Dec. 12, 1933. F. M. BROOKE 1,938,688

GAS TURBINE

Filed Dec. 19, 1931 3 Sheets-Sheet 1

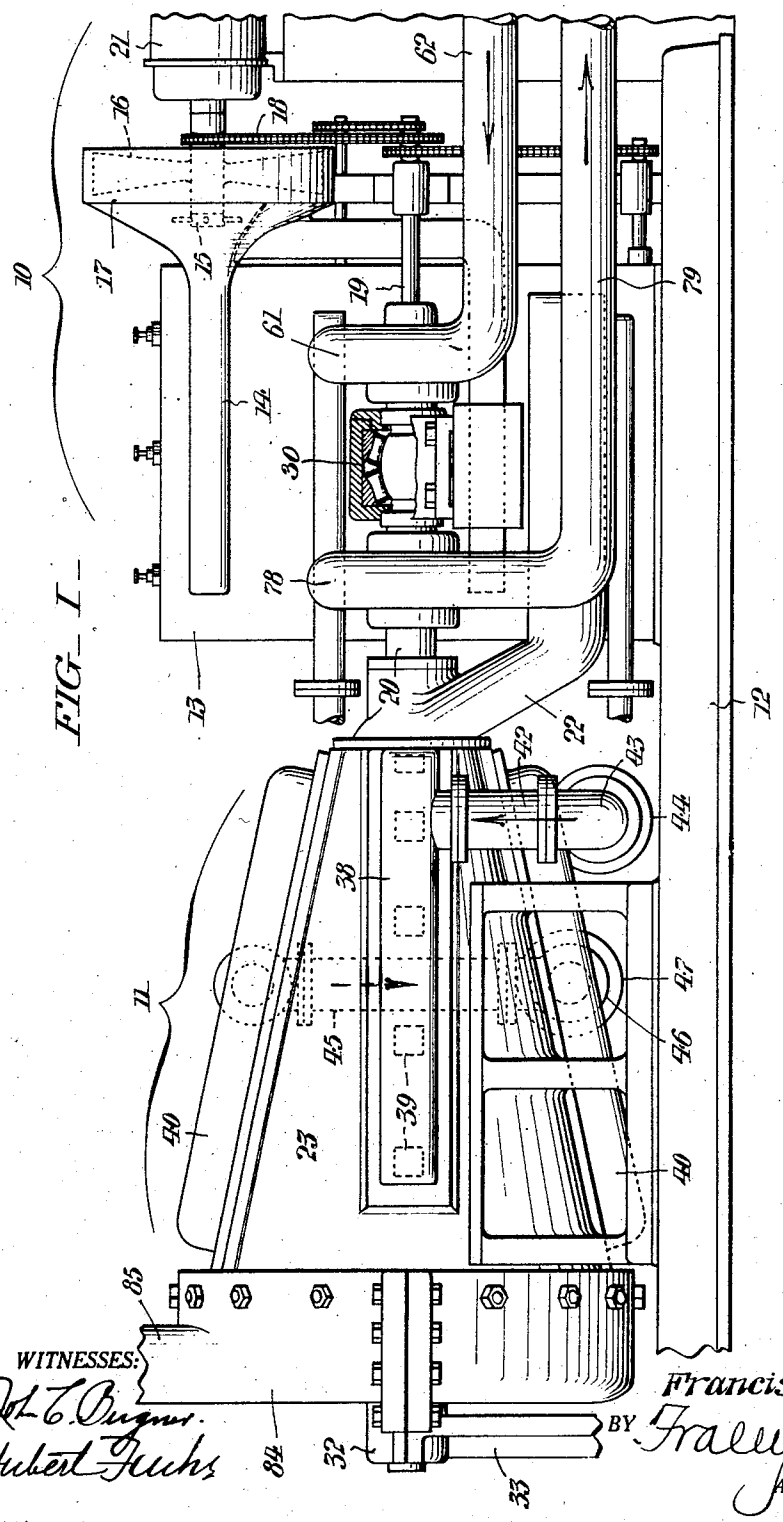


FIG. I.

