

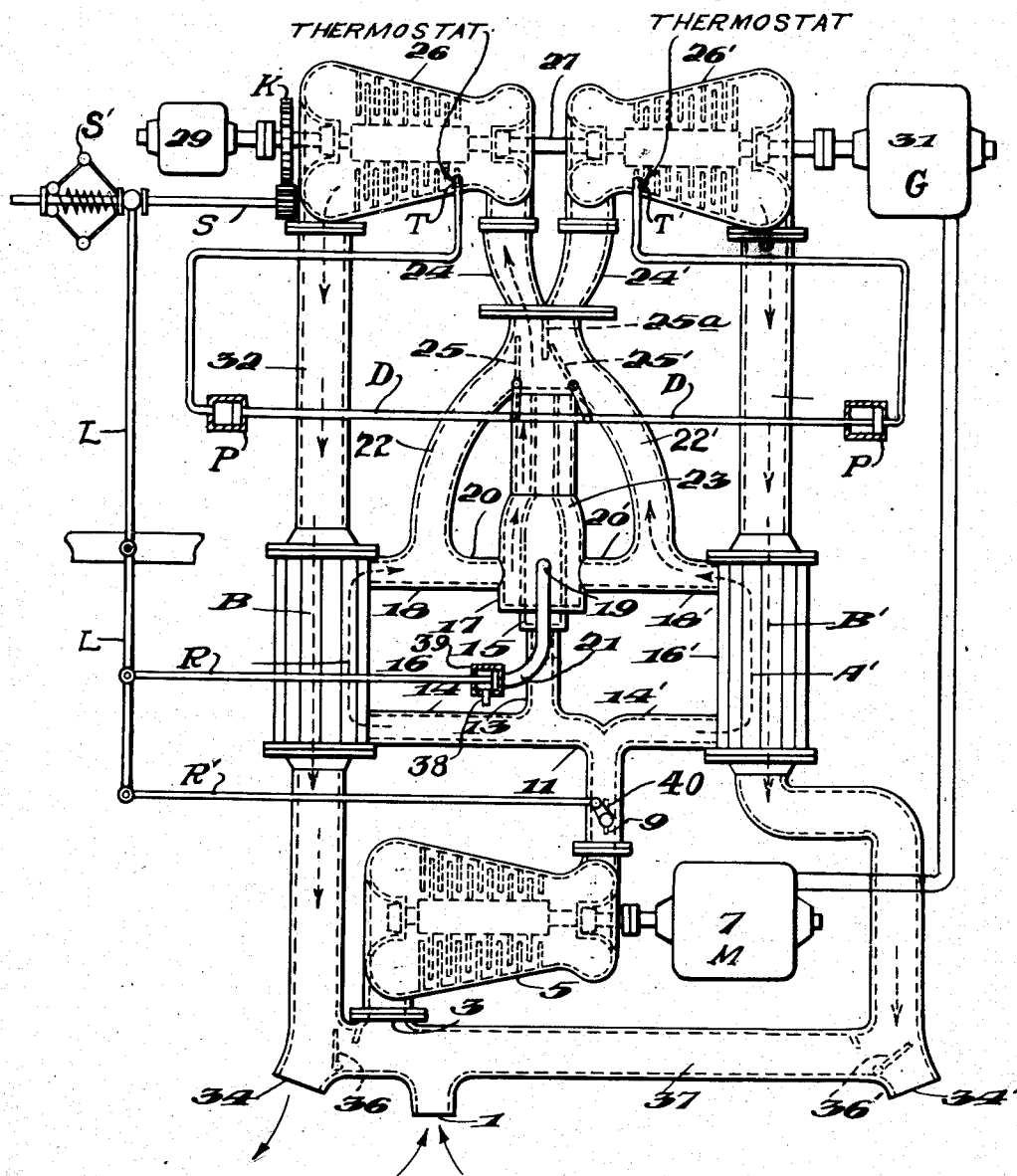
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TURBINE SYSTEM

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TURBINE SYSTEM

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This invention relates to turbines and, particularly, to a turbine system wherein relatively hot and cool motive fluids are alternately used.

