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PROTECTIVE MEANS FOR THE HEATERS OF THERMAL CIRCUITS

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2 Sheets-Sheet 1

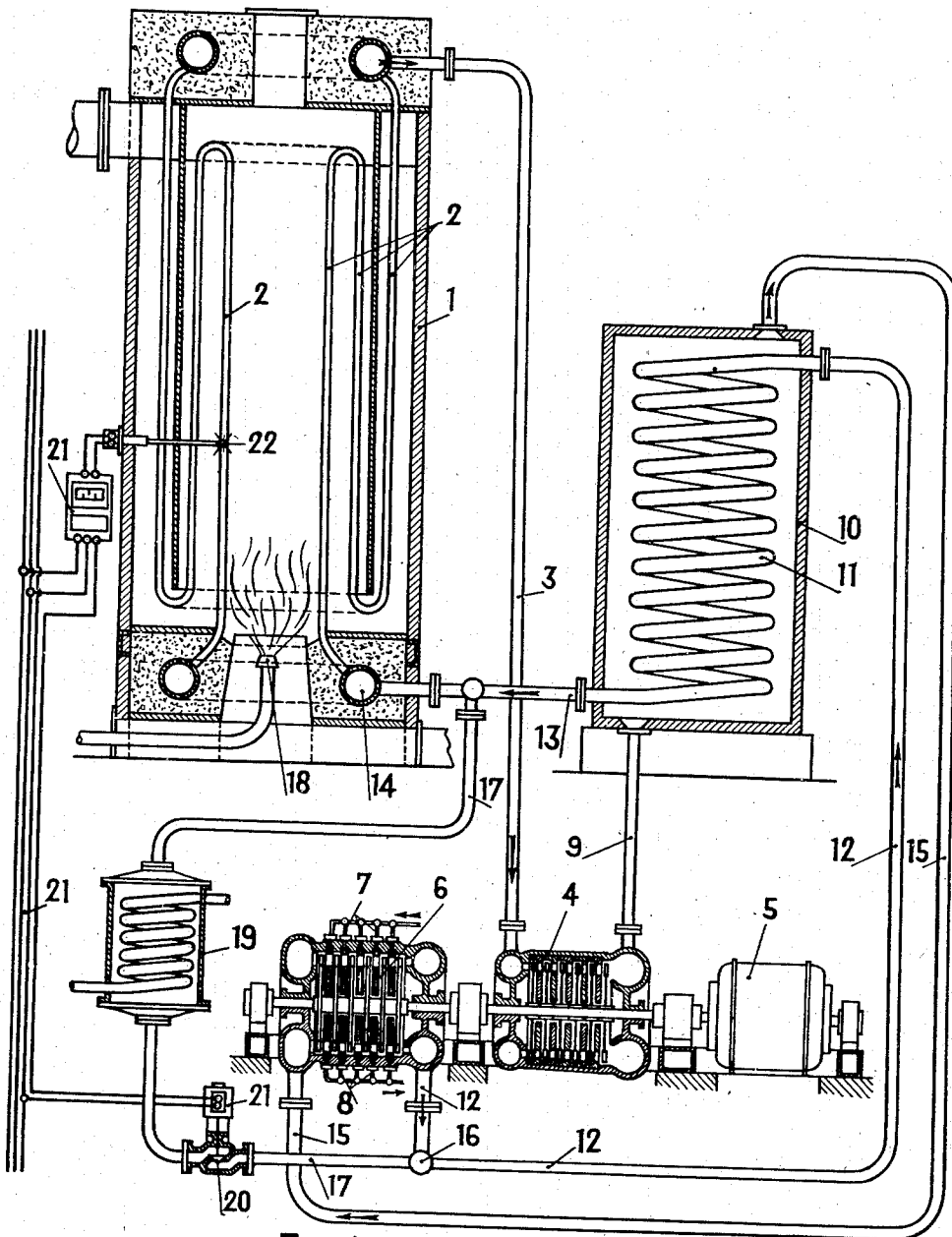


Fig. 1.