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J. L. C. Bigger.
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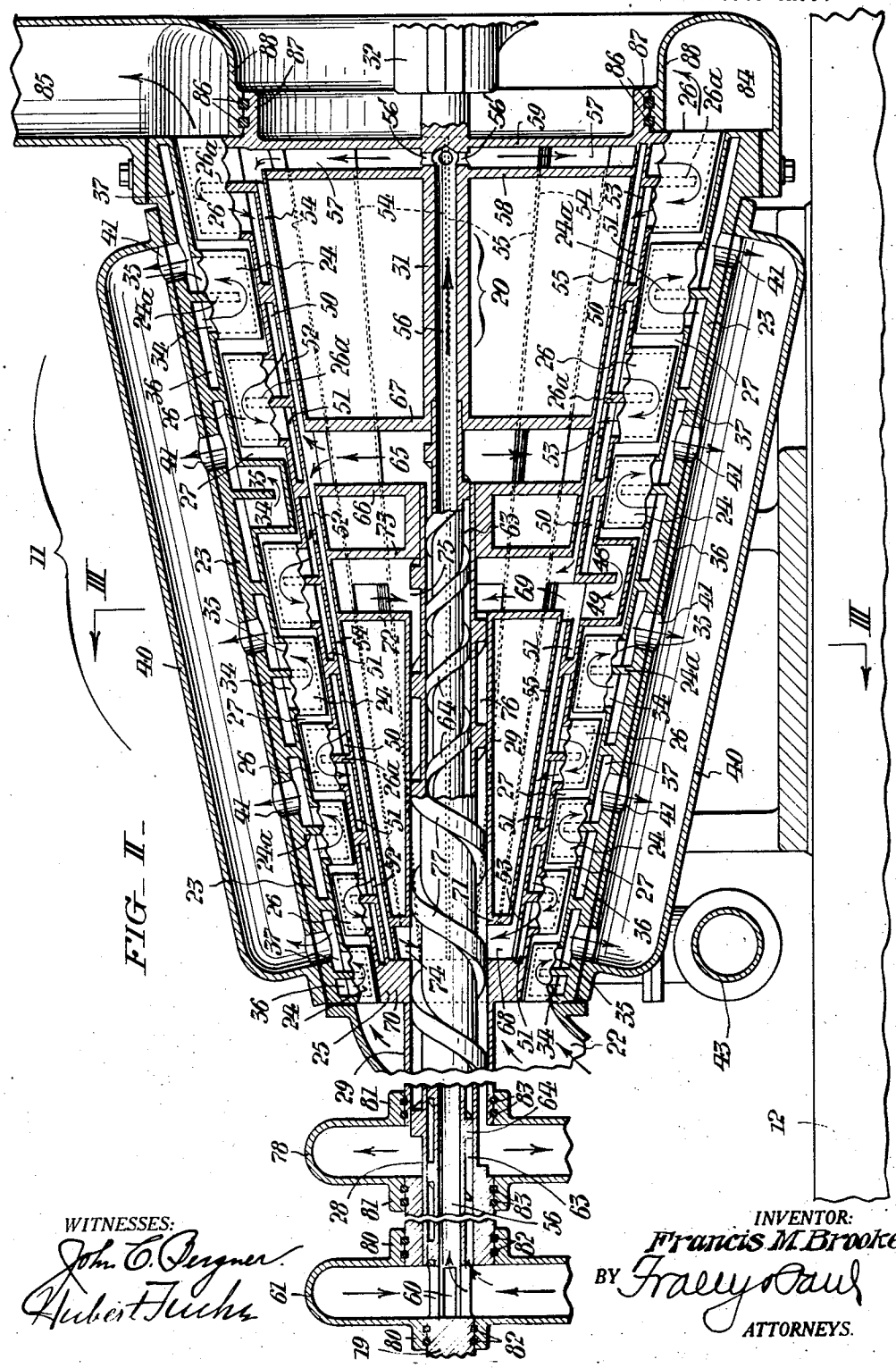


FIG. II.

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FIG. IV.