The object of this invention is to provide a turbine system driven, primarily, by the energy from the combustion products of gases, fuel oil, gasoline, natural gas, blast furnace gas, pulverized coal, or the like. Additionally, it is herein proposed to provide a system wherein continuous combustion occurs, and wherein the energy from combustion is substantially continuously utilized. Development of such systems, broadly known as gas turbines, has heretofore been deterred because the turbine blades would not withstand for long the heat from the combustion gases to which they were continuously exposed. With the efficiency of an engine directly proportioned to the contrast between the highest and the lowest heat content of the working fluid, it was found that the lower end of the temperature range was limited to about 70° F. in accordance with the temperature of the surrounding atmosphere and the overall efficiency of cooling apparatus, and that the upper end of the range was stunted by relatively poor heat withstanding properties of available metals at about 1000° F. It is an object of this invention to devise a turbine system wherein the upper end of the temperature range extends to around 1500° F. to 1800° F., the lower end remaining at about 70° F., thereby to provide a system of materially increased efficiency.

Still again it is an object to provide a turbine system including blades driven, for one part of a cycle, by extremely hot gases and cooled, during another part of the cycle, by air. To avoid heat loss, the cooling air is preheated by the hot gases during exhaust so that, as the cooling air expands into the turbine chamber, it absorbs heat therefrom and also drives the blades.

In contrast with previous systems utilizing, alternately, hot gas and cooling air and requiring intermittent combustion, the present invention contemplates utilizing two turbines geared together, and continuous combustion system, the products of the continuous combustion being directed first to one turbine and then to the other. While hot gases drive the first turbine, the second is simultaneously cooled and driven by air preheated and compressed by the hot gas exhaust. When the first turbine has absorbed as much heat from the hot gases as it can stand, the system is switched so that air cools and drives the first turbine while the gases drive the second. An auxiliary object is to utilize the exhaust of the hot air, after it leaves the turbines for preheat-

ing the air used for combustion. Yet another object is to provide a compact system, the principal elements of which serve double duty, first for utilizing gas, and then for air. Since relatively few of the elements are subject to the most intense heat in the system for very long, it is also intended to provide a unit of relatively low weight and cost.

These and other objectives will appear in the following specification and drawing which diagrammatically illustrates the system.

Starting at the lower end of the drawing, reference numeral 1 designates an inlet from the atmosphere of air, at relatively low temperature and pressure, air being drawn through inlet 3 into centrifugal air compressor 5 driven by an electric motor 7 suitably connected to a source of electric power, preferably a generator 31 described below. From the discharge end 9 of compressor 5 the air is driven to a header 11 for distribution to a center branch 13 and to left and right end branches 14 and 14', respectively.

Center branch 13 feeds air to the burner chamber 15 of a combustion chamber indicated generally by reference numeral 17, the burner chamber containing a continuously operating burner 19 fed with fuel from source conduit 33 through throttle apparatus 39 and fuel burner conduit 21, continuous burners of this type being well known in the art.

End branches 14, 14' feed air through heat exchangers 16, 16' as indicated by arrows A, A', the air being heated in transit through the heat exchangers, after which the air passes to left and right conduits 18, 18', respectively, conduits 18, 18' each being split into arms 20, 20' to feed an air chamber 23 which surrounds burner chamber 15 in combustion chamber 17, and arms 22, 22' which by-pass combustion chamber 17 and lead to yoked switch dampers 25, 25' detailed below.

From switch dampers 25, 25', conduits 24, 24', respectively, connect to the input side of turbines 26, 26' which have a common shaft 27 connected at one end to a starting motor 29 and at the other end to a generator 31 or other power utilizing device. Exhaust lines 32, 32' lead from the output sides of the turbines through heat exchangers 16, 16' as indicated by lines B, B' and to outlet openings 34, 34' to the atmosphere. Dampers 36, 36' are provided for closing off the outlet openings and, simultaneously, reverting the still hot air through return 37 to intake opening 1 for preheating the air coming from the atmosphere.

