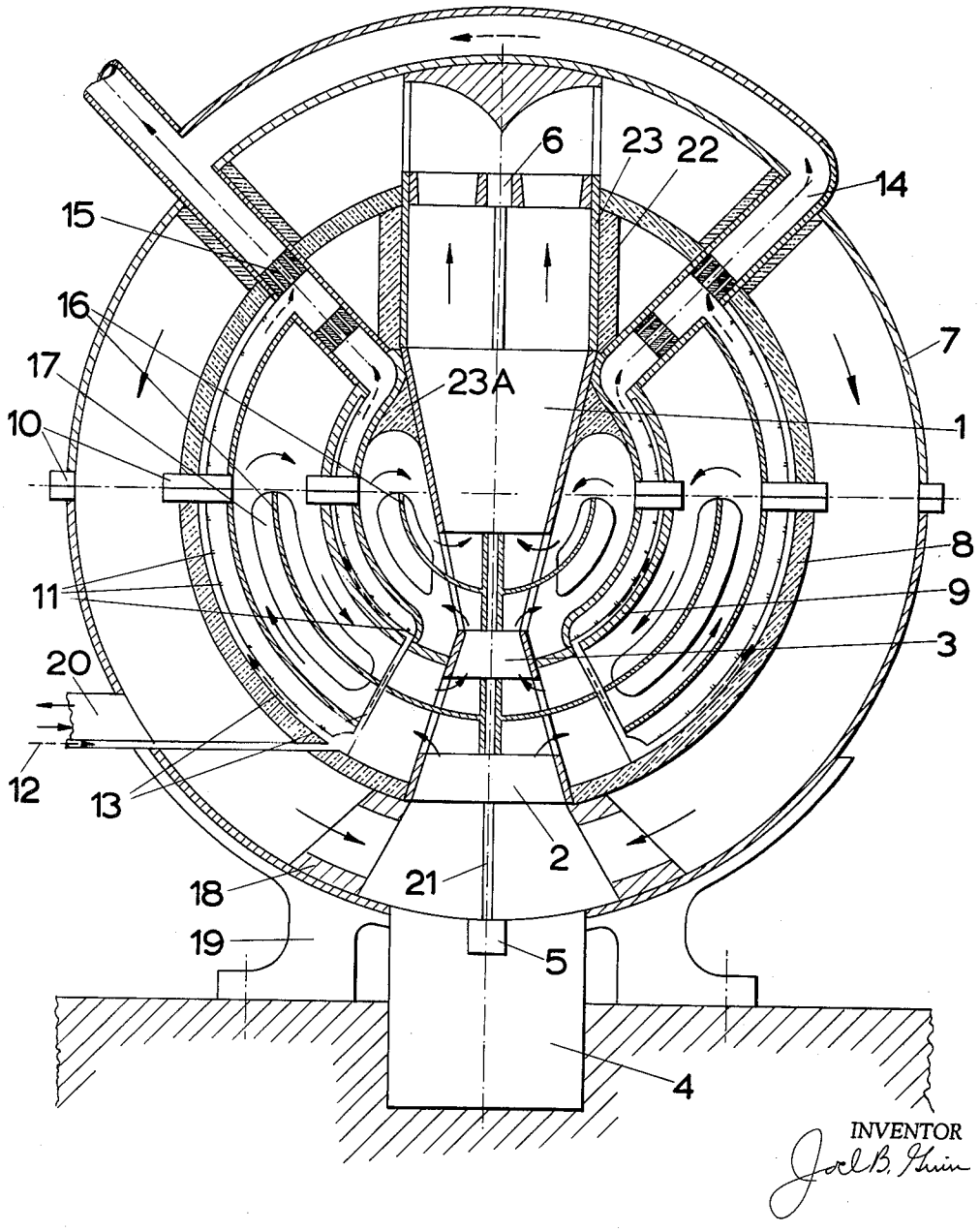
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CLOSED CYCLE GAS TURBINES

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CLOSED CYCLE GAS TURBINES

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Rapidly improving gas turbine technology has reached a point where the only significant economies are those of scale or of increased pressure. The chief object of the present invention is to add to those economies the following savings: in construction costs by maximum use of spheres, the most efficient form in nature, by using lower pressures of the outer spheres to back up the steel used in the inner spheres where pressures are so high as to otherwise demand much thicker steel to contain the steam, by reducing the number and size of pipes, pumps and plumbing, by reducing or eliminating insulation, by reducing or eliminating condensers, heaters, superheaters, separators, thrust bearings, etc.;

In heat losses through boilers, pipes and turbine, in steam condensation, and due to leakage, friction, vibration, etc.

Another object is to inclose the turbine within the upper half of the spheres so that steam enters the blade section directly from the highest pressure sphere at the center, and exhausts directly from the turbine into the lowest pressure sphere, the outermost, thus eliminating most connections, plumbing, valves, insulation, controls, etc. that are ordinarily required in comparable situations.

Further objects are: to reduce radial and axial vibration; to eliminate shaft "whip"; to reduce noise; to make possible fuller automation of the plant; to simplify cleaning, repair and maintenance.

The drawing shows a full vertical cross-section of the invention taken along the main axis through the turbine. The flow of steam or air is indicated by full arrows, that of heating gas and of combustion products by broken arrows.