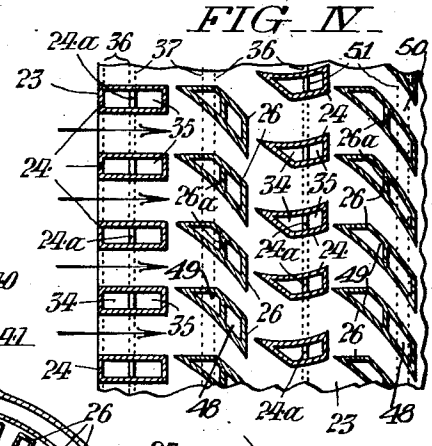
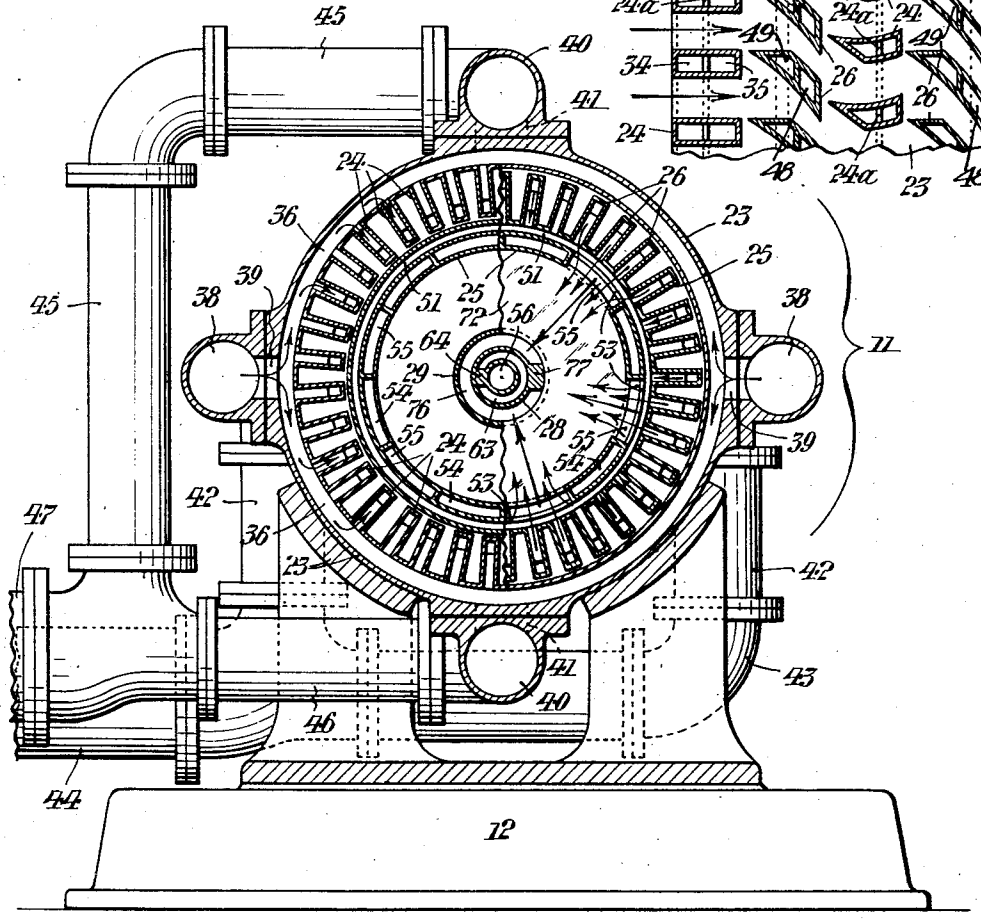


FIG. III.



WITNESSES:

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Patented Dec. 12, 1933

1,938,688

UNITED STATES PATENT OFFICE

1,938,688

GAS TURBINE

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Application December 19, 1931. Serial No. 582,090

10 Claims. (Cl. 60—41)

This invention relates generally to gas turbines and it has more particular reference to gas turbines of an elongate horizontal type generally resembling what are known as "Parsons" steam turbines.