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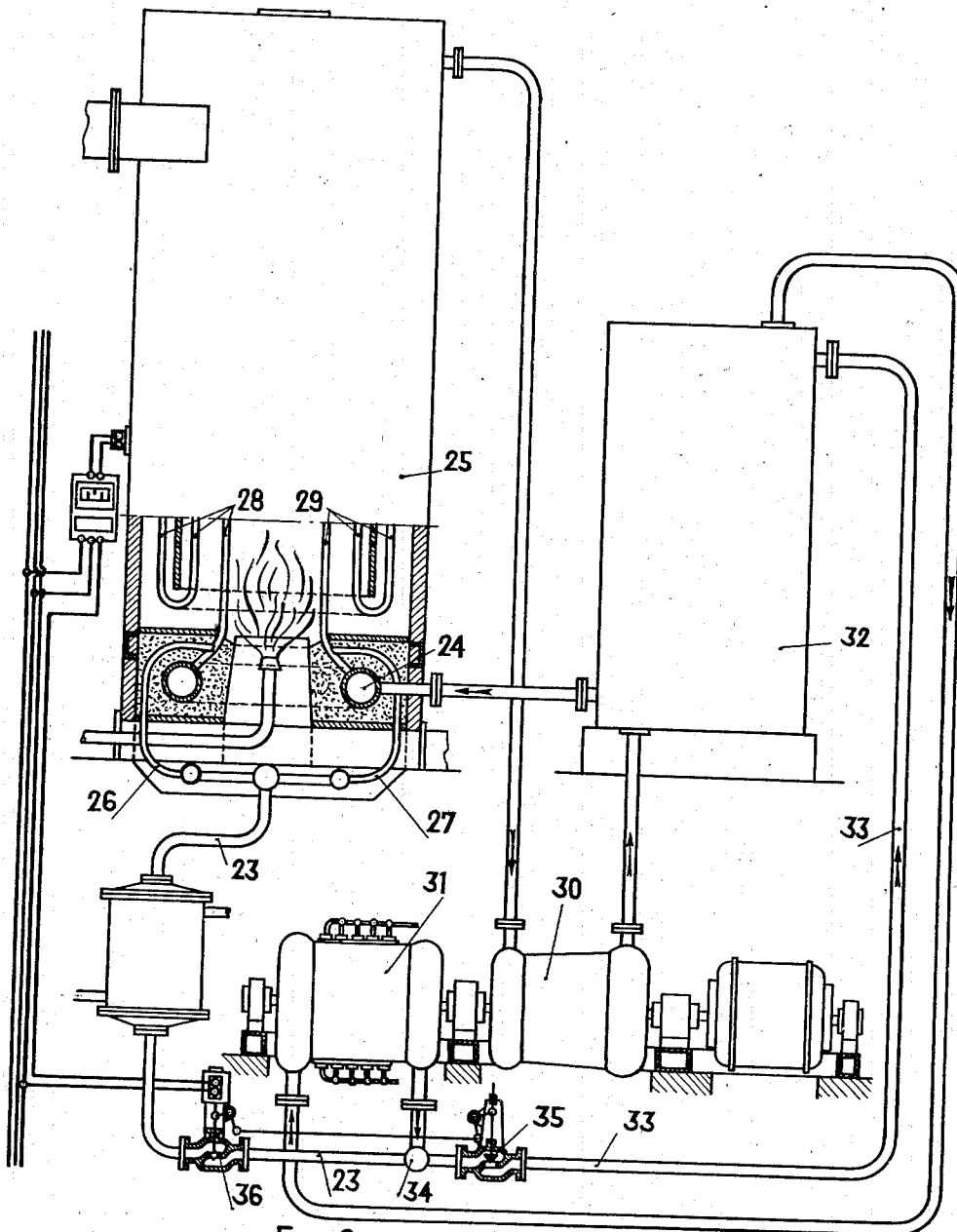


Fig. 2.

