing and having an inner edge connected to said inner peripheral wall of said annular casing so that said partitioning wall member forms in said casing an outer chamber and an inner annular combustion chamber, said partitioning wall member being formed with openings in said lateral wall portion thereof, said openings being located adjacent said inner peripheral wall of said casing; air inlet means for introducing compressed air into said outer chamber and located in the region of the edge formed by said one of said lateral walls and said outer peripheral wall of said annular casing for directing a stream of compressed air along the latter, said stream of compressed air forming in said outer chamber a vortex forcing air between said lateral wall portion of said partitioning wall member and said other lateral wall of said casing and toward said inner peripheral wall; fuel supply means for introducing fuel into said outer chamber located in said other of said lateral walls adjacent to said inner peripheral wall so that the fuel is injected into the whirling air stream at a point of high velocity, whereby high velocity fuel air mixture will be ignited in the region adjacent said inner peripheral wall and will expand through said openings into said combustion chamber; and guide blade means passing inwardly to said turbine rotor in the region of the edge between said one of said lateral walls and said inner peripheral wall of said casing and connecting said combustion chamber with said turbine rotor and guiding combustion gases to said turbine rotor.

4. In a gas turbine, in combination, a turbine rotor including a set of substantially radially extending rotor vanes having outer and inner ends; a stationary annular casing arranged coaxial with said turbine rotor, said annular casing including two opposite annular lateral walls arranged spaced from each other in axial direction of said turbine rotor, and outer and inner annular peripheral walls extending between said lateral walls, said inner annular peripheral wall having an axially extending tubular portion having one end located in the region of said inner ends of said rotor vanes and defining a tubular outlet, and an annular portion outwardly projecting from said tubular portion and extending along said rotor vanes from said inner ends and having an outer annular edge portion

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located outwardly of said outer ends of said rotor vanes; a partitioning wall member located within said annular casing and having an annular peripheral wall portion coaxial with said annular casing connected to one of said lateral walls of said annular casing outwardly of said annular edge portion of said inner annular peripheral wall, and a lateral wall portion extending substantially parallel and spaced a short distance from the other lateral wall of said annular casing and having an inner edge connected to said tubular portion of said inner peripheral wall of said annular casing so that said partitioning wall member forms in said casing an outer chamber and an inner annular combustion chamber, said partitioning wall member being formed with openings in said lateral wall portion thereof, said openings being located adjacent said tubular portion of said inner peripheral wall of said casing; air inlet means for introducing compressed air into said outer chamber and located in the region of the edge formed by said one of said lateral walls and said outer peripheral wall of said annular casing for directing a stream of compressed air along the latter, said stream of compressed air forming in said outer chamber a vortex forcing air between said lateral wall portion of said partitioning wall member and said other lateral wall of said casing and toward said tubular portion of said inner peripheral wall; fuel supply means for introducing fuel into said outer chamber located in said other of said lateral walls adjacent to said tubular portion of said inner peripheral wall so that the fuel is injected into the whirling air stream at a point of high velocity, whereby high velocity fuel air mixture will be ignited in the region adjacent said inner peripheral wall and will expand through said openings into said combustion chamber; and guide blade means extending in substantially radial direction between the outer annular edge of said annular portion of said inner peripheral wall and said one lateral wall of said casing toward said outer ends of said rotor vanes and guiding combustion gases from said combustion chamber to said rotor vanes.

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5. A gas turbine arrangement as claimed in claim 1 and including ignition means arranged in said other lateral wall of said casing adjacent said fuel supply means.

6. A gas turbine arrangement as claimed in claim 3 and including ignition means arranged in said other lateral wall of said casing adjacent said fuel supply means.

7. A gas turbine arrangement as claimed in claim 4 wherein said peripheral annular wall portion of said partitioning member is formed with other openings for admission of air into said combustion chamber for being mixed with the combustion gases entering through said first mentioned openings in said lateral wall portion of said partitioning wall member.

8. A gas turbine arrangement as claimed in claim 7 and including ignition means located in said other lateral wall of said casing adjacent said fuel supply means.

9. A gas turbine arrangement as claimed in claim 4 and including a radial flow impeller means connected for rotation to said turbine rotor; annular air guiding duct means located around said impeller means and formed with ducts communicating with said inlet means, said ducts having outer ends extending in at least partly tangential direction so that air pressed by said impeller means through said ducts and into said inlet means tends to move along said outer peripheral wall of said casing in a rotary motion.

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