The chief aim of my invention is to make possible the utilization of kinetic fluid resultant from the explosion of a combustible gas mixture to motivate turbines, of the kind referred to, without danger of burning the opposing stator and rotor blades, or any other stationary or movable parts of such structures.

With this end in view, I provide for the circulation of a fluent cooling medium, e.g. water, through the parts and surfaces of the turbines directly subjected to the hot motivating gases, with predetermination of definite circulation of the fluid through both the stator and rotor blades, and with determination of uniform apportionment of the flow of the cooling medium between the blades.

A further object of my invention is to secure the maximum operative efficiency in gas turbines of the character indicated, which desideratum I attain by constructing the stators and the rotors of the turbines with formation between them of a progressively flaring interspace for passage of the motivating fluid, and by gradually increasing the length of the stator and rotor blades from the charging end to the exhaust end of the turbine so that the full expansive power of the gases is utilized for useful work.

Other objects and attendant advantages of my invention will be manifest from the following detailed description taken in connection with the attached drawings; wherein, Fig. I is a side elevation of a power unit in which my improved turbine is associated with a generator suitable for the production of kinetic fluid for motivating the turbine, and with a minor portion thereof in section to illustrate a feature hereinafter explained.

Fig. II shows an axial section of the turbine drawn to a larger scale.

Fig. III is a staggered cross sectional view of the turbine taken as indicated by the arrows III—III in Fig. II; and,

Fig. IV is a fragmentary detail plan view showing the opposing blades of the stator and rotor of the turbine in horizontal section.

In Fig. I, the kinetic fluid generator is indicated comprehensively by the numeral 10, and the turbine by the numeral 11, both being mounted on a base plate or bed 12. The generator 10 is preferably of the construction set forth in my co-pending application, Serial No. 582,089 filed simultaneously herewith. Briefly described, the generator 10 comprises a housing 13 with a manifold 14 into which a combustible gaseous mixture is injected, through cooperative action of a rotary liquid fuel spray nozzle head 15 and a co-axially mounted air blower fan 16 which revolves in an open circular housing 17 forming a continuation of the manifold 14. Normally, the spray nozzle head 15 and the blower fan 16 are driven, through a sprocket chain connection 18, from a diametrically reduced prolongation 19 of the shaft 20 of the turbine 11; but a starting motor 21, directly connected to the fan 16, is provided by which the entire apparatus may be set in motion initially. The kinetic fluid resulting from the explosions of the fuel mixture in the generator 10, is continuously conducted from the housing 13 of the latter to the turbine 11 by way of a conduit 22.

As illustrated, my improved turbine 11 comprises an elongate hollow conical horizontal casing or stator 23 having inwardly directed stationary blades 24, and enclosing a co-extensive hollow rotor 25 of like configuration with outwardly directed blades 26 arranged in alternation with the blades 24 of the stator 23 within a circumferential interval 27 between said stator and rotor through which the motivating gases are caused to flow from the smaller to the larger end of the structure. The shaft 20 of the rotor 25 is of composite construction, its parts including the diametrically reduced prolongation 19 beyond the smaller end of the turbine 11, a sleeve 28 which surrounds said prolongation, and a larger tubular portion 29 in turn surrounding the sleeve 28, said tubular portion 29 being integrally formed with the turbine rotor 25 and extending inward from the smaller end of the turbine casing 23 to about the middle of the structure. As shown, a part of the tubular portion 29 of the shaft 20, protruding beyond the smaller end of the stator 23, in journalled in a thrust bearing 30, shown partly in section in Fig. I suitably supported at one side of the casing 13 of the kinetic fluid generator 10. The shaft 20 of the turbine rotor 25 further comprises an integrally formed tubular portion 31 of smaller diameter which constitutes a continuation of the reduced portion 19, already referred to, and extends from about the middle of said rotor out through the larger end thereof for journal sup-

port in the bearing 32 of a pedestal 33 upstanding from the base plate or bed 12, see Figs. I and II.

