

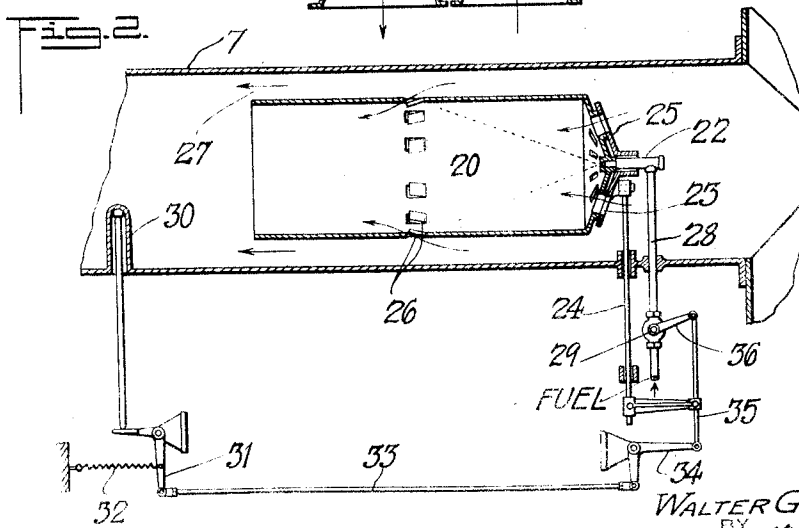
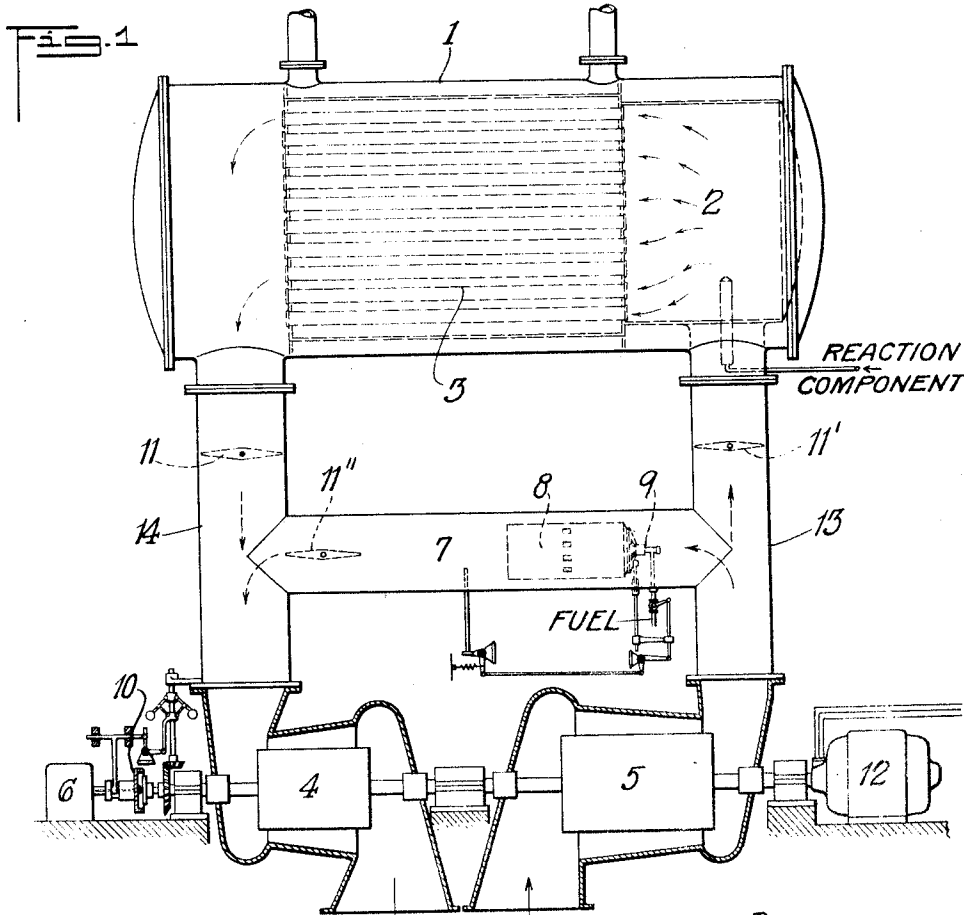
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STARTING UP SYSTEM FOR HEAT PRODUCING AND CONSUMING PLANTS

