United States Patent

Kalverboer

[15] **3,683,620**

[45] **Aug. 15, 1972**

[54] **ARRANGEMENT FOR PROTECTING A STEAM TREATMENT DEVICE AGAINST EXCESS PRESSURE**

[72] Inventor: **Cornelis Kalverboer,** Nussbauman, Switzerland

[73] Assignee: **Aktiengesellschaft Brown Boveri & Cie,** Baden, Switzerland

[22] Filed: **Sept. 29, 1969**

[21] Appl. No.: **861,613**

[30] **Foreign Application Priority Data**

Oct. 14, 1968 Switzerland 15316/68

[52] **U.S. Cl.**.....**60/73,** 60/105

[51] **Int. Cl.**.....**F01k 13/02**

[58] **Field of Search** 60/73, 105, 104; 122/483; 415/17

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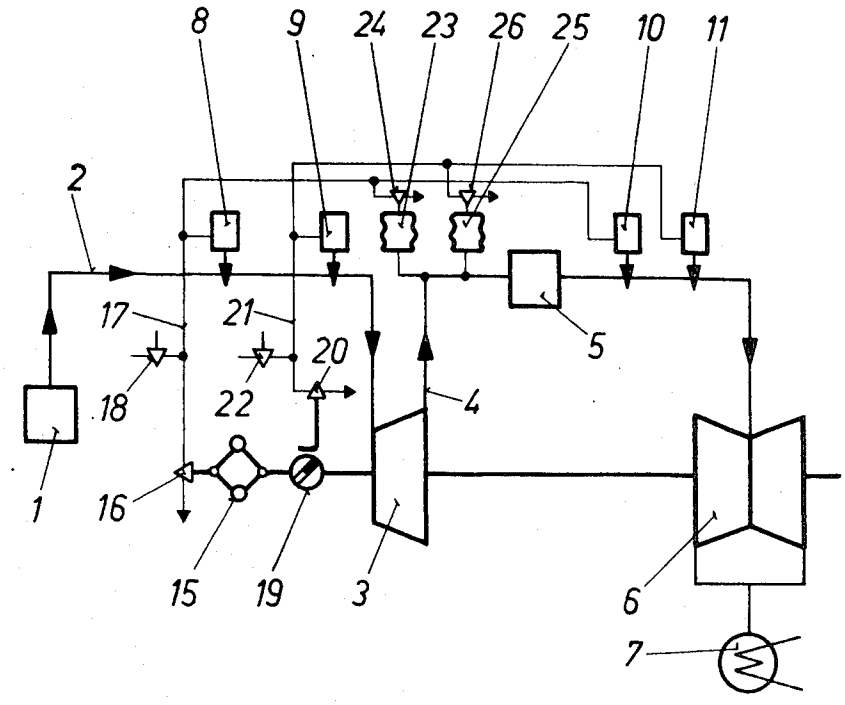
Primary Examiner—Martin P. Schwadron
Assistant Examiner—Allen M. Ostrager
Attorney—Pierce, Scheffler & Parker

[57] **ABSTRACT**

A steam turbine plant incorporating high and low pressure shaft coupled turbines connected in series in the steam flow path from the steam generator also includes a water separator in the steam flow path between the two turbines. Steam flow control valves controlled by a turbine shaft speed governor function to control the amount of steam going to the turbines, and safety shut-off valves controlled by a turbine shaft speed monitor function to shut-off the steam supply to the turbines in the event the turbine shaft exceeds a predetermined safe speed limit. In order to avoid build-up of any dangerous steam over-pressure from arising within the water separator, steam pressure responsive devices are included which operate in conjunction with the speed responsive controls so as to also shut off the steam flow, thus providing a control system operating conjointly on two different parameters, namely, turbine shaft speed and steam pressure.