The stationary blades 24 of the turbine stator 23 are made hollow as shown in Figs. II and IV and provided interiorly with inwardly directed baffle partitions 24*a* which determine, in each instance, a definite course for the cooling medium between inlet and outlet ports 34 and 35. These inlet and outlet ports 34 and 35 communicate, respectively, with annular flow channels 36, 37 alternately arranged along the length of the stator 23, there being a pair of the channels 36, 37 for each circumferential row of the blades 24. As shown in Figs. II and III, the annular channels 36 communicate with a pair of manifolds 38 exteriorly of the turbine stator 23 by way of ports 39, while the alternate channels 37 communicate with another pair of manifolds 40 by way of ports 41. By means of branch pipes shown at 42, 43 in Figs. I and III, the manifolds 38 are connected to a flow main 44. The return manifolds 40 are in turn connected by branch pipes shown at 45, 46 with a return main 47 which leads to a radiator or storage tank, not shown, for the fluid. Thus, through the described connections and under the action of the pump, the fluent cooling medium is continuously circulated in the stator 23 through its channels 36, 37 and through the individual hollow stator blades 24, always in one direction as indicated by the arrows in Fig. II, each blade 24 having a definite proportion of the flow diverted through it.

The rotor blades 26 are likewise made hollow for circulation through them of the cooling medium, the fluid being in each instance confined to a definite course by a transverse outwardly directed baffle partition 26*a*. The inflow and outflow ports 48, 49 of each hollow rotor blade 26 communicate respectively with annular channels 50, 51 arranged in alternation along the length of the rotor 25, see Figs. II and IV. These channels 50, 51 in turn communicate respectively by way of ports 52, 53 with longitudinal passages 54, 55 arranged in alternation circumferentially of the rotor 25. The cooling medium is conducted to the longitudinal passages 54 from the axial duct 56 of the turbine shaft 20 by way of terminal ports 56' and a passage 57 formed between a pair of partitions 58, 59 extending transversely of the rotor 25 at the larger end of the same. Beyond the smaller end of the turbine 11, the axial duct 56 of the turbine shaft 20 communicates, by way of radial ports 60, with a surrounding distributor head 61 positioned at one side of the thrust bearing 30, see Fig. I, said head receiving the cooling medium from a radiator, (not shown, which may be the same as the one serving the stator 23 of the turbine 11) through a connecting conduit 62. Part of the flow of the cooling medium conducted to the distributor head 61 is drawn into an interval or duct 63 between the shaft section 19 and the sleeve 28, under suction induced by a thread or spiral 64 formed on the said shaft section 19. Within the turbine 11 near the center, the interval or duct 63 of the rotor shaft opens into a passage 65 formed between another pair of partitions 66, 67 extending transversely of the rotor 25. From this crosswise passage 65, the cooling medium enters the several longitudinal passages 54 of the rotor 25 to supplement the supply of the cooling medium conducted to said passages by way of the transverse passage 57 at the larger end of the turbine 11. Circulation through the axial duct 56 of the rotor shaft 20 and the crosswise passage 57 at the larger end of the turbine 11 is induced, by centrifugal action, the cold and heavier water introduced into the larger end of the turbine 11 forcing the heated and lighter water toward the smaller end of said turbine, in a manner readily understood from Fig. II of the drawings. There are still two other crosswise passages 68, 69, the former at the smaller end of the turbine 11 and the latter adjacent to the passage 65, respectively formed by spaced transverse partitions 70, 71 and 72, 73 for the return of the cooling medium after the latter has circulated through the individual rotor blades 26 and coursed through the longitudinal passages 55. The transverse passages 68 and 69 respectively communicate, at 74 and 75, with the interval or duct 76 between the outer tubular portion 29 of the turbine shaft 20 and the sleeve 28, which latter, like said portion 19 of the shaft, is formed with a thread or spiral 77, such thread or spiral being however in this instance pitched oppositely, so that, by centrifugal-conveyor action, the cooling medium from the various return passages in the rotor 25, will be conducted or forced into a collector head 78 located at the opposite side of the thrust bearing 30 from that occupied by the distributor head 61, hereinbefore referred to. From the collector head 78, the cooling medium is conducted by way of a return conduit 79 back to the radiator from whence it originally came. To prevent leakage of the cooling fluid at the distributor and collector heads 61 and 78 I have interposed between bosses 80, 81 of said heads and the tubular portion 29 of the turbine shaft 20, packing rings which are indicated respectively at 82 and 83.

