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GAS TURBINE INSTALLATIONS OPERATING ON GASEOUS FUELS

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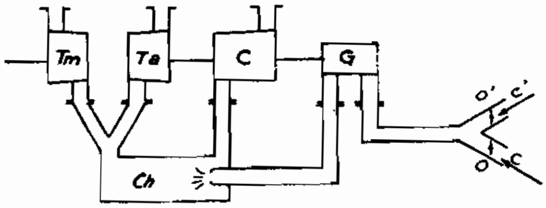

fig 1

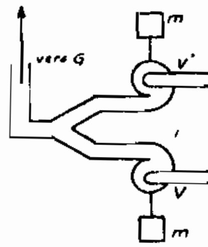

fig 2

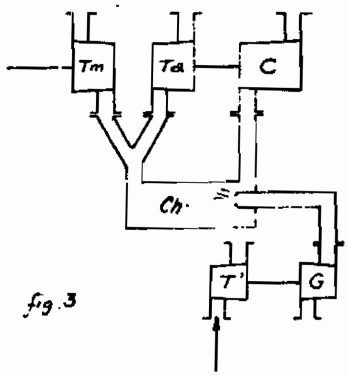

fig. 3

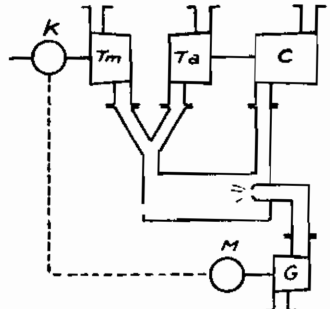

fig. 4

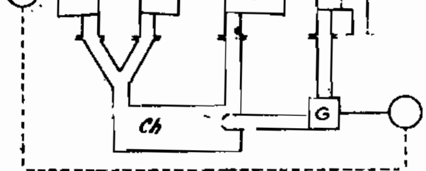

fig. 5

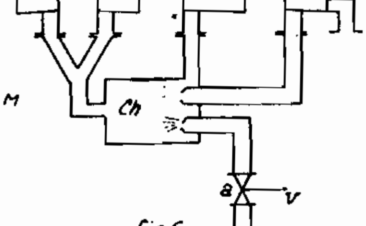

fig 6

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GAS TURBINE INSTALLATIONS OPERATING ON GASEOUS FUELS

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In gas turbine installations operating on liquid or solid fuels, the fuel control is obtained with power losses which represent only a small fraction of the total power. In installations which utilize gaseous fuels (blast furnace gases, coke furnace gases, producer gas, etc) the gas compressor consumes an appreciable power which is a relatively important fraction of the total compression power. It is important therefore, in order that the over-all efficiency of the system remain good, that the regulations of the fuel supply be effected with the smallest power losses. It is also desirable that the operating point of the gas compressor on its characteristic curve vary only little, so that its yield will be maintained in the proximity of the maximum value.

The present invention attains this double object.

According to an embodiment of the invention, the calorific power of the combustible gas is controlled at the suction end of the compressor of this gas, either by diminishing it, or by increasing it, or by both of these means concurrently, according to the load of the installations.

The increase of the calorific power of the combustible gas may be obtained by mixing it with a richer gaseous fuel (coke furnace gas, acetylene, natural gas, gas produced by the distillation of coal, etc) or by vaporization of a suitable liquid fuel (butane). The reduction may be obtained by mixing it with a poorer combustible gas (blast furnace gas, poor gas) or by mixing it with air or with inert gases (cooled combustion gases). The mixing is effected with the smallest possible power consumption by means of a set of valves or check plates mounted on large size piping, or by utilizing fans or centrifugal or volumetric compressors. The simultaneous regulating of the fans or of the valves may be carried out in such a way that the gas compressor's operating point remains substantially in the proximity of the maximum yield point.

According to another embodiment of the invention, the combustible gas compressor or compressors, when several machines are operated in series, are operated by a motive unit distinct from the motive unit operating the air compressor. This motive unit may be a gas turbine connected in any way whatever, in series or in parallel, with respect to the other gas turbines utilized, or an electric motor receiving its power from a generator mounted on the main shaft, or by means of a shunt connected onto the generator operated by the unit. The advantage of this arrangement is that the gas compressor's speed may be controlled independently of the air compressor's speed.

