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K. TOENSFELDT

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REGULATING MEANS FOR STEAM GENERATING PLANTS

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Fig. 1.

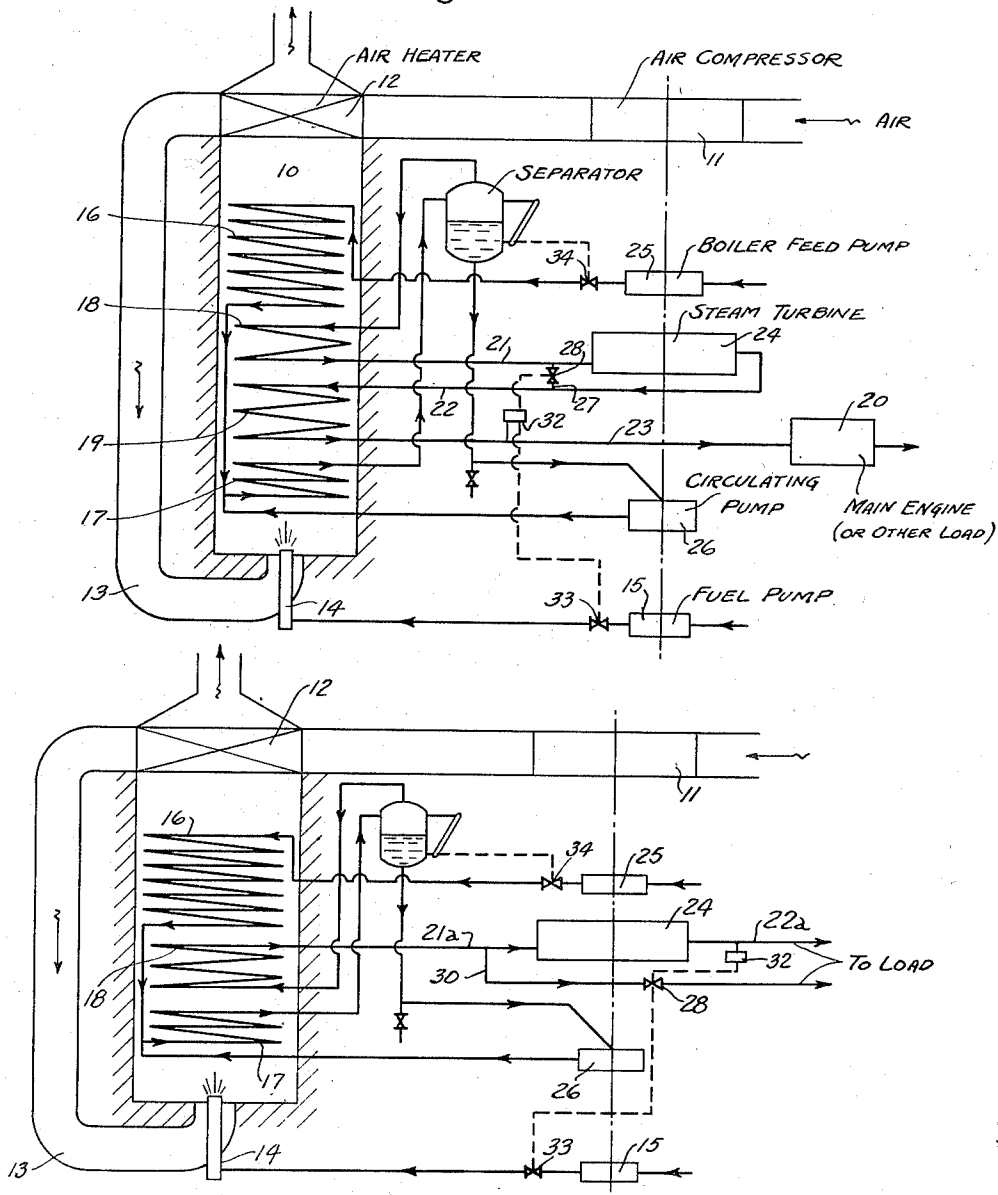


Fig. 2.

INVENTOR
KURT TOENSFELDT
BY
O. V. Hise
ATTORNEY

UNITED STATES PATENT OFFICE

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REGULATING MEANS FOR STEAM GENERATING PLANTS

Kurt Toensfeldt, Port Washington, N. Y., assignor
to Combustion Engineering Company, Inc., New
York, N. Y.

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5 Claims. (Cl. 60—105)

The present invention relates to improvements in means for operating steam generating plants.

The invention is particularly directed to a steam generator which burns fuel in the furnace under pressure and expands the products of combustion over the heating surfaces at relatively high velocities in order to generate large quantities of steam with relatively small heating surface. As the pressure of the air for combustion is increased for the purpose of generating larger quantities of steam, its compression becomes a marked proportion of the total output of the steam generator and efficient means of driving the compressor should be employed.

