D. S. JACOBUS.

STEAM BOILER PLANT.

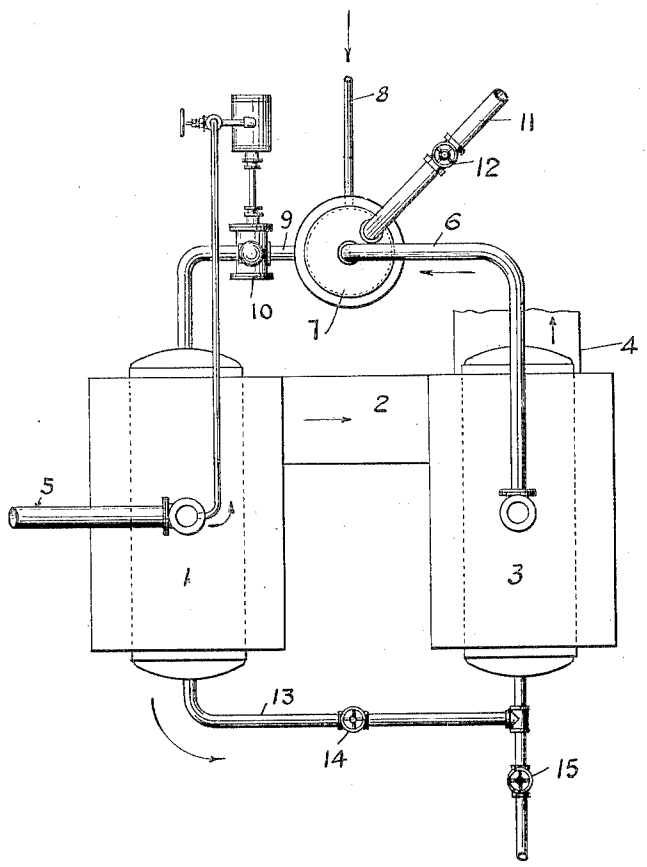
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1,068,058.

Patented July 22, 1913.

2 SHEETS—SHEET 1.

Fig. 1.



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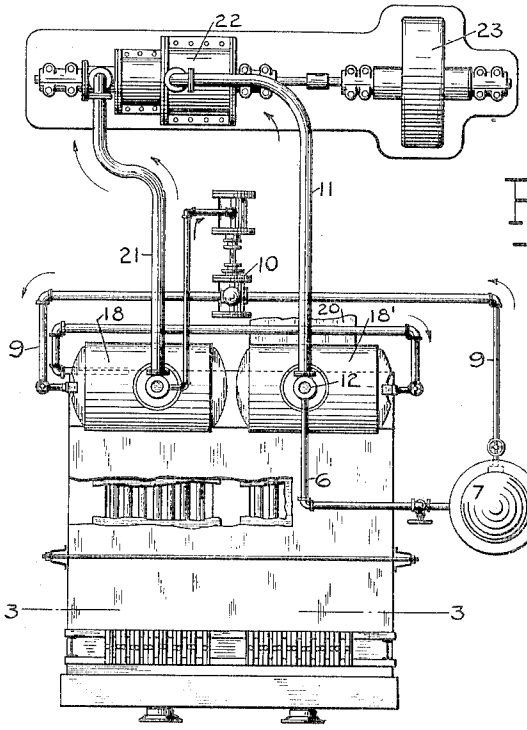


Fig. 2.

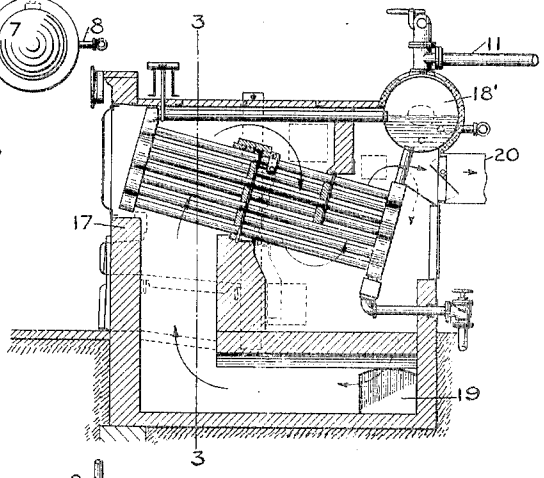


Fig. 4.

