June 23, 1942. E. KLAFSTAD 2,287,433

SYSTEM FOR SAFEGUARDING THE OPERATION OF STEAM BOILERS

Filed March 21, 1938 2 Sheets-Sheet 1

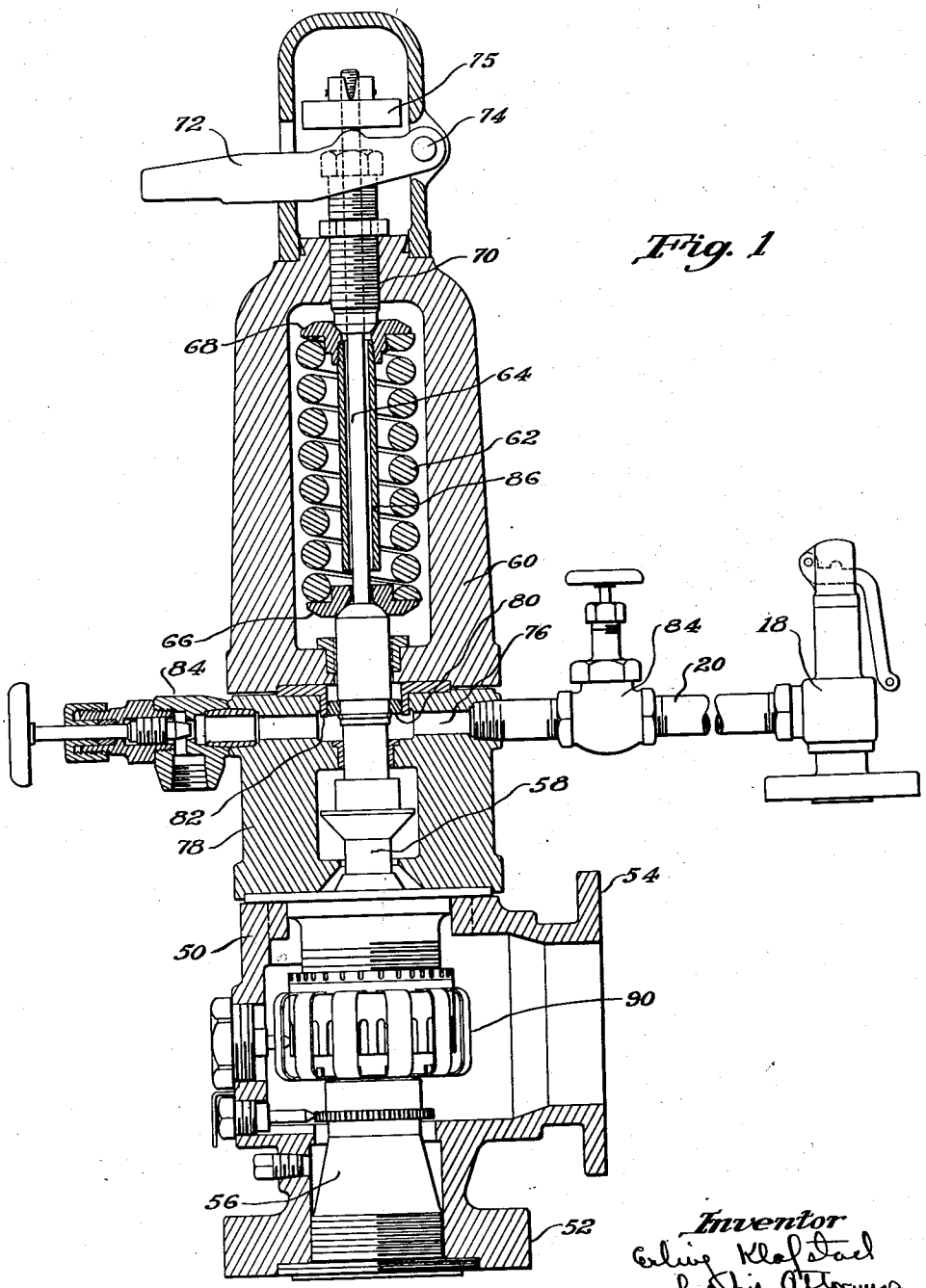


Fig. 1

Witness
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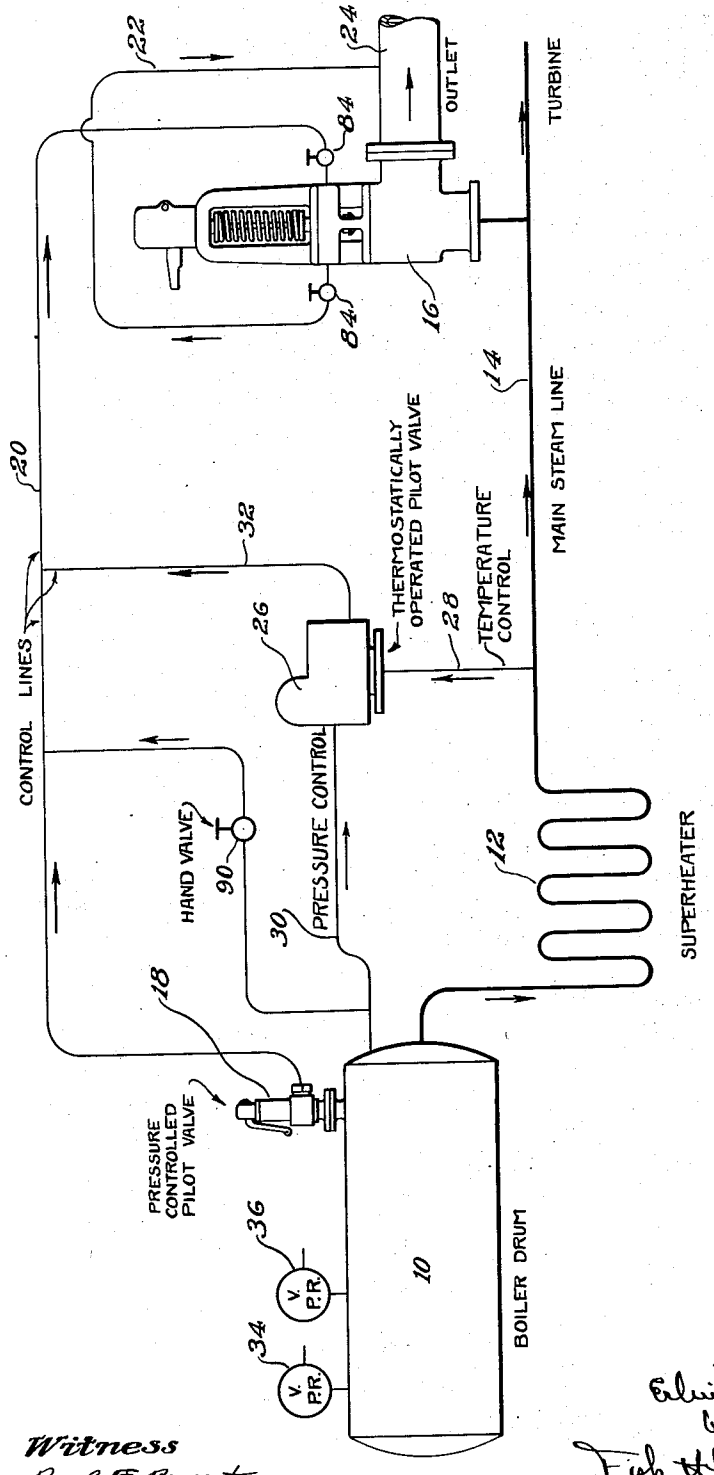


Fig. 2

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SYSTEM FOR SAFEGUARDING THE OPERATION OF STEAM BOILERS

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Application March 21, 1938, Serial No. 197,089

1 Claim. (Cl. 122—479)

The present invention relates to a system for safeguarding the operation of steam boilers equipped with a superheater either fired as part of the boiler or independently thereof, and as an integral part of such a system a safety valve designed for venting the main steam line beyond the superheater in the event of excessive pressure or temperature rise.

It is the purpose and object of the invention to provide adequate assurance that in a steam system provided with a steam boiler and superheater, failure or cutting down of steam demand or a steaming rate greater than the demand shall result in prompt and adequate venting of both the steam boiler drum and the main steam line beyond the superheater either before damage is done to the system through the excessive pressure generated therein or to the superheater because of cessation of flow therethrough.

With this and other objects in view, one feature of the present invention contemplates the employment of a spring-loaded safety valve venting the main steam line between the superheater and point of demand, and having in conjunction therewith a pilot control which directs saturated steam from the boiler drum in a manner to augment the lifting pressure exerted by the superheated steam from the main line, the construction being so designed that any excessive pressure in the boiler drum tending to open the pilot and admit saturated steam to the main valve will open the main valve even though the pressure of superheated steam in the line connected therewith is substantially below the pop-off or venting pressure. By providing a spring-loaded valve connected directly to the superheated steam line and capable of operating directly at a predetermined pop-off pressure, failure of the pilot control to operate upon excessive pressure in the boiler drum permits operation of the main valve in the orthodox fashion when the pressure of superheated steam in the line becomes excessive.