2 Claims, 2 Drawing Figures



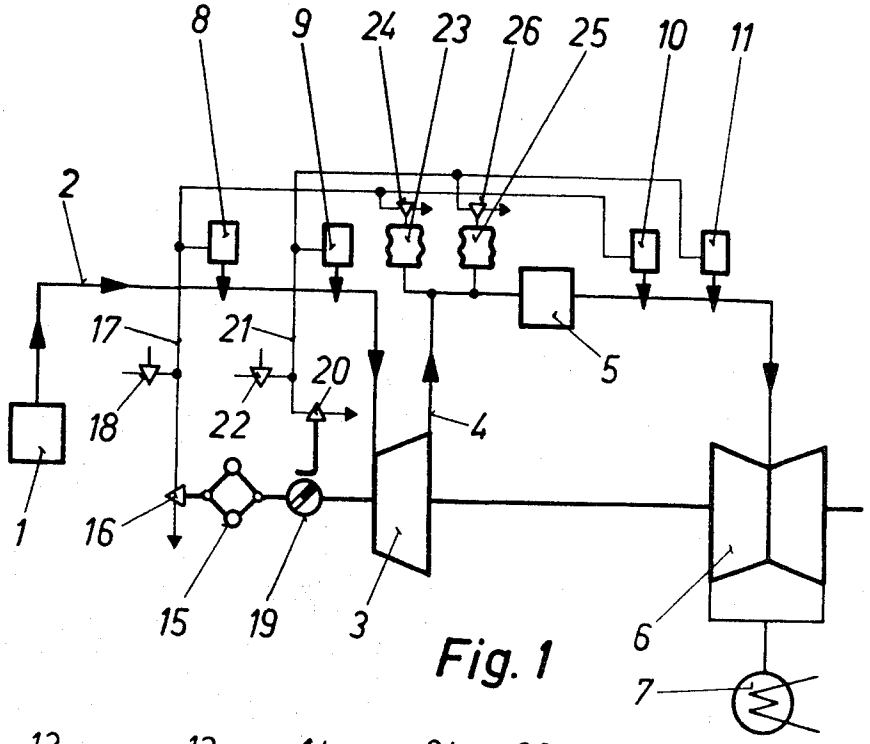


Fig. 1

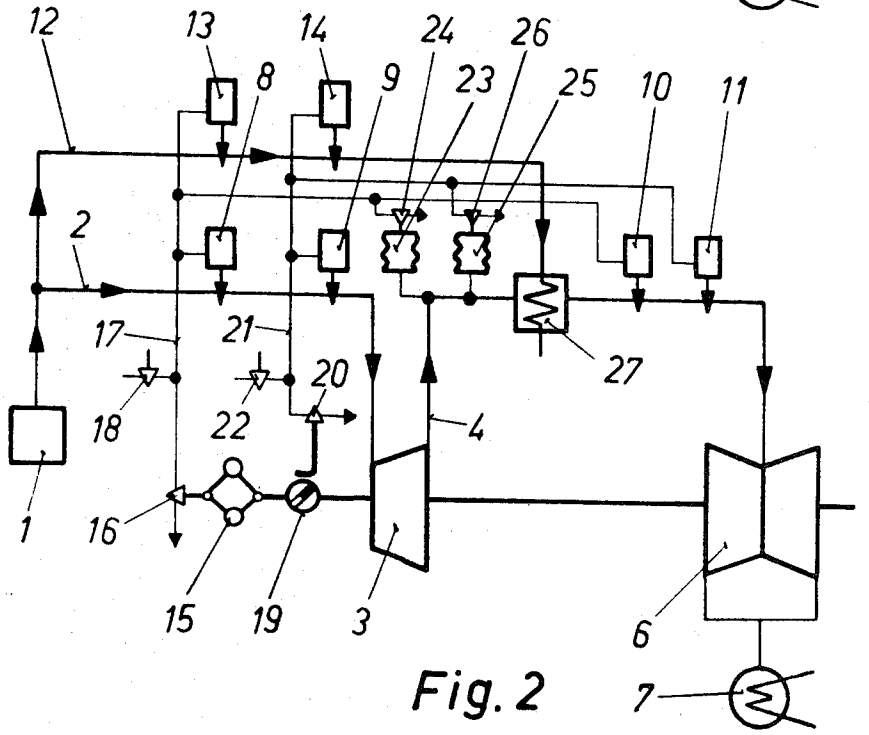


Fig. 2

Inventor

Cornelis Kalverboer

By Pierce, Scheffler & Parker

Attorneys

ARRANGEMENT FOR PROTECTING A STEAM TREATMENT DEVICE AGAINST EXCESS PRESSURE

The present invention relates to an improved arrange-ment for a steam-turbine plant for protecting a container enclosed steam treatment device such as a water separator against excess pressure, the device being arranged in the working steam pipe line between two series-connected turbines, with a control-system controlled by a speed-governor and a safety system independent of the control system and controlled by a speed-monitor, each system acting on a steam shutoff-device in each live-steam pipe.