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UNITED STATES PATENT OFFICE

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PROTECTIVE MEANS FOR THE HEATERS OF
THERMAL CIRCUITS

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1 Claim. (Cl. 60—59)

The invention relates to an arrangement for cooling the heater tubes of thermal power plants in which a gaseous working medium describes a closed cycle under a pressure greater than atmospheric, the working medium, which is heated in a tubular gas heater by a supply of heat from an outside source, being allowed to expand in at least one turbine while giving up energy externally and brought afterwards again to a higher pressure in at least one compressor, an exchange of heat taking place also in a heat exchanger between the expanded and recompressed current of working medium prior to the supply of heat from the outside source in the tubular gas heater.

The tubes of the gas heater of plants of this kind are subjected to very high temperatures. In addition to this they are subjected to severe mechanical stresses owing to the pressure existing inside them. If therefore it is intended to bring the working medium to a high temperature in the tubular gas heater, one is compelled to subject the constructional material of the tubes to the utmost limit of its heat resisting power, if it is desired to retain dimensions which are usable in practice. When the tubes are subject to such high stresses by the fire gases on their outsides and on their insides by the working medium which flows through them under a pressure greater than atmospheric pressure and is to be heated to a high temperature, it is important under all circumstances, to keep the temperature of the tubes at as high a value as possible with only very slight variations. If therefore for example the absorption of heat by the working medium ceases owing to fluctuations in the load, or, on the other hand, too much heat is given off by the furnace, there is risk that the temperature of the tubes may rise, at least for a short time, above the particular value permissible so that the tubes are no longer able to cope with the stresses to which they are subjected. The risk in overheating of this kind is greater in the tubular gas heaters of plants of the kind herein referred to than in steam boilers, because owing to the comparatively bad transmission of heat on the insides and outsides of the tubes the temperature thereof at a desired working temperature of the working gas to be heated up is considerably higher than it is at the equally high working temperature of the steam of a steam power plant. It is therefore all the more important not to exceed a fixed value of the tube wall temperature of tubular gas heaters, because in the range of temperature

involved, which lies between 600° and 800° C. for example, the strength of steel or corresponding alloys decreases rapidly with increasing temperature. Even increases of temperature of 20° C. for example weaken the strength of the metal very considerably.

The object of the present invention is therefore, to provide an arrangement for cooling the heater tubes of the thermal power plants of the kind hereinabove referred to, which, if the temperature of the tubes of the tubular gas heater be suddenly raised beyond a fixed point, permits of the particular rise of temperature being rapidly and effectively counteracted. According to the present invention this is accomplished by an additional pipe circuit which can be shut off, and permits of working medium supplied by the compressor being passed directly into the inlet of the gas heater without passing through the heat exchanger.

In the drawings affixed to the present specification and forming part thereof two embodiments of the invention are shown diagrammatically by way of example.

In the drawings:

Fig. 1 illustrates, partly in longitudinal section, partly in side elevation, a thermal power plant, wherein use is made of the cooling arrangement according to the invention.

Fig. 2 illustrates a similar plant, showing a modification of a detail.

Referring now to the drawings, and first to Fig. 1, 1 denotes a tubular gas heater, in which the gaseous working medium, which continuously describes a closed cycle under a pressure greater than atmospheric is heated by heat supplied from an external source 18. The actual heating of the working medium takes place in coils 2, around which the fire gases flow. The working medium thus heated passes through a pipe 3 into a multi-stage turbine 4 of the axial flow type wherein it expands while giving up energy simultaneously to an electric generator 5 and a turbo-compressor 6 for example. 7 denotes pipings connected to different points of the casing of the turbo-compressor 6 and supplying cooling water to the latter. The water heated in the turbo-compressor 6 is discharged through pipings 8. The working medium on leaving the turbine 4 passes through a pipe 9 into a heat exchanger 10 which is constructed in the form of a contraflow apparatus containing a system of pipes 11, whereby heat is given up to the part of the working medium at the higher pressure, which passes through a pipe 12

out of the turbo-compressor 6 into the heat exchanger 10 and out of this latter through a pipe 13 into a collector 14 of the heater 1. The part of the working medium which is cooled down in the heat exchanger 10 passes through a pipe 15 into the turbo-compressor 6, wherein it is raised to a higher pressure and cooled simultaneously. From the pipe 12 there branches off at 16 an additional pipe 17 in which an intermediate cooler 19 is interposed and which is connected to the collector 14 of the tubular gas heater 1. This pipe 17 also includes a shut off device 20. The adjustment of this shut off device 20 is controlled by a thermostatic arrangement 21, the activity of which in its turn is dependent on the temperature at the point 22 of a coil 2 of the tubular gas heater 1.

