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GAS TURBINE

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My present invention relates to gas turbines, and has for its special object to improve the construction of those parts which are exposed at the same time to high pressure and high temperature. Considerable difficulties have been experienced in practice with reference to such parts, and particularly the combustion chamber in which the driving gas is produced, the nozzles through which such gas is discharged against the rotor of the turbine, and the conduit through which the gas is conveyed from said combustion chamber or producer to such nozzles. It has been proposed to surround said parts with a jacket of refractory material capable of withstanding high temperatures and having heat-insulating properties, so as to prevent or minimize the outward propagation of the heat, and according to such proposition, the jacket (which is not particularly resistant to pressure) was to be encased in an outer wall of sheet metal, well able to resist pressure, but not so well adapted to resist high temperatures. The purpose was to have the refractory jacket keep the heat from reaching the sheet metal shell, while the latter was expected to furnish the requisite resistance against pressure. It was found, however, that the inevitable temperature variations would produce cracks in the refractory jacket material, and through these cracks the high temperature would reach the sheet metal shell, which would thus be deprived, in a large measure, of the protective effect exerted by the refractory jacket as long as the latter remained undamaged, that is to say, imperforate. The strength of the metal shell would then be reduced materially by such exposure of high temperatures. Another expedient proposed for dealing with the difficulty mentioned above, consisted in causing a fluid cooling medium (for instance air or other gases, or liquids) to circulate or flow through a jacket surrounding the path of the hot driving gas. This procedure, however, abstracted so much heat energy from the driving gas as to reduce very materially the degree of efficiency with which the turbine could be operated.

To overcome these defects, I have devised a construction according to which the parts constituting the path of the driving gas are made of refractory material, and are surrounded by a jacket which contains two kinds of materials, viz. one material, of granular structure, insulating against heat, and a fluid material under pressure, for instance compressed air or gas.

By this novel arrangement I secure a double advantage; first, the outer shell is insulated completely, by the granular filling layer, from the tube or casing exposed to the high temperatures, and second, the pressure of the air or gas admitted to the jacket space, counter-balances the pressure which the driving gas exerts outwardly on the said tube or casing, thus relieving such tube or casing of pressure. Mechanical or pressure strains are therefore borne exclusively by the shell which retains its strength since the interposed granular layer keeps the shell relatively cool, as compared with the parts forming the walls of the path through which the hot driving medium courses. I do not abstract heat by a continuous flow of a cooling fluid, as in some prior constructions, but the jacket space has no outlet, and is closed so as to contain permanently a stagnant body of gas, the only purpose of which is to exert a pressure counteracting that of the driving medium and thus to relieve the walls of the hot driving gas path, of excessive pressure.

In large-size installations, the walls forming the path of the driving gas may consist of elements, for instance segments or pipe sections, overlapping in such a manner as to permit longitudinal expansion or contraction, or such elements may simply be in loose contact at their meeting portions. Tight joints are not essential, since the pressure is preferably the same on the outside as on the inside. The granular material which fills the jacket space will admit of uneven expansion when heated more or less strongly. Should nevertheless cracks develop in the walls forming the path of the hot driving gas, this will have no serious consequences in my improved construction, since the gas will have practically no tendency to escape into the jacket through such cracks.

The stator blades or nozzles are preferably made of metal, for the sake of more convenient manufacture, and it is therefore desirable that these parts should not be subjected to high pressure and high temperature. In order to accomplish this, the expansion of the hot gaseous driving medium is caused to take place within the refractory material, that is to say, before such medium reaches the metallic stator blades or nozzles. For instance, such expansion may take place in an annular nozzle conduit located in the immediate vicinity of the stator blades or nozzles.

Some difficulty may be expected in obtaining tight joints at the points where the refractory material, exposed to high pressure, is in contact with the metal stator blades or nozzles, exposed to a lower pressure. According to my invention, this difficulty is overcome by providing flanges located within the jacket space and forced uniformly against the joint by the static pressure prevailing in said space.

To maintain the proper pressure in the jacket space, I prefer to connect said space with the delivery side of a compressor associated with the turbine and furnishing the pressure for the interior of the path through which the hot gaseous driving medium travels to the turbine. This connection may be made either at the outlet of the compressor, or at any other suitable point of the delivery conduit. It is to be understood that there is no flow in such connection, but only a transfer of pressure.

A satisfactory and preferred embodiment of my invention is shown, as an example, in the accompanying drawings, in which Fig. 1 illustrates such embodiment in vertical section, and Fig. 2 shows a detail, upon an enlarged scale.

The gas turbine 1 (of any suitable construction) has a direct drive connection with the air compressor 2 (likewise of any suitable construction) which delivers air for supporting combustion, to the combustion chamber 3, provided with fuel inlets or burners 14 of any appropriate type. Hot combustion gases produced in the chamber 3 are driven, under the pressure exerted by the compressor 2, through the pipe or conduit 4 and into the annular conduit 5. The gases then pass through the stator nozzles or blades indicated at 6, and impinge upon the rotor blades 7 of the turbine, whereupon they reach the outlet channel 8.