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STARTING UP SYSTEM FOR HEAT PRODUCING AND CONSUMING PLANTS

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The present invention relates to means for starting up pressure fired combustion and heat transfer plants, more particularly for starting up plants of the type specified and having a combustion chamber in which combustion takes place at high pressure and from which high pressure high temperature combustion gases emerge which gases are utilized by heat consumers at great efficiency because of their high pressure and high temperature and the high speed of gas flow obtainable thereby.

The high pressure prevailing in the combustion chambers of pressure fired steam generators, the high velocity of the heating gases and the use of a gas turbine for operating the compressor for supplying the high pressure furnace with combustion air or other combustion materials at high pressure have been found advantageous also in apparatuses other than steam generators in which apparatuses heat is liberated, bound or transmitted. Such apparatuses are, for example, furnaces or ovens for carrying out chemical reactions, or heating apparatuses which serve for heating a secondary medium by means of a hot primary medium. Due to the increased pressure or the increased pressure combined with increased gas velocity, the reactions are accelerated and the rate of heat transfer is increased and the size of the reaction chambers, of the heat transfer surfaces and the gas ducts can be considerably reduced. The dimensions of such plants are reduced and at the same time, of course, also the first cost and the operating cost.

Because apparatuses of the type set forth can develop their full capacity only at the increased pressure it is of importance that the pressure be generated quickly and by inexpensive means, in other words, the time required for starting up be reduced as much as possible. Plants of the character described may have, in spite of the reduction of their dimensions made possible by the increased pressure and velocity, such large masses that great quantities of heat are required for warming up said masses. It must be considered that the output of the gas turbine during the heating up period is small because pressure and temperature of the gas operating the turbine rise only slowly during the starting up period and the full amount of air or combustion materials to be furnished by the compressor operated by the gas turbine is produced gradually and slowly; the larger the masses are which must be heated up the longer it takes until normal production of said air or combustion materials is obtained. Many operations cannot be accom-

plished at all because of the conditions prevailing during the starting up period. It is therefore necessary to provide a starting up motor of comparatively large output besides the gas turbine so that gas turbine and compressor can be quickly brought up to full speed and the operating conditions prevailing at normal operation are obtained as quickly as possible. Starting up motors of small capacity, as sometimes used for starting up and bringing up to full capacity internal combustion engines, cannot alone fulfill the requirements of a quick bringing up to full capacity of plants referred to in the paragraph next above.

An object of the present invention is to provide means whereby starting of plants in which high pressures are used for increasing the capacity which pressures are provided by compressors operated by gas turbines is facilitated and large starting motors and consumption of energy which must be supplied to the plant from outside sources are avoided.

A starting up plant according to the present invention substantially consists of a small starting up motor by means of which a charging unit is put into operation, and an auxiliary combustion chamber which is arranged in parallel with a main heat consumer with respect to gas flow by means of which auxiliary combustion chamber the gas for operating the gas turbine is produced until the charging unit is brought up to full speed. Due to the small masses of the auxiliary combustion chamber and of the connecting conduits the auxiliary unit is brought to full capacity almost instantaneously. A high temperature gas is immediately available for operating the gas turbine and rapid acceleration of the starting up unit to full speed. As soon as the charging unit operates at full speed and output, change over to the main furnace can be effected which latter can be quickly put into operation due to the great available pressures and amount of heat.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawing which, by way of illustration, shows what I now consider to be a preferred embodiment of my invention.

In the drawing:

Figure 1 is a diagrammatic showing of a plant according to the present invention.

Figure 2 is a large scale diagrammatic showing of a detail of the plant shown in Fig. 1.