From Figs. II and IV it will be noted that the kinetic fluid from the generator 10 is conducted by the conduit 22 into the smaller end of the turbine 11 for traverse longitudinally of said turbine between the opposing stator and rotor blades 24 and 26. It is furthermore to be particularly noted that the circumferential interval 27 between the stator 23 and rotor 25 flares from the smaller to the larger end of the turbine 11, and moreover that the blades 24 and 26 increase in length from left to right in Fig. II, such flare and increase in blade lengths being in direct proportion to the rate of expansion of the kinetic or motivating fluid with resultant attainment of the maximum efficiency in the operation of the turbine 11. The spent gases ultimately discharge into an annular exhaust head 84 forming part of the turbine casing 23 at the larger end, and are finally conducted away from the turbine 11 through an upward flue pipe 85 connecting into said exhaust head.

To insure against gas leakage at the larger end of the turbine 11, packing rings are interposed, as shown at 86 in Fig. II, between an annular flange extension 87 of the rotor 25 and the inner circumferential wall 11 of the exhaust head 84. Similar provisions (not illustrated) are made against leakage at the region where the turbine shaft 20 enters the gas induction manifold 22 at the smaller end of the turbine housing 23.

Having thus described my invention, I claim:

1. In a gas turbine, an elongate frusto-conical stator with a multiplicity of inwardly-directed hollow blades having inflow and outflow ports, annular channels alternatingly arranged along

the length of the stator wall, there being a pair of such channels communicating respectively with the opposite ends of the several circumferential rows of the stator blades, and longitudinal flow and return manifolds for conducting cooling medium by way of the annular channels and inflow ports to the outflow ports, for continuous circulation through the hollow stator blades always in one direction, with a definite proportion of said flow being diverted through each individual blade.

2. In a gas turbine, an elongate flaring stator, a hollow rotor of like configuration, said stator and rotor being provided with inwardly and outwardly directed hollow blades having inflow and outflow ports, a hollow rotor shaft including means defining an axial flow and concentric return ducts, and annular longitudinal passages through the rotor walls, said annular passages connecting in alternation with the respective inlet and outflow ports of the rotor hollow blades, and the longitudinal passages alternatingly affording flow and return communication from and to the hollow shaft ducts aforesaid with predetermination of an equally distributed flow of the cooling medium.

3. In a gas turbine, an elongate frusto-conical stator with a multiplicity of inwardly-directed hollow blades having inflow and outflow ports, a rotor of like configuration with outwardly-directed hollow blades having inflow and outflow ports, annular channels alternatingly arranged along the length of the stator wall and communicating respectively with opposite ends of each circumferential row of the hollow blades, similar channels with communicating longitudinal passages through the rotor wall, flow and return manifolds arranged in alternation around the turbine wall for conducting cooling medium respectively to and from the stator hollow blades and annular channels, and a hollow shaft including means defining an axial-flow and concentric return ducts for conducting cooling medium to and from the rotor annular channels and longitudinal passages aforesaid.

4. In a gas turbine, an elongate frusto-conical hollow stator with a multiplicity of inwardly-directed hollow blades having inlet and outlet ports, a rotor of like configuration with a multiplicity of outwardly-directed blades alternating with those of the stator, said rotor blades being hollow and having inlet and outlet ports, a hollow rotor shaft including means defining an axial flow and spiral return concentric ducts, for the cooling medium, transverse passages afforded between partitions in the rotor connecting with the ducts in the shaft, and manifold means conducting cooling medium to and from the turbine for continuous circulation through the stator and rotor walls and blades.