In turbines such as those used, for example, in an atomic power station with boiling-water or pressure-water reactors it is known for the steam emerging from the high-pressure section of the turbine to be de-humidified in a water-separator before flowing to the low-pressure section of the turbine via the working steam pipe controlled by steam shut-off-devices. These steam shut-off-devices are necessary in order to prevent the turbine from over-speeding after full-load rejection as a result of vaporization of the water or the subsequent expansion of the steam. The build-in of the steam shut-off devices has the effect that excess pressure can occur in the water-separator, for example, as a result of the steam-shut-off devices in the working steam pipe to the low-pressure section being closed or kept closed in error, while the steam-shut-off devices in the live-steam pipe are open or are opening.

Safety valves or bursting discs or sometimes even both, are usually provided for the purpose of protection against impermissibly high pressure in the water-separator or similar container. The absorption factor of these devices is worked out for the maximum quantity of live-steam, which together with the low pressure to the container results in an increase of the necessary pipelines with a corresponding amount of space and becoming expensive.

It is known for large turbines to provide them with two mutually independent systems against over-speed. One system includes a governor which controls the control valves of the turbine. The second includes a speed-monitor, so known as a safety-governor, which closes the main-stop valves of the turbine when a limiting speed is exceeded and usually also gives a closure instruction signal to the control valves.

The present invention has, for its principal object, to provide an improved arrangement for protecting a container enclosed steam treatment device such as a water separator located in the work steam line between the high and low pressure turbine sections of a steam turbine plant against over-pressures which includes two mutually independently operating steam shut-off systems responsive to shaft speed but which avoids the disadvantages inherent in prior known protective arrangements incorporating dual control systems for effecting cut-off. In accordance with the invention, this objective is achieved by an arrangement in which the dual systems are also made to function in response to the working steam pressure in such a manner that if the working steam should exceed a predetermined permissible pressure limit, closure of the steam shut-off devices is likewise effected.

The invention is more precisely explained with reference to the accompanying drawings wherein:

FIG. 1 diagrammatically illustrates an example of embodiment in the form of a steam-turbine plant with two oil-pressure systems and

FIG. 2 is a diagrammatic illustration of a modification of the plant depicted in FIG. 1.

With reference now to FIG. 1, a steam-generator 1, for example, a reactor, supplies saturated steam or superheated steam which flows via a live-steam pipeline 2 to the high-pressure section 3 of the turbine and via a working steam pipeline 4, after de-hydration in the water-separator 5 to the low-pressure section 6 of the turbine and thereafter to a condenser 7. A steam control valve 8 and a safety shut-off valve 9 are incorporated in series in the live-steam pipe 2 between steam generator 1 and the high pressure turbine section 3 and a steam control valve 10 and safety shut-off valve 11 are installed in series in the working steam pipe 4 between the water-separator 5 and the low-pressure section 6.

The steam turbine is doubly protected against over-speeding by two mutually independent oil-pressure systems, each acting on a shut-off-device in the live-steam pipe 2 and in the working steam pipe 4. A speed governor 15 controls an outlet 16 from a first control-oil system 17 which is fed with oil at constant pressure from a suitable source via a throttle organ 18. The steam control valves 8 and 10 are controlled by this control-oil system. As the speed rises, governor 15 opens the outlet 16 to the oil return sump to a more open position, the pressure in the control-oil system decreases correspondingly and the control valves 8 and 10 move in the closing direction to reduce steam flow through the steam pipes 2 and 4.

When a predetermined permissible safe shaft speed is exceeded, a speed-monitor 19 opens an outlet 20 from the second or safety oil system 21 which is fed with oil at constant pressure via a throttle organ 22. Opening of the outlet 20 causes a decrease of pressure in the safety oil system 21, and the safety valves 9, 11 move from their normally open position to a fully closed position, thus shutting off the steam flow.

The control valves 8 and 10 are normally adjusted in such manner that valve 10 first of all begins to open as soon as the pressure in the control-oil system 17 rises, for example to 0.5 atmosphere. When a pressure level of about 1 atmosphere is reached, the control valve 8 also begins to open. At 2 atmosphere, for example, valve 10 is already fully open; meanwhile the maximum quantity of steam on fully opened control valve 8 is reached until the control-oil pressure is about 5 atmospheres. Thus, if the system is functioning satisfactorily it is quite impossible for any impermissibly high excess pressure to occur in the water-separator 5. Such pressure can be set up only if a fault occurs in one of the hydraulic servomotors provided for operation of the valves 10 or 11. In order to prevent any damage in such a case of failure, the invention provides a pressure-limiter 23 which is connected to the working steam pipe 4 and opens a second outlet 24 to the oil return sump in the control-oil system 17 when a pressure-limit in the working steam pipe is exceeded. In accordance with the basic principle of double safety, there is furthermore provided a pressure-monitor 25 in communication with the working steam pipe 4, which monitor opens an additional outlet 26 to the oil sump return line in the safety oil system 21 when the pressure

limit, which may be equal to or somewhat greater than that to which the pressure-limiter **23** responds, is exceeded in the working steam pipe.