The gas which drives the turbine can be steam, air or another suitable gas, but in this description only steam will be considered.

Turbine **1** drives both compressors **2** and **3**. Turbine and compressors are connected by shaft **21** which in turn rotates in lower bearing **5** and upper bearing **6** and drives generator **4**. Said turbine and compressors are contained within three spherical shells, two inner heating shells **9** and **8**, and outer cooling shell **7**. For many purposes, including extremely high pressures, four or more shells may be used. The second shell **8** is surrounded by insulating material. The heating gas-air mixture is brought in through channel **12**, then flows through fuel gas channels **13**. The gas is ignited at flame holes **11** and the burning products flow through exhaust channels **14** to the outside. To retain most of the heat of burning products within the shells said exhaust channels are provided with throttles **15**.

Steam is compressed by the first compressor **2** and flows around the outer of the two steam diversion hemispheres **16** where it is heated by burning gas. In order to increase the transferred heat both steam diversion hemispheres are provided with lamellae, thin radiator-like structures **17**. From this first heating arrangement steam flows into the second compressor **3** where it is compressed again. It then flows around the inner of the two steam diversion hemispheres **16** and is heated to its final temperature. The cycle continues with turbine **1** where the hot compressed steam is expanded. Both the upper part of the turbine and the exhaust channel therefrom are heavily insulated in order to aid proper expansion.

From turbine **1** steam flows into outer sphere **7** where essential cooling is done by radiation, or by an outside cooling source. After passing through sphere **7** the steam is drawn into compressor **2** where the cycle starts all over again. All spherical shells **7**, **8** and **9** consist of two hemispheres which are connected by mid-sphere joints **10**.

Sphere **8** rests on a supporting structure **18**, attached to the base **19**. Steam is extracted and fresh steam admitted through drainage unit **20**. Additional pumps and/or compressors may be attached to shaft **21**, or to generator **4**. If desired some of the excess heat from sphere **7** may be used for refrigeration, to cool the generator, etc.

I claim:

1. A high-pressure high-temperature gas turbine system comprising:

a rotatable shaft attached to and extending from an electric generator;

a cylindrical shaft-cover around portions of this shaft, to which cover are attached essential parts enumerated below;

a plurality of spheres one inside the other positioned around and attached to this shaft-cover, the outermost sphere containing steam at a given pressure, the next sphere toward the center containing steam at a higher pressure, the inmost sphere containing steam at the highest pressure, the increasing pressure of steam augmenting the steel in containing the increased pressure within each sphere toward the center;

a plurality of steam compressors, one less in number than the spheres, each attached rotatably to the shaft near the opening in a sphere, except the outermost sphere;

a plurality of steam-diversion hemispheres, one less than the number of spheres, each fitted with thin radiator-like lamellae, attached to the shaft-cover, and placed between each pair of spheres except the outermost;

pipes from an outside source into each of the inter-sphere spaces except the outermost, for bringing a fuel-air mixture into these spaces and into the inmost sphere;

burners for this fuel-air mixture, attached to said pipes;

exhaust channels leading from these inter-sphere spaces and from within the inmost sphere to the outside, to carry the waste products of combustion of the fuel-air mixture;

a gas turbine extending from within the inmost sphere through the upper portion of each of the spheres to the outside, the rotor blades being attached rotatably to the shaft and the stator blades being attached to a turbine shell which is attached in turn to each of spheres within which it is situated; and

all essential valve and control means.

2. A gas turbine system as in claim **1**, the separate components being arranged in the following manner, the ordinal numbers first, second and third being used for convenience to describe separate units starting with the outermost and increasing toward the center, the word inmost referring to the unit in the center:

first and second spheres attached to and located around the shaft-cover, and attached to and positioned around the gas turbine in the upper part of the system, with channels provided in the shell wall of the turbine to convey steam from the turbine, some being forced to the outside where it is cooled before returning and some being forced directly into the space between said first and second spheres;

steam compressors attached rotatably to the shaft, one

near the opening in the second sphere, one near the opening in the third sphere and one near the opening in the inmost sphere, each designed to draw gas from between two spheres, compress it and force it into the next inter-sphere space toward the center, at higher pressure;

fuel-air pipes from an outside source into all the spaces between the spheres except the outermost, and into the inmost sphere; sets of fuel-air burners connected to these fuel-air pipes, each set being located to heat the steam in one of the inter-sphere spaces;

steam diversion hemispheres each fitted with radiator-like lamellae and placed in one of the inter-sphere spaces so as to increase the heat-transfer rate from burning fuel to steam as the latter is forced upward, around and downward across the upper surface of the hemisphere in each space except the outermost;

exhaust channels to carry the waste products of combustion of the fuel-air mixture to the outside;

channels inside the inmost sphere to direct the steam into the turbine, the rotor blades being attached rotatably to the shaft and the stator blades being attached to the turbine shell which is attached in turn to each of the spheres;

channels from the upper part of the turbine to carry steam to the outside to be cooled and returned to the space between the first and second spheres and other channels to direct some of the steam from the turbine directly downward through the space between first and second spheres to the first compressor; and

an electric generator attached to one end of the shaft.

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