Referring more particularly to Fig. 1 of the drawing 1 designates a plant for the generation and supply of heat in which plant, for example,

in chamber 2 heat is generated by combustion or similar reactions of a medium under high pressure and transferred to another medium in the heat exchanger or consumer 3. The heat transfer is not complete and the products of combustion or other heat producing reaction in chamber 2, after having passed through heat exchanger 3 enter through conduit 14 the gas turbine 4 at high temperature where they produce power due to their pressure and temperature. This power is used for operating a blower or compressor 5 which is connected with chamber 2 by means of conduit 13 and produces the pressure needed in chamber 2 for accelerating the reactions taking place therein and for producing such a high speed of the heat supplying medium in heat exchanger 3 that the rate of heat transfer in said exchanger is considerably increased.

If the plant described above would be started by just starting the charging unit 4, 5 by means of a starter motor 6 and, for example, starting combustion in chamber 2, the gas turbine 4 would only slowly be brought up to full speed because the large masses of the apparatus 1 would readily and almost completely absorb the small amount of heat developed at low speed of the compressor 5 and the gases leaving the apparatus 1 would reach the gas turbine 4 at low temperature.

According to the present invention a by-pass is provided in the form of a tube or conduit 7 which connects conduits 13 and 14. In conduit 7 an auxiliary combustion chamber 8 is provided. Very little combustion medium, for example combustion air, is needed to start combustion in chamber 8 and obtain hot gases for operating the gas turbine 4. Fuel may be supplied to chamber 8 through a nozzle 9. The charging unit 4, 5 is rapidly brought up to full speed and output by means of the auxiliary motor 6 and the quickly increasing output of the gas turbine 4 which is directly operated by the gases produced in chamber 8. Motor 6 is disconnected before the unit 4, 5 has reached full speed. This may be done by hand or automatically by means of a clutch 10 which disconnects motor 6 from turbine 4 before the latter reaches full speed. Motor 6 which may be an electric motor or a small Diesel engine is needed for the very first starting operation only; it is preferably so designed, that it operates at its top speed when the charging group 4, 5 connected thereto operates at a speed which corresponds to the speed of the compressor at a power consumption which is substantially equal to the maximum power output of motor 6; said maximum power output of motor 6 need only be approximately 2% of the maximum power consumption of compressor 5.

During starting up of the charging unit valves or shut off means 11 and 11' are closed and valve 11'' is open. As soon as the charging unit is brought up to full or almost full speed valves 11 and 11' are opened and the unit is connected with and serves apparatus 1. Valve 11'' may then be closed. Due to the great heat which is immediately available apparatus 1 quickly assumes normal full load operating conditions.

Figure 2 diagrammatically shows an auxiliary combustion chamber as has been found useful in connection with the present invention. It consists of a cylinder 20 which may be made of high temperature resisting sheet metal and the tube 7 concentrically surrounding cylinder 20. Cylinder 20 is closed on one side and provided at said side with a fuel nozzle 22 and slots 23

through which slots the combustion air enters. A shield 25 may be provided having openings registering with slots 23 and be movable whereby the amount of the air can be changed. Further air is introduced through the annular space between cylinder 20 and tube 7. Cylinder 20 may be provided with openings 26 through which part of the air enters the interior of cylinder 20. The division of the air into three streams, one entering through slots 23, one through openings 26 and one through the annular opening 27 between cylinder 20 and tube 7 whereby one of said streams, namely, the one entering through slots 23, is adjustable and the separation of primary combustion air and excess air provides for most favorable combustion conditions; it also makes it possible that the temperature of the gases operating the gas turbine can be adjusted over a wide range; due to the particular construction shown in Figure 2 the cylinder 20 which forms the wall of the combustion chamber is effectively cooled by the incoming air; tube 7 which must withstand high internal pressures is effectively shielded against radiant heat and is also well insulated and cooled by the air passing between cylinder 20 and tube 7. The tube 7 in Figure 2 may form the by-pass in Figure 1 leading directly from the blower 5 to the turbine 4. In the fuel supply pipe 28 leading to nozzle 22 a valve 29 is provided for controlling the fuel supply to the nozzle and the auxiliary combustion chamber. An operating rod 24 is connected with register plate 25 for adjusting said plate. Valve 29 and rod 24 may be operated by hand or they may be operated automatically according to the temperature of the gas entering the gas turbine. In the latter case a temperature responsive means such as a thermostat 30 is provided which acts on elbow lever 31 against the tension of spring 32. The movements of elbow lever 31 are transmitted by means of rod 33 to elbow lever 34 and from therethrough rod 35 to handle 36 of valve 29. Rod 24 is connected with rod 35 and simultaneously operated therewith.

