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FEED WATER HEATING

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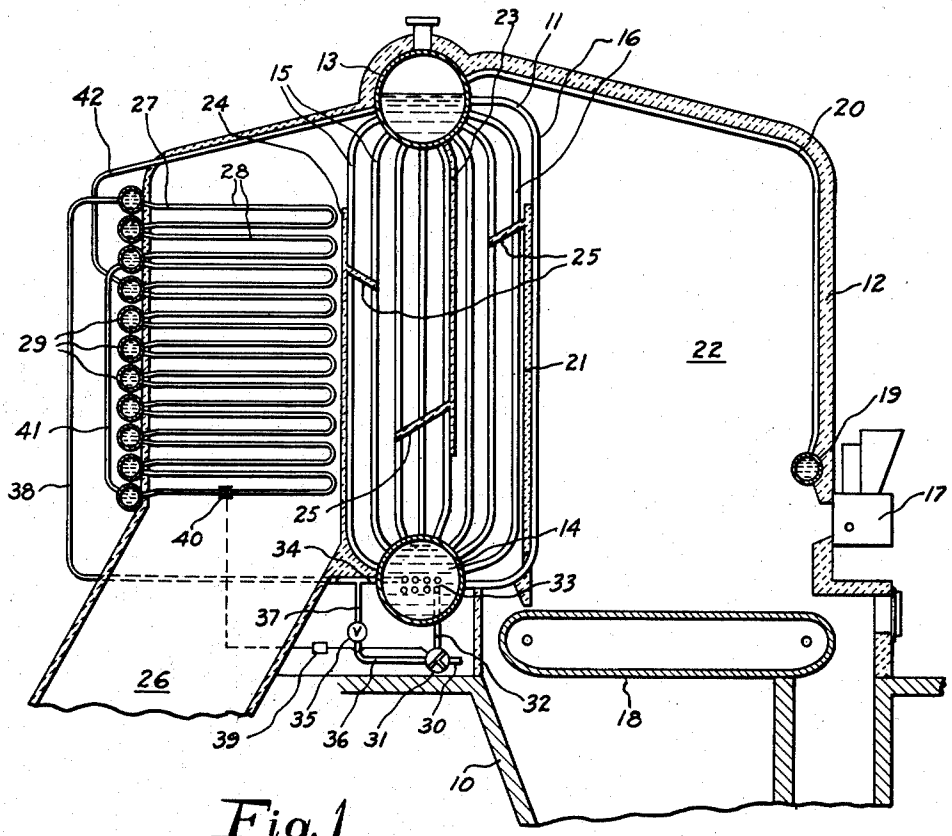


Fig. 1

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FEED WATER HEATING

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One of the problems which face the manufacturers of steam generating equipment is that of economizer corrosion. This is particularly true for industrial and central station installations located in districts where the fuel to be burned is high in sulphur and where at the same time, because of station heat balance, the feed water temperature is very low. It has been suggested that corrosion is due not so much to the temperature of the combustion gas as it is the temperature of the water passing through the tubes which produces condensation of sulphur dioxide with resultant corrosion. This is because the outer skin temperature of the economizer tubes is only a few degrees higher than the temperature of the water within the tubes regardless of what the gas temperature may be. This contention is confirmed by the fact that external economizer tube corrosion is being experienced with installations where the economizer is placed ahead of an airheater and where the economizer exit gas temperature is over 500° F., but where at the same time the temperature of the feedwater entering the economizer is in the neighborhood of 200° F. The temperature of condensation of flue gas moisture (dew point) rises with the increase of sulphur in the fuel. The higher the sulphur content the higher is the temperature at which condensation takes place. It is therefore important to keep the temperature of the water entering economizer tubes so high that it is above the condensation temperature of gas to prevent condensation and corrosion. The invention of the applicant obviates the difficulties described above and experienced in prior art installations.

It is therefore an outstanding object of the invention to provide means for preventing economizer corrosion.

Furthermore, it is an object of the present invention to provide a novel means of heating feedwater before its entrance into the economizer of a steam generating unit.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

The character of the invention, however, may be best understood by reference to certain of its structural forms, as illustrated by the accompanying drawings in which:

Figure 1 is a sectional, somewhat schematic view of a steam generating unit embodying the invention.

Generally speaking, the present invention consists in apparatus for passing the feedwater through a heat exchanger submerged under the boiler water and installed in one of the boiler drums. Referring to Figure 1 wherein is shown the preferred form of the invention, the steam generating unit, generally designated by the reference character **10**, comprises a boiler **11** situated in a setting **12**. The boiler **11** has an upper steam drum **13** and a lower submerged or water drum **14** joined in a well-known manner by downcomers **15** and risers **16**. A spreader stoker **17** and a traveling grate **18** provide for fuel burning. A header **19** situated immediately above the stoker **17** is joined to the steam drum **13** by water wall tubes **20**. A vertical wall **21** rises above the rear end of the grate **18** and serves to define a combustion chamber **22**. At least one row of risers **16** is situated forwardly of the wall **21** to constitute further water wall tubes. A downwardly-extending vertical wall **23** and an upwardly-extending vertical wall **24** serve to define the convection passes of the boiler and baffles **25** serve to cause the hot products of combustion to travel in a sinuous path from the combustion chamber **22** to a flue passage **26**.

