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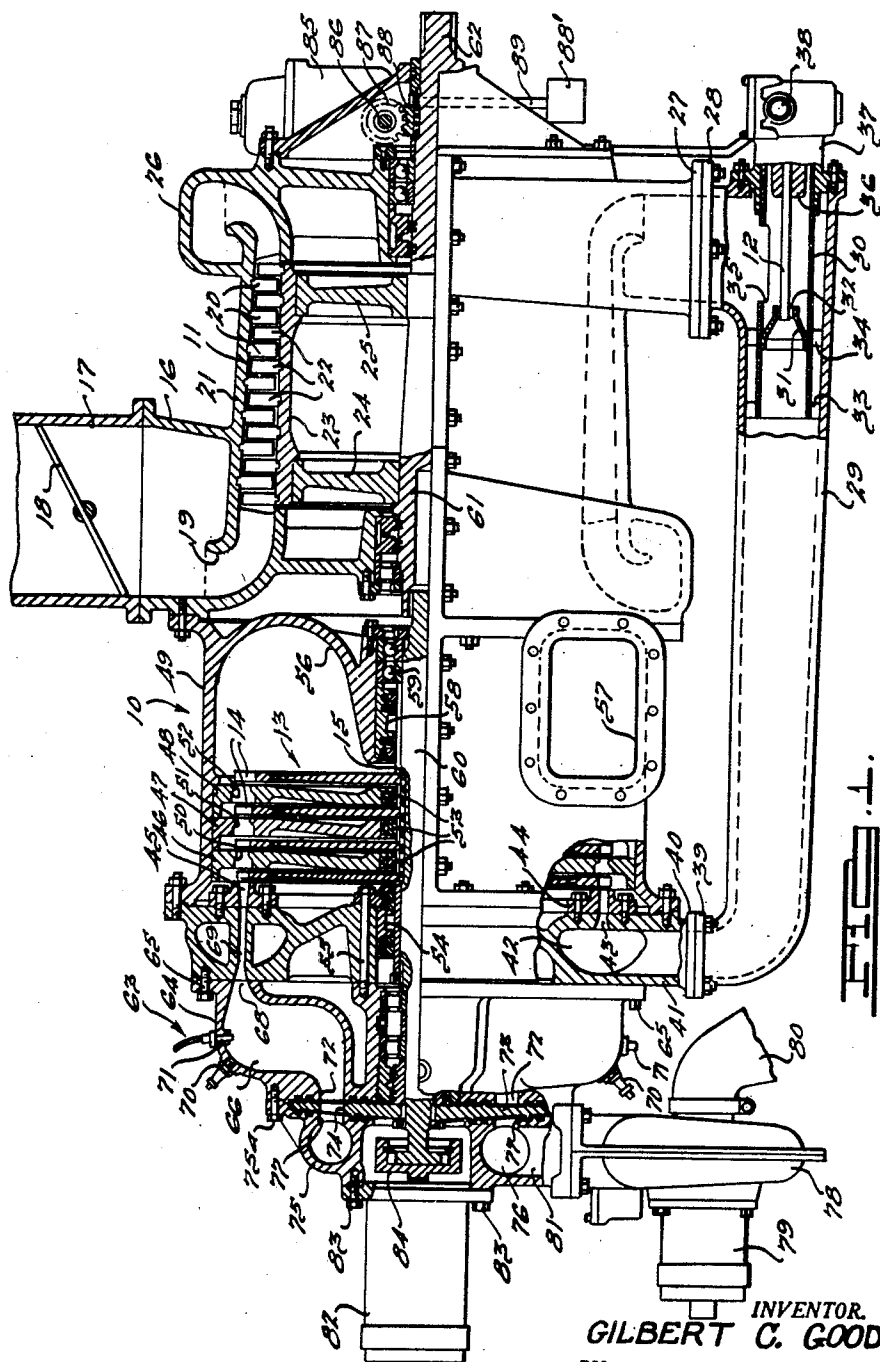
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2,452,298

STARTER

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 2.