According to the invention the air compressor and preferably also other auxiliaries for such a steam generator are driven from a steam motor, such as a turbine, through which flows substantially all of the steam produced by the generator, the exhaust from the turbine being the steam delivered from the generator for outside use. Substantially all of the energy taken from the steam by the turbine for driving the compressor and auxiliaries is recovered by the compressed air and returned to the furnace and by the water and fuel from the related pumps when these also are driven by the turbine.

The steam turbine is operated in such manner that substantially all of the steam produced by the generator flows through the turbine at all normal loads and only sufficient steam is by-passed to satisfactorily regulate the turbine speed. The amount of steam which flows to a point of use without passing through the turbine is regulated by a valve automatically operated by suitable mechanism in response to fluctuations in the pressure of steam in the main steam line at a point beyond the turbine that drives the compressor. This regulating valve may be actuated by other means responsive to loads at the point of use, such as steam flow or power output.

In the drawing:

Fig. 1 diagrammatically illustrates a steam plant embodying the invention; and

Fig. 2 illustrates a modified form of the invention.

Referring to the drawing, the steam generator is designated as a whole by the numeral 10 and is illustrated diagrammatically inasmuch as in an actual embodiment of the invention the steam generator itself may take various physical forms. The combustion air has its pressure increased by an air compressor 11 and passes through an air preheater 12 and conduit 13 into the furnace of the generator. Fuel is introduced into the fur-

nace by a burner or burners 14 which are supplied by a fuel pump 15 where fluid fuel is employed, or by a suitable means if other fuels are burned. As illustrated in Figs. 1 and 2, the steam generator 10 includes an economizer 16, generating elements 17, a superheater 18, and in the form shown in Fig. 1, a reheater 19 also.

All of the steam produced in the generator 10 passes therefrom to a main engine, a turbine or other load 20 through a conduit which in Fig. 1 comprises the parts 21, 22, 23, and the parts 21a, 22a in Fig. 2. Interposed in this conduit is a small turbine 24 arranged to drive the air compressor 11 and preferably other auxiliaries such as the fuel pump 15, boiler feed pump 25 and circulating pump 26.

In the arrangement shown in both figures substantially all of the steam produced in generator 10 passes through the compressor-driving turbine 24, only an amount of steam sufficient to regulate the turbine speed passing to the point of use without flowing through the turbine. In Fig. 1 piping 27, having a flow regulating valve 28 therein, is connected to the parts 21, 22 of the steam conduit that lead respectively to the inlet and from the outlet sides of turbine 24 so as to by-pass part of the steam around the turbine. In Fig. 2 the piping 30 controlled by a valve 28 permits some of the steam to pass from the portion 21a of the steam conduit that connects with the inlet of turbine 24 to a point of use without flowing through the turbine. The difference between Figs. 1 and 2 in this respect is that in Fig. 1 the steam diverted away from the turbine 24 to enable regulation of its speed is returned to the part 23 of the main steam conduit whereas in Fig. 2 this steam does not re-enter the main steam conduit but may flow directly to a point of use through the piping 30. In both arrangements the amount of steam diverted away from the turbine for regulating its speed is automatically controlled by a device 32 responsive to the pressure of steam in the main steam conduit at a point beyond the turbine 24 and acting through suitable mechanism to operate the valve 28. In addition to regulating the amount of steam by-passed around or away from the compressor driving turbine 24 the pressure responsive device 32 may also control and operate a valve 33 that supplements the regulation of the amount of fuel supplied to the burners 14 by the fuel pump 15.

In both Figs. 1 and 2 as described above substantially all of the steam produced in the generator passes through the steam turbine 24 as it flows to the point of use, the valve 28 being

opened only enough to by-pass an amount of steam to permit regulation so as to maintain a desired pressure in the main steam conduit for a certain load. In Fig. 1 the steam is preferably initially superheated only an amount sufficient to assure dry steam in the turbine 24 and is then passed through the reheater 19 to be superheated to the temperature desired at the point of use. In both arrangements the heat drop or energy required to operate the turbine 24 is substantially all recovered in the compressed air delivered to generator 10 and in the water and fuel from the related pumps. The heat from the gland leakage of the turbine may be returned to the boiler feed water by any suitable means, such as a heat exchanger. The pressure responsive device 32, being subject to the pressure of steam at a point beyond the steam turbine, acts to maintain a substantially constant pressure at the point by temporarily further opening the valve 28 as the steam pressure in the steam line tends to respond to a decrease in steam demand. This causes less steam to flow through turbine 24 with the result that the degree of air compression and rate of fuel supply are reduced and, hence the rate of steam generation is decreased. Conversely, the pressure responsive device 32 temporarily partly closes the regulating valve 28 to cause more steam to flow through the turbine and increase its speed with consequent increase in steam generation as the pressure in the main steam line falls upon an increase in steam demand. Upon readjustment of the steam flow and pressure, valve 28 again resumes a normal position.