In the plant described the pipe 17 forms a by-pass through which, when the shut off device 20 is open, working medium coming from the compressor 6 and which is still comparatively cold can pass directly into the collector 14 of the tubular gas heater 1 without passing through the heat exchanger 10. Under normal working conditions this by-pass 17 is shut off, so that the working medium compressed in the compressor 6 passes wholly through the pipe 12 into the pipe 11 of the heat exchanger 10, in which it is preheated and therefore enters in a preheated state into the tubular gas heater 1.

If however for any reason the walls of the tubes 2 of the heater 1 are raised to too high a temperature, the thermostatic arrangement 21 will open the by-pass 17 at least partially, so that now comparatively cool working medium passes, without going through the heat exchanger 10, directly into the collector 14 of the tubular gas heater 1 and then out of this collector 14 into the tubes 2 which are too hot, where it mixes with the working medium which has been already preheated and comes from the heat exchanger 10. In this way the temperature of the tubes 2 will be rapidly lowered whereby the temperature of the walls of the tubes is naturally also reduced. If then in the meantime the working conditions of the gas heater 1 have been readapted to the modified loads by adjusting the amount of heat supplied by the furnace and if therefore the temperature of the walls of tubes 2 has dropped again to the permissible upper limit, the thermostatic arrangement 21 closes the shut off device 20, so that the flow of the working medium through the by-pass 17 is interrupted.

The auxiliary cooler 19 ensures that the portion of the working medium flowing through the by-pass 17 shall be particularly effective as regards the reduction of the temperature of the

tubes 2, in that it permits this part to be brought to a low temperature in the cooler 19. Under some circumstances however it is possible to dispense with such an auxiliary cooler.

The by-pass 17 can also be used, when the tubular gas heater 1 is shut off, that is to say when the plant is stopped, to deliver colder working medium to the coils of tube 2, so as to cool them down as rapidly as possible. This is important under certain circumstances, when there is but little time available and there is no opportunity of allowing the gas heater to slowly cool down naturally.

In the plant shown in Fig. 2, the portion of the working medium flowing through the additional pipe 23 is not delivered to the collector 24 of the tubular gas heater 25 but to pipes 26, 27 connected to tubes 28 and 29 respectively, of the tubular gas heater 25. In Fig. 2, 30 denotes a turbine, 31 a compressor and 32 a heat exchanger, all of similar designs as the corresponding parts 4, 6 and 10 respectively, of the plant shown in Fig. 1. In that part of the pipe 33 which leads from the branch point 34 to the heat exchanger 32 is provided a throttling device 35 ensuring that in certain cases by far the greater part of the working medium shall be driven through the open by-pass 23. This throttling device 35 is so coupled to the shut off device 36 of the additional pipe 23 that when the one is closed the other is open and vice versa.

What is claimed is:

A thermal power plant comprising a closed circuit containing a gaseous working medium which, under operating conditions, is throughout the circuit above atmospheric pressure, said circuit including a surface heater in which heat from an external source is transmitted to the medium, an expansion motor in which the working medium heated in the surface heater expands while doing external work, a compressor driven by said expansion motor and serving to recompress the medium expanded in the motor to a higher pressure and deliver it to said surface heater, said circuit including a normal and a supplementary path from said compressor to said heater; a heat exchanger in said normal path in which medium leaving the compressor exchanges heat with medium flowing from said expansion motor to said compressor, the supplementary path supplying medium issuing from the compressor directly to said heater; controllable means for causing the diversion of at least a portion of the medium through said supplementary path; and cooling means interposed in said supplementary path.

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