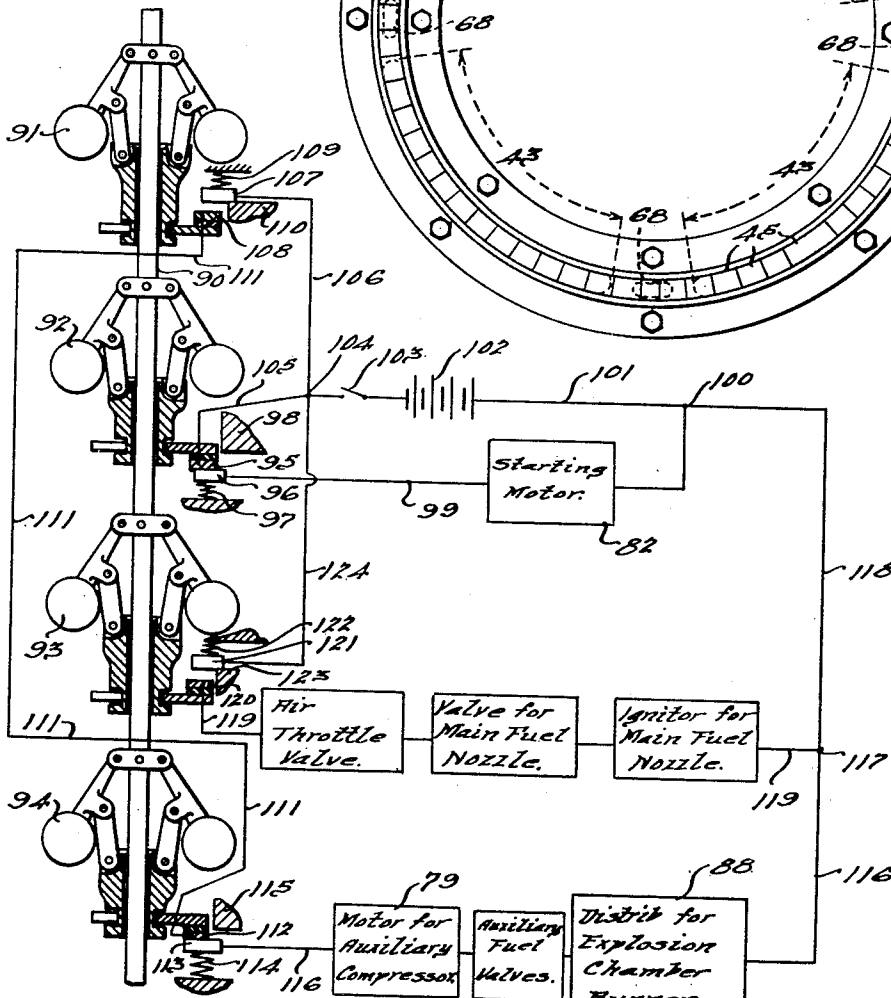
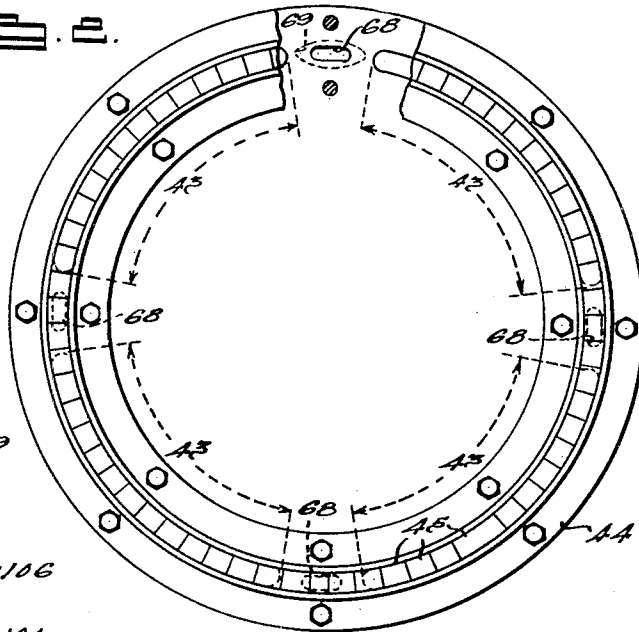


FIG. 3.