5. In a gas turbine, an elongate frusto-conical hollow stator with a multiplicity of inwardly-directed blades embodying flow-defining partitions, manifold means conducting cooling medium for circulation by way of connecting ports, through said stator blades, a hollow rotor of like configuration with a multiplicity of outwardly-directed blades alternating with those of the stator, said rotor blades being similarly-partitioned and having inlet and outlet ports, for circulation of the cooling medium through them, a hollow rotor shaft embodying concentric components defining flow and return ducts for the cooling medium, transverse passages afforded between partitions in the rotor for conducting the cooling medium to and from the hollow shaft to the rotor blades, and helical means included in the hollow shaft for impelling the cooling medium through the rotor.

6. In a turbine, an elongate frusto-conical hollow stator with a multiplicity of inwardly-directed hollow blades embodying flow-defining partitions, manifolds conducting fluent cooling medium for circulation, by way of connecting ports, through said stator blades, a hollow rotor of like configuration with a multiplicity of outwardly-directed blades alternating with those of the stator, said rotor blades being similarly partitioned and having inlet and outlet ports for circulation of the fluent cooling medium through them, a hollow rotor shaft embodying coaxial tubes defining concentric flow and return ducts for the cooling medium, transverse passages afforded by partitions across the rotor for conducting the cooling medium to and from the rotor and its blades, and a spiral in the hollow shaft intermediate the coaxial tubes operating to impel the cooling medium through the rotor.

7. In a gas turbine, an elongate frusto-conical stator with a multiplicity of inwardly-directed hollow blades, a hollow rotor of like configuration with a multiplicity of outwardly-directed blades alternating with those of the stator, said rotor blades being hollow for circulation of a fluent cooling medium through them, a hollow rotor shaft with means defining concentric flow and return ducts for the cooling medium, transverse passages afforded by partitions across the rotor for conducting the cooling medium to and from the rotor blades, and reversely pitched spirals respectively in the flow and return passages of the shaft for impelling the cooling medium through the rotor.

8. In a gas turbine, an elongate frusto-conical hollow stator with inlet and outlet ports for circulation of a fluent cooling medium therethrough and a multiplicity of hollow inwardly-directed blades, said blades embodying flow-defining partitions, a correspondingly configured hollow rotor with a multiplicity of outwardly-directed opposing blades, said rotor blades being formed hollow and similarly-partitioned for circulation of the fluent cooling medium through them, annular channels alternatingly arranged lengthwise of the rotor wall and communicating respectively with opposite ends of each circumferential series of the hollow blades, spaced longitudinal passages around the rotor and communicating respectively with the annular channels aforesaid, a hollow shaft embodying coaxial tubes with intervening spirals defining concentric flow and return ducts for the cooling medium, and transverse passages afforded by partitions across the rotor for conducting the cooling fluid between the ducts of the rotor shaft and the longitudinal passages aforesaid.

9. In a gas turbine, an elongate frusto-conical hollow stator with inlet and outlet ports for circulation of a fluent cooling medium therethrough and a multiplicity of inwardly-directed hollow blades, said stator having ports communicating with inlet and outlet manifolds and the blades embodying flow-defining partitions, a correspondingly-configured hollow rotor with a multiplicity of outwardly-directed opposing blades, said rotor blades being formed hollow and having outwardly-directed transverse partitions defining inflow and outflow passages for circulation of the fluent cooling medium through

them, a hollow shaft for the rotor with concentric flow and return ducts including reversely pitched spirals for impelling the cooling fluid through the hollow rotor blades, distributor and collector heads surrounding the rotor shaft and communicating respectively with the flow and return ducts through the latter, and supply and return mains for conducting the cooling fluid to and from the distributor and collector heads respectively.

10. In a gas turbine, an elongate horizontal frusto-conical rotor with longitudinal passages through its walls with communicating annular channels for circulation of a fluent cooling medium, a hollow rotor shaft of coaxial tubular members defining concentric flow and return ducts with associated spirals for impelling cooling medium therethrough, a transverse passage between spaced partitions in the rotor for conducting the cooling medium from the flow duct in the shaft to the longitudinal passages aforesaid at the larger end of the turbine, and another transverse passage between similar partitions at the smaller end of the rotor for conducting the cooling medium from the longitudinal passage aforesaid to the return duct in the shaft.

FRANCIS M. BROOKE.