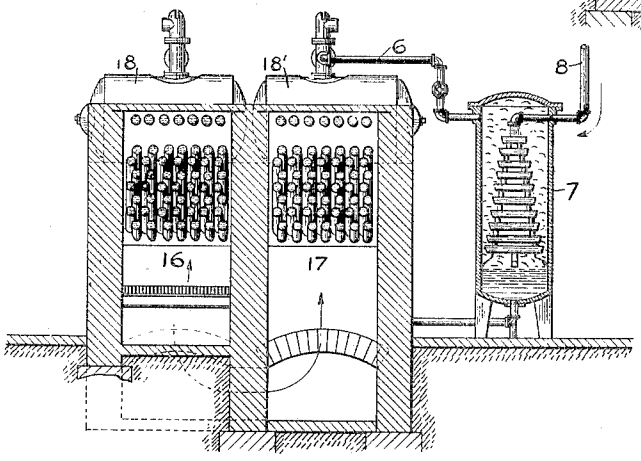


Fig. 3.

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STEAM-BOILER PLANT.

1,068,058. Specification of Letters Patent. Patented July 22, 1913.

Application filed November 21, 1912. Serial No. 732,642.

To all whom it may concern:

Be it known that I, DAVID S. JACOBUS, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Steam-Boiler Plants, of which the following is a specification.

My invention relates to a steam boiler plant the main feature of which is the setting of boilers carrying different pressures in series, to obtain high efficiencies by reducing the temperature of the waste gases to a minimum, and in combination therewith a feed water heater heated by the steam generated by the boiler or boilers which are run at the lower pressures.

The utilization of the heat in gases at comparatively low temperatures is receiving more and more attention, and in obtaining economy in such cases there is a great advantage in setting two or more boilers in series. In power plant operations, a feed water heater called an economizer, is often set in the path of the waste gases from the boiler for utilizing the heat of such gases, but a cumbersome and an expensive construction is involved because of the practice of building the economizer entirely of cast iron in order to prevent internal corrosion.

According to the present invention I secure the additional efficiency obtained by the use of an economizer by the employment of a secondary boiler in place of an economizer, setting such boiler in series with a primary boiler so as to utilize the heat of the waste gases therefrom and combine with such arrangement a feed water heater heated by the steam generated in the secondary or waste heat boiler or boilers.

The above and other features of the invention will be understood by reference to the accompanying drawings in which—

Figure 1 is a top view of a plant embodying the invention; Fig. 2 a top view, certain parts being in section, of another arrangement of a plant embodying the invention; Fig. 3 a vertical transverse section on the plane of the line 3—3 of Fig. 2; and Fig. 4 a longitudinal section through the waste heat boiler.

Similar reference numerals indicate similar parts in the several views.

Referring to Fig. 1, the numeral 1 designates what I call the primary boiler which is fired with fuel in the usual way. The hot waste gases pass through the flue 2 to the secondary or waste heat boiler 3 and are used for generating steam in the latter, and are then discharged through the flue 4. If the boilers were operated in the ordinary way and the steam taken off through a steam main common to both boilers, the pressure in the boilers would be the same and both boilers would be at the same temperature. According to the present invention, the secondary or waste heat boiler 3 will be carried at a lower pressure than the primary boiler 1 and consequently at a lower temperature, and the efficiency of the two boilers in absorbing heat from the gases will be greater than when both boilers are maintained at the same pressure and temperature. The secondary or waste heat boiler 3 will generate much less steam than the primary boiler 1 and this steam instead of flowing to the steam main 5 is utilized by conducting it through the pipe 6 to a feed water heater 7 in which it is condensed. The feed water enters the heater through a pipe 8 and is heated to the temperature, or thereabout, of the steam generated by the secondary boiler 3. From the heater 7 the hot feed water passes through a pipe 9 to the feed pump 10 which forces it into the primary boiler 1. If the heater 7 is a closed heater, the pump 10 may be placed in the feed main 8. If it is an open heater, that is, one in which the steam from the secondary boiler 3 comes into direct contact with the feed water, as shown in Fig. 3, the pump will be attached in the manner shown in the drawings.

The feed water heater 7 is vented, or the pressure is equalized by means of a pipe 11. When the feed water heater 7 is vented the valve 12 in said pipe will be a relief valve set at a given pressure. When the pressure is equalized the pipe 11 will be connected to a source of steam supply in the power plant and the pressure in the heater 7 will be maintained approximately at the pressure of this source of supply, the steam flowing either one way or the other through the pipe 11. The source of steam supply from the power plant for the pipe 11 may be from the exhaust steam of the auxiliaries, or from one of the steam receivers of a steam engine or steam turbine.