In large plants with good operating efficiency of the gas turbine and the blower or compressor the output of the gas turbine may exceed the power requirements of the blower. In such case a power consumer, for example an electric generator 12 may be connected with the gas turbine for producing outside power. This generator may also be used as motor instead of the auxiliary motor 6.

While I believe the above described embodiment of my invention to be a preferred embodiment, I wish it to be understood that I do not desire to be limited to the exact details of the design and construction shown and described, for obvious modifications will occur to a person skilled in the art.

I claim:

1. In a heat producing and consuming plant, a main heat producer and a heat consumer connected thereto, a charging unit comprising a gas turbine and a compressor connected to and driven by said gas turbine, a conduit connecting said compressor with said main heat producer and supplying a gaseous medium under high pressure to said heat producer, a second conduit connecting said gas turbine for gas flow with said heat consumer and receiving operating gas therefrom, a starting up motor, a coupling disconnectably connecting said motor and said charging unit, speed responsive operating means connected with said coupling and with said charging unit and

responsive to the speed of said charging unit for disengaging said coupling and thereby disconnecting said motor from said charging unit when the speed of the latter exceeds the maximum allowable speed of said motor, and an auxiliary combustion chamber arranged in parallel with said main heat producer and consumer with respect to gas flow and supplying operating gas to said turbine, when starting up said charging unit, until said unit is brought up to full speed and can be used for operating said main heat producer.

2. In a heat producing and consuming plant, a main high pressure hot gas producer and a heat consumer connected thereto, a charging unit comprising a gas turbine and a compressor connected to and driven by said gas turbine, a conduit connecting said compressor and said main gas producer for supplying a gaseous medium under high pressure to said gas producer, another conduit connecting said heat consumer and said gas turbine for supplying high pressure gas to said turbine, an auxiliary gas producer having an intake side which is connected with said compressor and a gas outlet which is connected with said gas turbine, and shut off means in said conduits for shutting off said main gas producer and heat consumer from said charging unit, said auxiliary gas producer, when starting up said heat producing and consuming plant, supplying operating gas to said gas turbine and thereby operating said charging unit until it is brought up to full speed and can be used for operating said main gas producer.

3. In a heat producing and consuming plant, the combination of a main high pressure hot gas producer and a heat consumer connected thereto, a charging unit comprising a gas turbine and a compressor connected to and driven by said gas turbine, a conduit connecting said compressor with and supplying a gaseous medium under high pressure to said gas producer, a second conduit connecting said gas turbine with said heat consumer and receiving operating gas therefrom, a starting up motor connected to and adapted to operate said charging unit as long as there is not sufficient gas available from said main gas producer for operating said turbine and compressor, an auxiliary starting up gas producer arranged parallel with said main gas producer and heat consumer with respect to medium and gas flow, medium flow preventing means arranged in the path of the medium between said compressor and said main gas producer, and gas flow preventing means arranged in the path of the gas between said heat consumer and said turbine, for preventing medium flow to said main gas producer and gas flow from said heat consumer, respectively, when starting up said plant, until the output of said charging unit is sufficient for operating said main gas producer.