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STARTER

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This application relates to the starting of a power-generating device. More specifically it relates to a starter for a continuous-flow gas turbine. It also relates to a novel association of a gas generator of the explosion type with a continuous flow gas turbine.

One drawback incidental to the use of a continuous flow gas turbine has been the difficulty of starting the turbine. Since such a turbine is designed to operate at generally a certain constant speed, the turbine must be brought to this certain speed before its operation can begin, and so some starter must be employed that will accomplish the tremendous job of bringing the turbine to speed. A large electric motor has been used for this purpose. I propose to make possible the reduction in size of the electric motor by using the motor to bring the turbine only to a low speed and employing another starting means to bring the turbine from the low speed to its rated speed.

An object of the present invention is to provide an improved starting means for a turbine. More specifically this involves a starting means for a gas turbine of the continuous flow type.

A further object is the provision of a novel association of a gas producer of the explosion type with a gas turbine of the continuous flow type.

Another object is to provide a device for starting a gas turbine of the continuous flow type by operating directly upon the blading of the turbine. This may involve projecting hot gases from a supplementary source against the blading.

Other objects will appear from the disclosure.

In the drawing:

Fig. 1 is a side view, partially in section, of a gas turbine and a starter therefor;

Fig. 2 is an end view of a deflecting plate and a portion of the structure of the turbine to which it is attached; and

Fig. 3 is a schematic showing of the means for controlling the turbine and the starter therefor.

The reference character 10 designates a gas turbine of the continuous flow type, which includes an axial compressor or supercharger 11, a burner nozzle 12, and an impeller 13 comprising a plurality of movable blade members or wheels 14 secured in spaced relation to one another upon a shaft 15. Adjacent one end of the compressor 11 is an air inlet 16, to which is connected an air supply pipe 17, in which is mounted a throttle valve 18. Within the air inlet 16 is a smaller air inlet 19 leading directly to the compressor 11 which includes a plurality of sets of

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stationary blades 20 mounted in a portion 21 of the casing for the turbine 10, in which the air inlet 16 is integrally formed. The compressor 11 also includes a plurality of movable blades 22 spaced alternately between the stationary blades 20 and mounted on a rotor 23, secured upon hub members 24, in turn secured upon the shaft 15. At the right end of the compressor 11 is a delivery duct 26 for the compressor 11, formed integral with the turbine casing portion 21. At the lower side as viewed in Fig. 1, the delivery duct has a flanged outlet 27 to which is secured a flange 28 of a conduit 29. The burner nozzle 12 is positioned within one end of the conduit 29 adjacent the flange and is also mounted directly within a burner jacket 30. The discharge end of the nozzle 12 is supported in a bell-shaped member 31 by means of a spacer 32 through which air may pass. The bell-shaped member is mounted, constructed for the passage of air or other combustion-supporting gas between the nozzle 12 and the member 31. The left end of the burner jacket is supported in rings 33 and 34, constructed for the passage of air there-through between nozzle 12 and the conduit 29. One side of the burner jacket 30 has an opening 35 directly opposite the open end of the delivery duct 26. The right end of the burner nozzle 12 is mounted in a fitting 36, mounted in turn in a fitting 37, secured to the right end of the conduit 29 and mounting the right end of the burner jacket 30. The fitting 37 has a fuel supply inlet 38.