In addition there is provided a temperature control pilot operated from the superheated steam and serving to open and vent the main valve regardless of pressure as the temperature of the superheated steam at the outlet of the superheater exceeds a predetermind amount.

In the accompanying drawings illustrating the preferred form of the invention, Fig. 1 represents a section in elevation of the main pilot-controlled relief valve connected with the superheated steam line; and Fig. 2 is a view illustrating diagrammatically a system incorporating such a valve and designed for adequately safeguarding the boiler and superheater.

The present invention has particular application to systems employing a steam boiler with auxiliary superheater either fired from the boiler or independently thereof. Although this type of apparatus is more frequently than not provided with various types of automatic combustion controls, it is nevertheless a fact that safety valves must be provided for venting excessive pressure from the system either in the case of sudden cessation of demand as shutting down a turbine, or failure or inadequacy of the combustion control. Such a system is provided with one or more safety valves of adequate capacity venting directly from the boiler drum, and an additional safety valve or valves venting from the main steam line between the superheater and the region of steam demand. It is important to prevent damage or injury to the superheater in the case of cessation of demand with possible accompanying failure of the combustion control that superheated steam be instantly and adequately vented from the main line beyond the superheater in order to compel the continued flow of steam therethrough and avoid collecting or pocketing of stagnant steam in the superheater tubes with an accompanying burning or destruction of the tubes. To this end the safety valve connected with the superheated steam line is spring-loaded and normally set to vent at a pressure somewhat lower than the steam pressure in the boiler drum. This valve is provided with a pilot control from the main steam drum set to operate at a somewhat lower pressure than that of the superheated steam, and functioning to invariably open the valve even though the pressure of superheated steam may be on the order of 40 to 50 lbs. below the pop-off or venting pressure. The pilot control connected with the main steam drum is also set to open at a pressure lower than the main safety valves in the drum, insuring in consequence that if pressure builds up in the system due to cessation of demand or too high a steaming rate, the pilot will invariably operate to open the safety valve in the superheated line prior to the venting of any other portion of the system. This prior opening of the safety valve immediately relieves pressure in the main steam line and causes a flow of steam from the boiler through the superheater to protect the latter so long as venting continues. Failure of the pilot to operate for any cause whatsoever does not cause failure of

the valve, as the main valve functions to open when the pressure of superheated steam rises to the venting point which normally is below that of the saturated steam in the drum. In other words, assurance is had the building up of excessive pressure for any reason will cause venting of the main steam line in advance of drum venting either through the pilot control from the drum or directly from the superheated steam line. It will be evident to those skilled in the art that if the need for venting arises from a sudden cessation of demand, the back pressure surges the system and immediately builds up pressure, normally causing the pilot to open with consequent opening of the controlled safety valve. If this fails for any reason whatsoever the increasing pressure of superheated steam beneath the valve almost instantly causes opening of the valve and insures continued venting therethrough even though the drum valves follow and vent the steam boiler through continued rise in pressure.

Excessive rise of temperature without accompanying pressure at the outlet of the superheater likewise causes opening of the superheater vent valve through a pilot control opening a steam line from the boiler drum, thus again insuring the flow of steam through the superheater tubes and reduction of temperature thereby.

As shown in the illustrated embodiment of the invention, the boiler is indicated at **10** and is connected at its outlet with superheater coils **12** which deliver superheated steam to the main steam line **14** designed to conduct superheated steam to turbines or other source of steam demand. A safety valve indicated generally at **16** is cut into the main line between the superheater coils and demand, and is at all times subjected to the pressure of superheated steam in the main line. This superheater vent is operated not only directly from the superheated steam pressure but also through a pilot control **18**, located on the boiler drum and connected with the main venting valve **16** through a steam line **20** which upon opening of the pilot is designed to introduce saturated steam at drum pressure to lift or open the main valve. This auxiliary steam is vented through the line **22** into the main valve outlet **24**. An additional control for the main valve is created through the thermostatically controlled pilot **26** connected with the line beyond the superheater through the connection **28**. Opening of this valve causes a flow of saturated steam from the drum through the connections **30** and **32**, and thence through the connection **20** to the main valve, as indicated. In addition to the superheater vent valve as described, the steam boiler drum is equipped with one or more pressure relief valves indicated at **34** and **36** in order that adequate venting capacity for the entire system may be provided.

In actual practice, if the system is operating with 600 lbs. boiler pressure approximately, the drum valves will be set to pop off or vent at pressures of 616 and 618, or thereabouts. The superheater vent valve which is spring-loaded will be set to vent when the pressure in the superheated steam line rises to 612 or 613, approximately. In other words, this valve is set to vent at a lower pressure than the drum valves. The pilot control mounted upon the drum will be set at a still lower pressure, for example, 610 lbs., so that when excessive pressure is created in the drum the pilot will invariably operate to open the superheater valve before opening and venting of the drum valves. Under the same conditions of pressure the thermostatically controlled pilot valve may be set to operate and vent the main valve when the temperature in the line reaches 850° F. approximately.