The parts exposed to high pressure and high temperature, that is to say, the combustion chamber 3 and the conduits 4, 5 are made of firebrick, carborundum, special temperature-resisting steel, or other material refractory to heat. At a suitable distance, these parts are surrounded by a metal shell 15, resistant to pressure. The intervening

jacket space 10 is filled with granular material 9 refractory to heat (for instance, pieces of fire-brick) and arranged loosely so as to leave a substantially continuous air-space; in other words, there will be no isolated air-pockets, or practically none, so that air under pressure from the outlet of the compressor 2, will be able, through a pipe 11 connecting the heat-insulating space 10 with the said outlet, to produce within said space (as long as the compressor is in operation) a pressure equal to the delivery pressure of the compressor. This delivery pressure will also prevail in the combustion chamber 3 and the conduits 4, 5.

The conduit 5 may be provided with an annular expansion outlet 5', that is to say, an outlet flaring toward the stator nozzles 6, so that the gases during their passage through said outlet 5' will be cooled by expansion, and also reduced in pressure, to a point where their temperature and pressure will not affect the nozzles 6 injuriously.

At the outlet end of the conduit, and still within the jacket space 10, the refractory material of which said conduit is made, is provided with a flange 12 fitted tightly against the metal nozzles 6 and against the metal casing 13 of the turbine 1. The compressor pressure prevailing in the jacket space 10 will thus hold the flange 12 in tight engagement with said metal parts. A similar flange 12' may be located at the air inlet of the combustion chamber 3, to preserve, in the same manner, a tight joint between the refractory material of said chamber and the metal of the surrounding shell 15, at the outlet of the delivery pipe coming from the compressor 2.

Fig. 2 illustrates the details of an expansion joint which I may employ in the conduit 4 when the parts are of relatively considerable dimensions. The two conduit sections have nested portions 16 of reduced thickness which may slide lengthwise upon each other when the conduit expands or contracts. The gap 18 which generally remains between the extremity of one conduit section and the shoulder on the other conduit section, is covered by a ring 17 wide enough to bridge said gap in all positions of said sections, thus to prevent the granular material 9 from entering the gap 18 and interfering with the longitudinal movement of the overlapping ends of the conduit sections.

Various modifications may be made without departing from the nature of my invention as set forth in the appended claims.

I claim:

1. In combination, a conduit made of heat-resisting material, for conveying a hot gaseous driving medium to a place of use, a jacket surrounding said conduit at a distance, and means for keeping said jacket filled with a stagnant gaseous fluid under pressure.

2. A device according to claim 1, in which the jacket, in addition to the stagnant gaseous fluid under pressure, contains a loose filling of refractory material.

3. In combination, a refractory combustion chamber for producing hot gases under pressure, a conduit made of refractory material, for conveying said hot gases to a place of use, a jacket surrounding said combustion chamber and said conduit at a distance, and means for keeping said jacket filled with a stagnant gaseous fluid under pressure.

4. In combination, a refractory combustion chamber for producing hot gases under pressure, a conduit made of refractory material, for conveying said hot gases to a place of use, a jacket surrounding said combustion chamber and said conduit at a distance, means for keeping said jacket filled with a stagnant gaseous fluid under pressure, and a loose filling of refractory material in said jacket.

5. In combination with a turbine, a combustion chamber for producing hot gases under pressure, an air compressor driven by said turbine and arranged to deliver air under pressure to said chamber, a refractory conduit for conveying the hot gases from said combustion chamber to the turbine, and a jacket surrounding said conduit at a distance, said jacket being connected only with the delivery side of said compressor, whereby said jacket will be filled with a stagnant body of air under the delivery pressure of the compressor.

6. A device according to claim 5, in which the jacket contains a loose filling of refractory material.

7. In combination, a combustion chamber for producing hot gases under pressure, a refractory conduit for conveying the hot gases from said chamber, an annular refractory conduit connected with the delivery end of said first-named conduit, and arranged to convey said gases to a place of use, a jacket surrounding said conduits, and means for keeping said jacket filled with a stagnant gaseous fluid under pressure.

8. A device according to claim 7, in which the jacket, in addition to the stagnant gaseous fluid under pressure, contains a loose filling of refractory material.

9. A device according to claim 7, in which the refractory annular conduit is provided at its outlet end, within said jacket, with a flange forming a tight joint with a stationary part.

10. In combination with a turbine, a refractory combustion chamber for producing hot gases under pressure, a conduit made of refractory material, for conveying said hot gases to the turbine, a jacket surrounding said combustion chamber and said conduit at a distance, an air compressor driven by said turbine and arranged to deliver air under

pressure to said chamber, the latter having, within the jacket, a flange located at the air inlet and forming a joint with the delivery connection of the air compressor, and a connection from the delivery side of the compressor to said jacket whereby said jacket will be filled with a stagnant body of air under the delivery pressure of the compressor.

11. A device according to claim 1, in which the conduit consists of relatively movable sections having overlapping ends flush at their outer surfaces, and a ring bridging the gap between the extremity of one section and a shoulder on the adjoining section.

In testimony whereof I have hereunto set my hand.

CHRISTIAN LORENZEN.