The left end of the conduit 29 terminates in a portion 39 curved upwardly and having a flanged outlet 39, which is secured to a flanged inlet 40 of a structure 41 having an annular passage 42. The annular passage has four arcuate outlets 43 spaced around in a circle and each extending for somewhat less than ninety degrees as indicated by the arrows leading from the reference characters 43 in Fig. 2. Secured to the structure 41 in covering relation with respect to the openings 43 is an annular plate 44 having a plurality of baffles 45, arranged in a circle and forming openings between them. The baffles 45 and the openings between them are directly opposite the peripheries of the blade wheels 14. A plurality of partitions 46, 47 and 48 mounted in a casing portion 49 between the wheels 14 have openings 50, 51, and 52, respectively, increasing in size in the order named. The openings 50, 51, and 52 are directly opposite the peripheries of the wheels 14. The inner portions of the partitions 46, 47, and 48 carry seals 53 in cooperative relation with

the shaft 15. A sealing member 54 of some length is secured to the structure 41 in cooperative relation with the shaft 15 by long screws 55, of which only one is shown. To the right of the wheels 14 and the partitions between them is an interior portion 56 integral with the casing portion shaped to conduct gases from the wheels 14 to an exhaust outlet 57. A seal 58 and a ball bearing 59 are positioned between the portion 56 and the shaft 15. The shaft 15 is actually composed of two shafts 60 and 61, shaft 60 being within the casing portion 49 and the turbine wheels 14, and shaft 61 being within the compressor 18. The left end of the shaft 61 is hollow and receives in driving relation the right end of the shaft 60. The shaft 61 has a right end 62, which is adapted to transmit power.

A burner or gas producer 63 of the explosion chamber type includes a structure 64 secured to the structure 41 by the long screws 55 and by short screws 65. The structure 64 is formed in four explosion chambers 66, of which only one is shown. Each chamber has an outlet 68 registering with a passage 69 extending through the structure 41 to the openings in the ring member 44. The outlets 68 and the passage 69 are spaced ninety degrees apart between the long arcuate openings 43, as shown in Fig. 2. Each chamber has a spark plug 70, a fuel injector nozzle 71, and an inlet 72, controlled by a valve plate 73, having an opening 74. A casing 75 is secured to the structure 64 by screws 75^a, of which only one is shown, and has an annular passage 76 and passages 77 leading to the inlet passages 72 of the combustion chambers 66. A compressor 78 is secured to the casing and is driven by an electric motor 79. The compressor is adapted to supply air or other combustion-supporting gas in a compressed state to the gas producer 63. An intake line 80 is connected to the compressor 78. A passage 81 in the casing 75 leads from the compressor 78 to the annular passage 76 in the casing 75. An electric motor 82 is secured by screws 83 to the casing 75 and has an overrunning or free-wheeling connection 84 with the left end of the shaft 60.

At the right end of the shaft 61 is a governor housing 85 into which extends a shaft 86. A wheel 87 is secured to the shaft 86, and a worm 88 in the shaft 61 meshes with the wheel 87. A distributor 88' for the spark plugs 70 is shown drivingly connected with shaft 61 by a shaft 89 and other means, not shown. The connections between the distributor 88 and the spark plugs 70 are not shown, since they are conventional.

In operation, the turbine will run at a certain constant or nearly constant speed. During such operation air will be drawn through the inlet 11 past the open throttle valve 18 into the compressor 11. From this it will pass through the outlet 26 to the burner nozzle 12. This nozzle will receive a continuous supply of fuel, and a flame will burn continuously at the nozzle. Gaseous products of combustion will be delivered to and through the conduit 29 to the annular space 42 in the structure 41. Thence the gases will be projected through the arcuate slots 43 and the spaces between the baffles 45 in the ring 44 against the periphery of the wheels 14. The wheels 14 are thereby caused to rotate, and they in turn cause the shafts 60 and 61, forming the shaft 15, to rotate.