As an alternative of this arrangement, it is possible to utilize separate controls for only a part of the combustible gas compressor, either by dividing the compression ration into two parts, or by dividing the gas supply into two parts. An arrangement which is to be particularly recommended is that which consists in effecting the low pressure portion of the gas compression in a centrifugal fan operated or not by a special motor, and the high pressure portion by an alternative or rotating volumetric compressor operated by an independent motor. The control of the latter's speed allows to reduce the supply with a good yield the low pressure compressor being no longer adapted, but the resulting loss remaining small because of the low head produced by this machine.

According to a third embodiment of the invention, a solid or liquid complementary fuel is utilized in addition to the gaseous fuel, the regulations bearing on the said complementary fuel. The gas compressor may then be or not be directly coupled to the air compressor, but always keeps its optimum adjustment. The additional fuel may or may not be burned in the same combustion chamber as the gas.

The description which will follow with reference to the appended drawings, given by way of non-limitative example will allow a thorough understanding of how the invention can be embodied, those peculiarities which appear in the text as well as in the drawing constituting of course, a part of the invention.

Figures 1, 2, 3, 4, 5, 6 are diagrammatical views relating to the various embodiments of the invention.

Figure 1 represents, only by way of example, a gas turbine installation of the simplest type, that is to say comprising an air compressor C and a combustible gas compressor G operated by the same auxiliary turbine *Ta*. The motive turbine *Tm* is supposed to be connected in parallel with the auxiliary turbine *Ta*. The conduit *c* for the main gaseous fuel is connected to the suction end of the compressor G in parallel with a conduit *c'* for the richer gaseous fuel. The regulation of the richness of the fuel admitted into the compressor G and from there into the combustion chamber *Ch* is obtained by simultaneously operating the two valves O and O', it being possible to calculate or determine by experimentation the simultaneous position of these two organs, so as to allow a total gas supply of such a value that the operating point of the compressor G on its characteristic curve be maintained in the proximity of the maximum yield point.

The conduit c' can also be a suction conduit for sucking in air or an inert gas, or it can be a conduit for a gas poorer than the one mainly used. Regulation by the richer gas or by the poorer gas can be indifferently resorted to, the compressors C and G not having the same sizes or dimensions in both cases, as can be easily understood.

Figure 2 is a modified form in which two fans V and V' are utilized instead of the two valves O and O'. The regulation is obtained by acting on the speed of the motors M and M' which drive these fans and these two simultaneous actions can also be carried on in such a way as to keep the compressor G's operating point substantially constant.

Naturally, in both these cases, the regulation could be effected with only one valve or on only one of the fans. There can even be only one valve or only one fan, if the pressure in one of the conduits is greater or lower than in the other.

Of course, these arrangements can be utilized in conjunction with any arrangements whatever adopted for the installation of the gas turbine motive unit itself. In particular, the gas compressor G may be mounted on a shaft distinct from that of the air compressor C.

Figure 3 relates to the second way of embodying the invention. The gas compressor G is operated by a special motive unit—in the present example, a small gas turbine T'—which may be connected to the others in series or in parallel. In the example shown, this turbine T' is connected in parallel with the turbines T*a* and T*m*. The regulating of the quantity of combustible gas fed to the combustion chamber *Ch* is then effected on the governing motive unit T', for example, by more or less closing, by means of the valve O'', the inlet of hot gases actuating this turbine.

Figure 4 is a modified form of the preceding embodiment in which the compressor G of the gaseous fuel is operated by an electric motor M on which the control means act. This motor receives its power from a shunt winding connected to the electric generator K driven by the motive turbine T*m* by means of—a rheostat *r*. The speed of the motor M is adjusted and consequently the gas discharge supplied by the compressor G.

In Figure 5, the compression of the combustible gas is effected in two distinct stages connected in series. The low pressure portion of the compression is effected in a fan V mounted or not on the shaft of the compressor C. The high pressure portion is effected in a volumetric compressor G operated by a motor M (electric for example) the speed of which can be controlled as mentioned above.

Figure 6 relates to the third embodiment of the invention. A complementary liquid fuel is utilized which is supplied by piping *a* and on which the regulation is effected by means of a valve *v*. In the example represented by this figure, the air compressor C and the gas compressor G are mounted on the same shaft (it could be otherwise) and the gas and the complementary fuel are burned in one and the same combustion chamber *Ch*. If necessary, two different combustion chambers could be utilized.

In all these figures, the gas turbine installation chosen by way of example is of a particular type. Of course, the invention applies to all other types of gas turbines, whatever arrangements and groupings are adopted, whether refrigerating means, regenerators, reheaters, etc. are utilized or not.

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