In the flue passage **26** resides an economizer **27** of the return-bend type having tube loops **28** lying transversely of the path of the gases in the flue passage and having headers **29** lying externally of the flue passage to which the tube loops are connected in a well-known manner.

A conduit **30** is connected with the source of feedwater and to the entrance of a dividing valve **31**, which valve may be automatically controlled, as will be described hereinafter. One exit of the valve **31** is connected by a conduit **32** to a heat-exchanger **33** situated in the submerged drum **14**. The heat-exchanger **33** may consist of a number of coils of extended-surface tubing as is well-known in the art. The exit end of the heat exchanger **33** is joined to a conduit **34**. The other exit of the valve **31** is connected to a two-way, hand-operated shut-off valve **35** by a conduit **36**. The other side of the valve **35** is connected to a conduit **37** which joins with the conduit **34** to merge with a conduit **38**.

The valve **31** is connected mechanically to a power relay **39** which in turn is connected electrically to a temperature measuring device such as a thermocouple **40** which is situated adjacent one of the last loops of the economizer.

The conduit **38** is connected to the first header of the economizer. A header next subjacent the first header is connected by a conduit **41** to the last header. The header just below the header from which conduit **41** emerges is connected to the steam drum **13** by means of a conduit **42**.

The operation of the apparatus is as follows: the feed water enters the conduit **30** and passes into the dividing valve **31**. Some of the feedwater leaves the valve **31** through the conduit **32**, passes through the heat exchanger **33** into the conduit **34**. While passing through the heat exchanger **33**, the feedwater receives heat from the warm water in the submerged drum **14**. Some of the feedwater is by-passed by flowing from the valve **31** into the conduit **36**, through the shut-off valve **35** into the conduit **37**. The warmed feedwater in the conduit **34** and the by-passed feedwater in the conduit **37** mingle in the conduit **38** to an intermediate temperature which should be higher than the dew point of the flue gases. The temperature of the feedwater in the conduit **38** is dependent on the setting of the dividing valve **31**, which in turn is determined by the power relay **39** responsive to the thermocouple **40**. The thermocouple is associated with the last loop of the economizer since this is the portion where corrosion takes place most readily due to the fact that the gas is coolest and the feedwater is coolest in a counter-flow economizer.

In the preferred embodiment the feedwater passes through the conduit **38** into the first loops of the economizer to temper the feedwater even further before it passes through the conduit **41** into the last loop of the economizer. The feedwater then proceeds in counter-flow to the gases in the usual manner before passing through the conduit **42** into the drum **13** of the boiler.

The feedwater temperature rise is about 30° F. in a small installation where the feedwater temperature is 210° F. and the operating pressure is 200 p. s. i. g. at full load of the boiler. In other words, the temperature of the water entering the economizer will be approximately 240° F. with the system of the invention instead of 210° F. Invariably, this is sufficient to prevent condensation. Naturally, a higher water temperature rise can be obtained with higher operating pressures when the temperature of the water contained in the drum is higher.

One of the objections to the system of the invention may be based on the assumption that the heat recovery in the economizer will be impaired by the higher feedwater temperature entering the economizer. While this may be true to a certain extent, for the average industrial installation a loss of perhaps one quarter of one percent in overall efficiency will be compensated for by the absence of, or at least greatly reduced, expense for economizer maintenance and extended boiler outages.

The performance of the heat exchanger is such that a lower feedwater temperature rise is obtained with the highest rate of feedwater flow corresponding to the highest rate of boiler steam output. For example, the feedwater temperature rise is approximately 60° F. at half load and 40° F. at full load. This characteristic is desirable because it is usually necessary to maintain a

higher feedwater temperature at part load to prevent condensation of flue gas moisture than at maximum load when the temperature of the flue gas is naturally higher. It can also be seen that the heat recovery in the economizer is least impaired by this scheme during high loads when high efficiency is important.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desided to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. A steam generating unit comprising: a boiler having a steam drum and a water drum, an economizer for heating feedwater before its introduction into said boiler, a heat exchanger situated in said water drum, means responsive to the temperature of the section of the economizer over which the coolest gases flow for causing a portion of the feedwater to flow through the heat exchanger before entering the economizer to maintain the temperature of the said section of the economizer above the dew point of the gases passing thereover.

2. A steam generating unit having an external source of feedwater, comprising: a boiler having a steam drum and a water drum, an economizer for heating feedwater before its introduction into said boiler, a heat exchanger situated in said water drum, a three-way dividing valve, a temperature measuring device associated with the section of the economizer over which the coolest gases flow, a power relay connected to said device and responsive thereto, said power relay being also connected to said dividing valve to change its setting in response to changes in economizer temperature, said dividing valve being connected to the source of feedwater, the heat exchanger, and the economizer for causing a portion of the feedwater to flow through the heat exchanger before entering the economizer to maintain the temperature of the said section of the economizer above the dew point of the gases passing thereover.

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