The turbine 10 is adapted to operate at a nearly constant rated speed, and it cannot be operated until it is brought to that speed. For this purpose

the motor 82, the burner 63, the compressor 78, and the motor 79 are provided. The motor 82, acting through the free-wheeling connection 84, sets the shaft 15 and the blade wheels 14 in motion. When a certain low speed of rotation has been reached, the compressor 78 and the explosion chamber burner 63 are placed in operation. The gaseous products of combustion generated thereby pass through the openings 68 in the structure 41 and through the spaces between the baffles 45 in the ring 44 to the blade wheels 14, increasing the speed of the wheels from the aforementioned low speed to the rated speed of the turbine. Then the throttle valve 18 is opened, causing air to be drawn through the compressor 11 and fed to the burner nozzle 12. Fuel is fed to the nozzle 12 and is ignited. The turbine 10 is now in operation. At this point or at a slightly more advanced speed the compressor 78 and the burner 63 are taken out of operation. The motor 82 will have been taken out of operation in the neighborhood of the aforementioned low speed. Of course, the motor could be kept in operation without damage, because the overrunning clutch 84 is so arranged that the shaft 60 because of the burner 63 or the turbine 10 may rotate faster than the motor 82 can drive it.

Fig. 3 shows schematically the controls for placing in and taking out of operation the various devices previously described. The reference character 90 designates a shaft located within the housing 85 and drivingly connected by means not shown with the shaft 86 so as to rotate at a speed proportional to the speed of the shaft 15. Mounted on the shaft 90 are four speed-responsive governors 91, 92, 93, and 94. Governor 92 has a contact 95 engaging another contact 96 urged against contact 95 by spring 97. Movement of the contact 96 in direction in which it is urged by spring 97 is limited by a stop 98. The contact 96 is connected to a line 99 in which is connected the starting motor 82. The line 99 extends to a connection point 100, from which extends a line 101 in which is connected a source of electric power 102 and manually operated switch 103. The line 101 terminates in a connection point 104 from which extends a line 105 to the contact 98. From the connection point 104 extends a line 106 to a contact 107 urged toward a contact 108 by a spring 109 but held in spaced relation to the contact 108 by a stop 110. The contact 108 is connected to the speed governor 91. A line 111 extends from the contact 108 to a contact 112 connected to the speed governor 94. The contact 112 is engaged by a contact 113 urged against the contact 112 by a spring 114. A stop 115 limits the movement of contact 113 in the direction in which it is urged by the spring 114. From the contact 113 extends a line 116, in which are connected the motor 79 for the auxiliary compressor 78, a control for the fuel valves 71 in the explosion chamber burner 63, and a control for the distributor 88. The line 116 terminates in a connection point 117, from which extends a line 118 to the connection point 100. Also a line 119 extends from the connection point 117 and in the line 119 are connected an ignitor for the fuel nozzle 12, a control for a valve supplying fuel to the fuel nozzle 12, and a control for the air throttle valve 18. Line 119 extends to a contact 120, connected with the speed governor 93. The contact 120 is adapted to engage a contact 121, urged toward contact 120 by a spring 122 but held out of contact with contact 120 by a stop 123. Line 124 extends from contact 121 to connection point 104.