A regulating valve 33 may be provided in the boiler fuel pump discharge line, to supplement the regulation of the rate of fuel feed by the turbine 24. This regulating valve 33 is responsive to the pressure change impulse delivered by the device 32 and functions to throttle or release the flow of fuel to the generator upon rise or fall, respectively, of the pressure in steam main. A prompt response to load changes by the fuel is thereby attained.

A regulating valve 34 may be provided in the boiler feed water pump discharge line, to supplement the regulation of the rate of water feed by the turbine 24. This regulating valve 34 is responsive to the water level in the steam and water separator and is actuated by means such as an expansion type of feed water regulator and the usual connecting links. The valve functions to throttle or release the flow of water to the generator upon rise or fall, respectively, of the water level in the separator.

Accordingly the air compressor 11, fuel pump 15, and other auxiliaries are operated substantially in proportion to the steam demand and a substantially constant pressure of steam is maintained in the main steam conduit while at the same time the energy required to operate the turbine to drive the compressor and other auxiliaries is recovered in the compression of the air and also in the fuel and water supplied to the generator.

In cases where the steam generator is provided with a convection type superheater a further advantage is obtained as a result of the employment of a steam turbine for driving the air compressor. A convection type superheater has a dropping temperature characteristic, i. e. the superheat temperature attained falls with reduction in load. The heat drop through the turbine 24 also decreases with reduction in load but to a

lesser extent than fluctuations in superheat and accordingly there is a partial offsetting or compensation for the fall in superheat leaving the generator at normal loads, thereby tending toward maintaining a more constant superheat leaving the turbine at these loads.

What I claim is:

1. In a steam plant including a steam generator, an air compressor and a fuel supply means therefor, and wherein the fuel is burned under pressure in the furnace of said generator and the products of combustion are expanded over the heating surfaces of said generator at relatively high velocities; a conduit for carrying away from the generator all of the steam that is generated therein; a steam turbine connected into said conduit and arranged to operate said air compressor; piping connected to said conduit at the inlet side of said turbine for carrying part of the steam from said generator to a point of use without passing through said turbine; a valve regulating the flow of steam through said piping; and means responsive to the steam demand in the conduit connecting the turbine and the point of use, controlling said valve to vary the flow through said piping thereby correcting the operating rate of the turbine to suit the variations in said steam demand.

2. In a steam plant including a steam generator, an air compressor and a fuel supply means therefor, and wherein the fuel is burned under pressure in the furnace of said generator and the products of combustion are expanded over the heating surfaces of said generator at relatively high velocities; a conduit for carrying away from the generator all of the steam that is generated therein; a steam turbine connected into said conduit and arranged to operate said air compressor; piping connected to said conduit at the inlet side of said turbine for carrying part of the steam from said generator to a point of use without passing through said turbine; a valve regulating the flow of steam through said piping; and means, responsive to the load demand at the point of use of the steam, controlling said valve to vary the flow through said piping thereby correcting the operating rate of the turbine to suit the variations in said load demand.

3. In a steam plant including a steam generator, an air compressor and a fuel supply means therefor, and wherein the fuel is burned under pressure in the furnace of said generator and the products of combustion are expanded over the heating surfaces of said generator at relatively high velocities; a conduit for carrying away from the generator all of the steam that is generated therein; a steam turbine connected into said conduit and arranged to operate said air compressor; piping connected to said conduit at the inlet side of said turbine for carrying part of the steam from said generator to a point of use without passing through said turbine; a valve regulating the flow of steam through said piping; and means responsive to the pressure of steam in said conduit at a point beyond said turbine for controlling said valve to increase the flow of steam through said piping as said steam pressure rises above a predetermined point and to decrease said flow as said steam pressure falls below said predetermined pressure.

4. In a power plant having a steam generator, means for supplying fluid or pulverized fuel to the furnace of said generator and a valve or the like for regulating the fuel supply; a conduit for carrying all the steam generated in said boiler to a

point of use; a turbine interposed in said conduit between said generator and the point of steam use and arranged to drive said fuel supplying means; and means responsive to the pressure of steam in said conduit at a point beyond said turbine for controlling said fuel regulating valve to increase the rate of fuel supply as said pressure falls and decrease said fuel supply rate as said pressure rises for varying the rate of steam generation oppositely to fluctuations in said pressure.

5. In a power plant including a steam generator, an air compressor and a fuel supply means therefor and wherein the fuel is burned under pressure in the furnace of said generator; a conduit for carrying all the steam generated in said generator to a point of use; a steam motor interposed in said conduit between said genera-

tor and said point of steam use and arranged to drive said air compressor and fuel supply means; piping connected to said conduit at the inlet and discharge sides of said steam motor to form a steam by-pass around said motor; a valve for regulating the flow of steam through said by-pass; and means responsive to the pressure of steam in said conduit at a point beyond said by-pass and controlling said valve to increase the flow of steam through said by-pass as the steam demand falls and decrease said flow as the demand rises for respectively decreasing or increasing the operating rate of said turbine, air compressor and fuel supply means to correspondingly vary the rate of steam generation in said boiler.

KURT TOENSFELDT.