In the first cycle of operation, considering the left side of the system first for clarity, relatively

cool, low pressure air is taken from the atmosphere through intake opening 1, driven by compressor 5 through header 11 through center branch 13 to burner chamber 15 to provide continuous combustion of fuel in burner 19. The hot combustion gases pass from combustion chamber 17 between switch dampers 25, 25' which, when in the position shown, direct the hot gases through input 24 to turbine 26 to drive shaft 27. Hot gases from turbine 26 exhaust through line 32 and through heat exchanger 16, thus giving up heat to air fed through heat exchanger 16 from left end branch 14 of header 11. The preheated air from heat exchanger 16 is fed to conduit 18, branch 22 of which is blocked by switch damper 25. Branch 20 being open, however, the preheated air is fed into the air chamber 23 which surrounds burner chamber 15 in combustion chamber 17 for tempering the hot combustion gases. One part of the air in chamber 23 passes from the open end thereof between switch dampers 25, 25' and intermingles with the combustion gases to drive turbine 26, the other part passing on through chamber 23 to arm 20' of conduit 18' and through arm 22', which is switched by switch damper 25' into communication with input conduit 24' of turbine 26'. From turbine 26', hot air is exhausted by line 32' through heat exchanger 16' to partially closed damper 36', from which a part of the hot air returns through 37 to preheat the air entering at 1.

Considering now the right-hand side of the system, air from compressor 5 is meanwhile driven through header 11 and through right hand branch 14' to heat exchanger 16', in which it derives some heat from the exhaust of turbine 26'. From heat exchanger 16', the now hot air passes through conduit 18' into arm 22' where it combines with the heated air from the other side of the system and passes switch damper 25' into input conduit 24' to drive turbine 26'.

In the second cycle of operation, the positions of switch dampers 25, 25' are reversed, that is, damper 25 is swung to the right to engage baffle 25a, thereby placing arm 22 in communication with input conduit 24 of turbine 26; combustion chamber 17 is cut-off from input conduit 24; damper 25' is swung to the right to close arm 22', and combustion chamber 17 is switched into communication with input conduit 24' of turbine 26'. Simultaneously damper 36 swings to the left partially to close outlet opening 34, and damper 36' is swung to the left to shut off return 37 from exhaust line 32'. In the second cycle, the operation of the system is the reverse of that in the cycle first described. Turbine 26 is now driven and cooled by hot air while turbine 26' is driven by the hot combustion gases.

The system being diagrammatically illustrated, it is to be understood that any of the well known fuel injectors may be utilized to feed burner 19, and any necessary relief valves, dampers or the like to prevent excess pressures or undesired back pressures in the lines and combustion chamber may be incorporated.

In the preferred embodiment, switch dampers 25, 25' are yoked together as shown and oscillated between their left and right hand positions by a single driving member D. The driving member D is operated by piston mechanism P and P' controlled by thermostatic elements embedded, as shown, in stationary blades T and T' in turbines 26, 26' so that the dampers will remain in the position shown until the blades in turbine 26 reach their maximum allowable temperature.

When the blades in turbine 26 can absorb no more heat without deterioration, the thermostatic element in turbine 26 causes dampers 25, 25' to swing to the right, thus switching the system to its second cycle. Thereafter, a thermostatic element in turbine 26' returns dampers 25, 25' to the positions shown when the blades in turbine 26' have been heated to their limits, the blades in turbine 26 meanwhile having been sufficiently cooled.

In order to govern the power output and speed of the system to suit load requirements, throttle apparatus may be interposed either in the compressed air supply or in the fuel or gas supply. These may be operated either in accordance with the speed changes in the turbines or manually controlled arbitrarily. For instance, control mechanism including gearing K, shaft S, governor S', and pivoted link L, is effective upon increase of turbine speed to (1) cause through movement of rod R, actuation of throttle apparatus 39, thus reducing fuel flow to burner 19, and (2) cause through movement of rod R', actuation of throttle valve 40 in the compressed air line, thus reducing the supply of air. Of course a reduction in turbine speed reverses the action of the controls.

From the above description, it will be seen that not only is heat derived by the relatively cool air from the heat exchangers, but also from the turbines themselves, the materials of which store heat derived from the hot gases for rapidly expanding the cooling air entering the turbines.

The invention is not to be limited to the specific system disclosed, but is intended to cover all equivalents, substitutes, and modifications within the scope of the following claims.