4. In a heat producing and consuming plant, the combination of a main gas producer, a charging unit comprising a gas turbine and a compressor connected to and driven by said gas turbine, a conduit connecting said compressor with said main gas producer and supplying a gaseous medium under high pressure to said gas producer, a second conduit connecting said gas turbine with said gas producer and receiving operating gas therefrom, a starting up motor connected to and operating said charging unit as long as there is not sufficient gas available from said main gas producer for operating said turbine and compressor, the full speed of said starting up motor

being substantially equal to the speed of said compressor at a power consumption which is substantially equal to the maximum output of said starting up motor, an auxiliary starting up gas producer arranged parallel to said main gas producer with respect to medium and gas flow, medium flow preventing means arranged in the path of the medium between said compressor and main gas producer, and gas flow preventing means arranged in the path of the gas between said main gas producer and said turbine and preventing medium flow to and gas flow from said main gas producer when starting up said plant, until the output of said charging unit is sufficient to operate said main gas producer.

5. In a heat producing and consuming plant, a main hot gas producer and a heat consumer connected thereto, a charging unit comprising a gas turbine and a compressor connected to and driven by said gas turbine, a conduit connecting said compressor with said main gas producer and supplying a gaseous medium under high pressure to said producer, a second conduit connecting said gas turbine for gas flow with said heat consumer and receiving operating gas therefrom, another conduit interconnecting said first and said second mentioned conduits and by-passing said main gas producer and said heat consumer, and an auxiliary gas producer disposed in said other conduit for producing operating gas for said turbine when starting up said plant and as long as insufficient gas for operating said turbine is produced in said main gas producer.

6. In a heat producing and consuming plant, a main hot gas producer and a heat consumer connected thereto, a charging unit comprising a gas turbine and a compressor connected to and driven by said gas turbine, a conduit connecting said compressor with said main gas producer and supplying a gaseous medium under high pressure to said producer, a second conduit connecting said gas turbine for gas flow with said heat consumer and receiving operating gas therefrom, another conduit interconnecting said first and said second mentioned conduits and by-passing said main gas producer and said heat consumer, and an auxiliary gas producer disposed in said other conduit for producing operating gas for said turbine when starting up said plant and as long as insufficient gas for operating said turbine is produced in said main gas producer, said auxiliary gas producer comprising a substantially cylindrical combustion chamber disposed coaxially in said other conduit.

7. In a heat producing and consuming plant, a main hot gas producer and a heat consumer connected thereto, a charging unit comprising a gas turbine and a compressor connected to and driven by said gas turbine, a conduit connecting said compressor with said main gas producer and supplying a gaseous medium under high pressure to said producer, a second conduit connecting said gas turbine for gas flow with said heat consumer and receiving operating gas therefrom, another conduit interconnecting said first and said second mentioned conduits and by-passing said main gas producer and said heat consumer, and an auxiliary gas producer disposed in said other conduit for producing operating gas for said turbine when starting up said plant and as long as insufficient gas for operating said turbine is produced in said main gas producer, said auxiliary gas producer comprising a substantially cylindrical combustion chamber disposed coaxially within and having an outer

wall substantially equally spaced from the interior wall of said other conduit.

8. In a heat producing and consuming plant, a main hot gas producer and a heat consumer
5 connected thereto, a charging unit comprising a gas turbine and a compressor connected to and driven by said gas turbine, a conduit connecting said compressor with said main gas producer and supplying a gaseous medium under high
10 pressure to said producer, a second conduit connecting said gas turbine for gas flow with said heat consumer and receiving operating gas therefrom, another conduit interconnecting said first and said second mentioned conduits and by-
15 passing said main gas producer and said heat consumer, and an auxiliary gas producer dis-

posed in said other conduit for producing operating gas for said turbine when starting up said plant and as long as insufficient gas for operating said turbine is produced in said main gas producer, said auxiliary gas producer comprising 5 a substantially cylindrical combustion chamber disposed coaxially in said other conduit, adjustable combustion supporting medium supply means connected to one end of said auxiliary gas producer, and temperature responsive means 10 disposed in said other conduit and connected with and adapted to adjust said supply means in response to temperature conditions in said other conduit.

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