FIG. **2** illustrates basically the same plant as in FIG. **1**, but wherein the water-separator built into the working steam pipe **4** is combined in one structural unit **27** with a superheater. It is heated by means of a steam feed pipe line **12** with steam from generator **1** at a higher pressure than that of the working steam in the water-separator **5**; safety shut-off valves **13** and **14** in series are built into the steam feed pipe line **12**. Valve **13** controlled by connection to the normal control system **17**, and the valve **14** to the back-up or safety system **21**, with the result that as the shaft speed increases and these systems become consequently pressureless, the valves **13** and **14** and also the control and safety shut-off valves in the live-steam pipe close. This prevents the rise of an impermissibly high excess pressure in the water-separator in the case of a tube-fracture in the steam-heated tube-bundle which was not noticed during operation.

This method ensures that both existing speed-dependent oil-pressure systems act in response to the working-steam pressure, i.e. that each of these systems is controlled either by the speed or by the working-steam pressure. The advantage attainable by the invention resides, on the one hand, in that it is not necessary to provide a new regulating or safety system since the existing systems are now influenced by two operational main facts i.e. speed and steam pressure. On the other hand, only little structural expense is necessary to achieve a degree of security against excessive pressure in the water-separator which is just as great as the usual and widely proved security against an impermissible increase in turbine speed. The safety of operation of the whole plant is therefore essentially increased.

The invention may be used in the same manner if there is not only one but a plurality of live-steam pipes each equipped with a safety shut-off valve. Furthermore, mention is made throughout the description of only one valve for the sake of simplicity, but it is quite obvious that there may be a whole set in each case. Attention is also drawn to the fact that the same working steam pressure exists in the working steam pipe and in the container enclosed steam treatment device which is to be protected from excess pressure.

The impulse for the correlative responsible acting of the primary control system and the secondary safety system may therefore be taken from the working steam pipe or from the container. Neither does it matter in principle whether the control and safety systems are of the hydraulic, pneumatic or electrical type.

The shut-off devices arranged in the steam-pipes ahead of the low-pressure turbine do not have to be connected to the same systems as the shut-off devices in the live-steam pipe as assumed in the illustrated examples of the embodiment. It is then all the more likely for them to be closed with error and the pressure increases in the working steam pipe and also in the container enclosed steam treatment device which is protected.

I claim:

1. In a steam turbine plant, the combination comprising a steam generator, a high pressure turbine, a low pressure turbine shaft-coupled with said high pressure turbine, a steam pipe line leading from said steam generator through said high and low pressure lines in series, a container-enclosed steam treatment device located in said steam line between said high and low pressure turbines, a first steam control system controlled by a governor responsive to actual turbine speed and which actuates a steam regulating valve disposed in said steam line in advance of said high pressure turbine for regulating steam flow in relation to speed, a second steam control system controlled by a speed monitor and which responds upon attainment of a turbine speed exceeding a predetermined limit value to actuate to its closed position a safety shut-off valve disposed in said steam line in advance of said high pressure turbine, steam pressure monitoring means located in said steam line between said high and low pressure turbines for continuously monitoring the pressure of the steam entering the container of said steam treatment device while the turbine plant is in operation, and means actuated by said steam pressure monitoring means when the steam pressure exceeds a predetermined maximum safe limit value for effecting actuation of said steam regulating valve and also said safety shut-off valve to their closed positions.

2. A steam turbine plant as defined in claim **1** wherein said container-enclosed steam treatment device includes a superheater supplied with heated steam at a pressure higher than that of the steam which is passed through the container, said heated steam being supplied through a steam line which includes two other safety shut-off valves correlated respectively with said first and second steam control systems and which are actuated to their closed positions simultaneously with actuation of said steam regulating and safety shut-off valves in said first and second steam control systems to their closed positions when the steam pressure in the container of said steam treatment device exceeds its maximum safe limit value.

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