Referring more particularly to the superheater valve indicated generally at **16**, it will be observed from Fig. 1 that this valve is provided with a body portion **50** having a flange **52** for attachment to the main steam line **14**, and an outlet flange **54** for attachment to the discharge outlet **24**. The valve is the overhead guided disk type with the valve disk exposed directly to the pressure of superheated steam in the throat **56**. The valve itself is supported upon the lower end of a valve spindle **58** which extends upwardly through the valve bonnet **60**, housing a loading spring **62** surrounding the extension **64** of the spindle, the spring being held between seats **66** and **68**, the upper seat having provision for adjustment to vary the tension of the spring by virtue of a threaded collar **70**. The valve is provided with the usual lifting lever **72** fulcrumed at **74** and serving through contact with a head **75** to manually elevate the valve when desired.

With this type of construction the safety valve is set to open or vent whenever the pressure of steam within the throat tube beneath the disk reaches or exceeds a predetermined amount. In other words, if the valve is set to vent when the pressure of superheated steam reaches 613 lbs. as indicated, the valve will invariably open and vent steam from the main line when this pressure is reached.

In addition to direct control of the valve in this manner, it is indirectly controlled through a pilot operation to be opened by the attainment of excessive pressure in the drum of the steam boiler. To this end the pressure control line **20**, as indicated in Fig. 2, communicates with a passage **76** formed in the valve housing **78**, this passage extending transversely of the housing and being intercepted by the vertically movable valve spindle **58**. Attached to the spindle is a collar **80**, fitting within a stationary sleeve **82** which is held between the housing and the bonnet **60**, the structure forming in effect a piston or shoulder attached to the valve spindle. When the pilot **18** operates to open the line **20** to saturated steam from the boiler, this steam entering the passage **76** beneath the piston and augmenting the steam pressure normally under the valve seat, will elevate and open the valve against the loading spring.

As the pilot is set to open before opening of either the drum valves or opening of the main valve through the pressure of superheated steam thereon, it will be evident that the normal operation of this valve is by virtue of the pilot control, the direct operation of the valve through superheated steam pressure normally taking place only upon failure of the pilot control. On the other hand, if for any reason pressure of superheated steam in the main line should exceed the pressure within the drum and at the same time reach or exceed the pop-off pressure, the main valve will be opened directly even though the pilot is closed.

The valve may be provided at each side of the passage **76** with control or metering valves **84**, two of which are employed merely for the purpose of convenience to permit connection of the control line into either side of the valve. These valves to some extent serve to regulate the flow of steam through the control line into the main

valve. I find it desirable to provide a limiting stop for the main valve with this type of operation which will serve to positively control and limit opening movements under the impact of the steam head. To this end I provide a tube **86** threadedly secured at its upper end to the spring seat **68** and extending downwardly about the valve spindle into proximity to the lower spring seat **66**, the lower end of the tube serving to engage with the spring seat and resist further movement after the valve has been elevated.

As will be evident from an inspection of Fig. 1, the operation of the valve is identical under thermostatic control as the opening of the thermostatically controlled pilot **26** delivers steam at drum pressure to the passage **76** in precisely the same manner as the pressure control.

In order that the main valve shall function equally well to vent saturated steam from the line if the superheater is cut out, I provide a series of thermostatic control rings **90** which serve to regulate the position of the deflecting shroud depending on the temperature of the steam, all as covered clearly in the copending application of Klafstad and Gundersen, filed November 16, 1937, Serial No. 174,816.

I also provide a hand-operated valve **90** in the pressure control line, which may be located conveniently in front of the boiler and manually operated in case it is desired to vent the main steam line at any time.

What is claimed is:

Means for safe guarding a steam system having a boiler and superheater, comprising a safety valve venting directly from the drum of the steam boiler at a predetermined pressure, a second and spring-loaded safety valve venting from the steam line at the delivery side of the superheater and set to vent through the spring load at a predetermined and lower pressure than the drum safety valve, an independent pilot valve connected with the steam drum and set to operate at a predetermined pressure lower than the setting of the drum safety valve, a pressure chamber associated with the superheater safety valve, connections for delivering steam from the drum to the pressure chamber when the pilot valve opens, and a piston within the chamber and connected with the spindle of the superheater safety valve and of sufficient area to augment the lifting pressure exerted by the superheated steam and invariably cause operation and venting of the superheater safety valve independent of the spring load upon opening of the pilot.

ERLING KLAFSTAD.