I claim:

1. In a continuous combustion turbine system, a first turbine, a second turbine, a continuous type combustion chamber for producing hot gases, a source of relatively cool fluid under pressure, conduit means connecting said chamber and said source to said turbines, switch means for regulating the flow of said gases and said fluid in said conduit means, said switch means being movable between two positions, in the first of which said positions said chamber and said source respectively communicate with said first and second turbines, in the second of which positions said source and said chamber respectively communicate with said first and second turbines, and means for oscillating said switch means between said positions.
2. The combination claimed in claim 1, said means for oscillating said switch means between said positions including thermal-responsive means operable in accordance with the heat in at least one of said turbines, and control means operably connecting said thermal-responsive means and said switch means whereby, when said switch means is in one of said positions, to move said switch means from one to the other of said positions when said one turbine attains a predetermined temperature.
3. The combination claimed in claim 1, said source of air under pressure including heat-exchange means connected with at least one of said turbines, and means for forcing said fluid through said heat-exchange means.
4. The combination claimed in claim 1, said source of air under pressure including heat-exchange means on the output side of each of said turbines, and means for forcing said fluid

through said heat-exchange means whereby to preheat said fluid.

5. In combination, first and second turbines having rotors, input and outlet sides, means gearing said rotors together, a combustion chamber, heat-exchange means connected to the outlet sides of said turbines, fluid line means for feeding fluid under pressure through said heat exchange means, first and second input conduit means connected, respectively, to the input side of said turbines, means movable between two positions for connecting said combustion chamber to said first input conduit means and said fluid line means to said second input conduit means in the first of said positions, and for connecting said fluid line means to said first input conduit means and said combustion chamber to said second input conduit means in the second of said positions, and means for moving said movable means between said positions.

6. In a turbine system, first and second sets of turbine blades, a source of hot combustion gases, a source of relatively cool fluid under pressure, control means movable between two positions for causing said gases and said fluid to impinge upon said first and second sets, respectively, and, in the second of said positions, to cause said fluid and said gases to impinge upon said first and second sets, respectively, and means for oscillating said control means between said positions.

7. In a turbine system, first and second sets of turbine blades, means gearing said sets to one another for rotation together, continuously operable combustion means, a source of relatively cool fluid under pressure, conduit means for directing the products of said combustion means and said fluid to said first and second sets, control means in said conduit means movable between two positions whereby, in the first of which positions, to limit the flow of the combustion products and the fluid to said first and second sets, respectively, and whereby, in the second of said positions, to limit the flow of said combustion products and said fluid to said second and first sets, respectively, and means for moving said control means between said positions in accordance with the temperatures of said blades.

8. In a turbine system, first and second sets

of turbine blades, input and outlet means for respectively directing and exhausting motive fluid to and from said sets, heat-exchange means connected to said outlet means, said heat-exchange means including air conduit means, continuously operable combustion means, means for feeding air under pressure to said combustion means and to one end of said air conduit means, means connecting the other end of said air conduit means and said combustion means to said input means, and switch means in said last-mentioned means for directing the products of said combustion means, selectively, to the input means of said first and second sets while simultaneously directing air to said second and first sets, and means operable in accordance with the temperatures of said blades for controlling said switch means.

9. In the combination claimed in claim 8, means connecting said other ends of said air conduit means to said combustion means for supplying pre-heated air thereto.

10. The combination claimed in claim 8, said outlet means including exhaust conduit means passing through said heat-exchange means and exhausting to the atmosphere, said means for feeding air under pressure including air intake means, feed-back conduit means connecting said exhaust conduit means and said air intake means, and damper means in said feed-back conduit means for selectively closing off said exhaust conduit means from said air intake means.

11. In a turbine system, a plurality of sets of turbine blades, a plurality of input means for respectively supplying motive fluid to said sets, continuously operable combustion means for supplying hot combustion gases under pressure, a plurality of sources of relatively cool fluid under pressure, first conduit means connecting said combustion means to said input means, second conduit means connecting said sources of relatively cool motive fluid to said combustion means, third conduit means connecting said sources to said input means, and control means between said first and third conduit means and said input means for alternately directing said combustion gases to one of said intake means while simultaneously directing said cool motive fluid to another of said input means.

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