Closing of the switch 103 causes current to flow from the power source 102 through the lines 101 and 105, contacts 95 and 96, and line 99 to the starting motor 82. From the starting motor the current flows through the line 99, the connection point 100 and line 101 back to the power source. As the shaft 15 increases in speed, the shaft 90 does likewise causing the contact 95 to rise somewhat. However, the spring 97 maintains engagement of the contacts 95 and 96 with one another, and current continues to flow to the motor. When the speed of the shaft 15 has increased to a certain speed such as 1,000 R. P. M., the contact 108 will have risen sufficiently under the action of the governor 91 to engage the contact 107. This causes current to flow through the lines 106 and 111, the contacts 114 and 115, and the line 116 to the motor 79 for the auxiliary compressor, the control for the fuel valves 71, and the control for the distributor 88 for the spark plugs 70. This puts in operation the explosion-chamber burner 63 causing it to generate gases acting against the turbine wheels 14. The speed of the shaft 15 continues to rise, and when it has reached a somewhat higher speed, for example, 1,300 R. P. M. the governor 92 will have caused the contact 95 to rise sufficiently to allow the contact 96 under action of the spring 97 to strike the stop 98. Thereupon, contact between the contacts 95 and 96 is broken, flow of current to the starting motor 82 is interrupted, and the motor 82 is shut down. Thereafter, speed of the shaft 111 increases by the action of the explosion chamber burner 63 until it reaches a high value, for example, 3,000 R. P. M. At this point the governor 93 will have caused the contact 120 to rise sufficiently to engage the contact 121. Thereupon, current flows through the line 124, contacts 120 and 121, and line 119 to the controls for the air throttle valve 18, the valve for the main fuel nozzle 12, and the ignitor for the fuel nozzle 12. This places the turbine 10 in operation. The explosion-chamber burner 63 continues in operation and may be considered to act as a booster for the turbine 10, until the speed of the shaft 15 reaches a value, for example, 3,500 R. P. M. At this point the governor 94 will have caused the contact 112 to rise sufficiently for the contact 113 under the action of the spring 14 to reach the stop 115. Thereupon contact is broken between the contacts 112 and 113, and flow of current to the motor for the auxiliary compressor 79 and to the controls for the fuel valves 71 and the distributor 88 for the spark plugs 70 of the combustion chamber. The turbine 10 now runs without the help of the combustion-chamber burner 63. The speed of the turbine 10 now rises to its rated value, which may for example be 4,000 R. P. M. When the turbine is to be shut off, the switch 103 is opened. This action interrupts the flow of current to the controls for the turbine. Opening of the switch 103 prevents flow of current to the starting motor 82 and to the controls for the combustion chamber burner 63, preventing their operation. The turbine 10 comes to rest.

It is contemplated that the turbine 10 may be used to drive an automotive vehicle through a fluid coupling, which is well suited to receive drive at a certain speed and to transmit drive at a varia-

ble speed. The combustion-chamber burner may be used as a booster to meet the additional load requirements that arise at times in an automotive vehicle.

I claim:

1. In combination, a gas turbine of the continuous flow type comprising an impeller wheel adapted to rotate in a certain speed range, a continuously operating burner for continuously supplying gaseous products of combustion, means for feeding the gaseous products of combustion from the burner to the impeller, including a generally annular structure for distributing the gaseous products about the periphery of the wheel; and a starter for the turbine comprising a motor initiating rotation of the impeller wheel and bringing it to an intermediate speed below the certain speed range, a burner having combustion chambers for producing gases, and means providing passageways at a plurality of spaced regions through the annular structure for supplying gases produced in the combustion chambers against the impeller to bring the same from the intermediate speed to the certain speed range.

2. A starter for a gas turbine of the continuous flow type comprising a rotatable impeller and a continuously operating burner for continuously producing gas to be directed continuously against the impeller to maintain the same in a certain speed range, the starter comprising a motor for initiating rotation of the impeller and bringing it to an intermediate speed, a burner having combustion chambers and spark plugs and being positioned with respect to the impeller so as to direct gaseous products of combustion thereagainst for bringing the impeller from the intermediate speed to the certain speed range, means for compressing and supplying combustion-supporting gas to the combustion chambers of the last mentioned burner, and a rotary valve for interrupting the supplying of the combustion-supporting gas to the combustion chambers during ignition of fuel in the chambers by the spark plugs.

3. A starter for a gas turbine of the continuous flow type comprising a rotatable impeller and a continuously operating burner for continuously producing gas to be directed continuously against the impeller to maintain the same in a certain speed range, the starter comprising a motor secured to the shaft for initiating rotation of the shaft and impeller and bringing them to an intermediate speed below the certain speed range, and a burner of the combustion chamber type for supplying gaseous products of combustion to the impeller to bring it from the intermediate speed to the certain speed range.

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