Feed water may be supplied to the secondary or waste heat boiler 3 from the

primary boiler 1 through a connecting pipe 13, the said pipe having a throttling cock or valve 14, in which case the feed water entering the secondary boiler 3 will be at a higher temperature than the water and steam in the boiler 3, and this will remove all tendency of the water to settle to a cool part of the boiler 3. The secondary boiler 3 may also be supplied with feed water from another source through the valved pipe 15, in which case the make-up water for the plant, or that water used in addition to the condensed steam returned from the condensers, may be used and any scale or impurities in the make-up water will be deposited in the boiler 3.

In Figs. 2, 3 and 4 I show another arrangement of plant embodying the same principles as above described in connection with Fig. 1. In this plant the primary boiler 16 and the secondary or waste heat boiler 17 are of the inclined water tube type, the banks of tubes being divided by transverse baffles, and the down-take headers nippled to cross drums 18 and 18′. The primary boiler 16 is fired in the usual way, the gases passing over the heating surfaces down past the rear headers to a flue 19, shown in Fig. 4, thence to the up-take pass of the waste heat boiler 17, over the heating surface of said boiler to the outlet flue 20. The pipe 6 leads the steam from the cross drum 18′ to the heater 7 and it is condensed therein. The steam generated in the primary boiler 16 is delivered by the steam main 21 for any useful work, a high pressure steam turbine 22 being shown for purpose of illustration driving an electrical generating unit 23.

The pipe 11 is shown as a direct continuation of the pipe 6, pipe 11 connecting the drum 18′ with a lower stage of the high pressure steam turbine to equalize the pressure of steam in the waste heat boiler 17 of the heater 7.

The ordinary practice of using economizers is to pass all of the feed water through the economizer and thence into the boiler. Where this is done practice has demonstrated that it is often necessary to employ cast iron tubes to avoid corrosion and pitting due to the action of the water on the same. In the present arrangement the feed water for the primary boiler is not passed through the waste heat boiler or boilers but the latter are fed in the same way as an ordinary steam boiler, namely, by supplying just enough water to make up for the steam which has been generated, and the pitting action is thereby avoided. With the present arrangement, if the feed water is of such a nature that it would cause pitting, some chemical, such as a soda ash, may be introduced into the waste heat boiler or boilers to overcome the corrosive action, and this chemical will remain in the boilers and will become exhausted only in proportion to the work done in neutralizing the corrosive action of the water, whereas in an ordinary economizer any chemical introduced into the feed water would be washed through the economizer with the feed water and thus have but little effect.

Experience has shown that as long as the water in a properly designed and operated boiler is kept in a state of ebullition there is no trouble through pitting. According to the present invention each one of the waste heat boilers is necessarily in a state of ebullition because only enough feed water is added to make up for the steam which has been generated. Furthermore, as already stated, the secondary or waste heat boiler, which is at a lower pressure than the primary boiler, may be fed directly with feed water from the primary boiler, and this would tend to increase the effectiveness of the circulation in the waste heat boiler as it would then be fed with water at a higher temperature than that of the water which it contains.

More than two boilers may be placed in series. If three boilers are placed in series, the second boiler may be run at atmospheric pressure and equalized to the exhaust of the auxiliaries, and the third boiler equalized to one of the stages or receivers of the steam turbine where the steam pressure is below that of the atmosphere. In this way the first, or primary boiler, may be run at say, two hundred pounds steam pressure, or a temperature of about 388° F., the second boiler at atmospheric pressure, or a temperature of about 212° F., and the third boiler at about ten pounds below atmospheric pressure, or a temperature of about 160° F.

Two or more secondary boilers may be used in connection with a single primary boiler, and the same advantage gained as by using a single secondary boiler for each primary boiler.

The method of feeding from one boiler to the other as herein described is desirable where there is air in the feed water which might cause corrosion, with a lack of circulation in any part of the secondary boiler as the hot feed water from the primary boiler would contain no air and would materially assist in the circulation. Where the make-up water of the plant contains foreign solids or salts it may be desirable to feed it into the secondary or waste heat boilers, in which case any deficiency of feed for the secondary boilers can be made up through feeding from the primary boilers, or by feeding from some other source.

What I claim and desire to secure by Letters Patent of the United States is:—

1. A steam boiler plant comprising a primary boiler, a secondary boiler run at

a lower steam pressure than the primary boiler, a feed water heater, means for heating said heater by the steam generated in the low pressure boiler, and means for feeding the heated water to the primary boiler.

2. A steam boiler plant comprising a primary boiler, a secondary boiler heated by the waste gases from the primary boiler, a feed water heater, and means for heating said heater by the steam generated in the low pressure boiler.

3. A steam boiler plant comprising a primary boiler, a secondary boiler run at a lower steam pressure than the primary boiler, a feed water heater for the primary boiler, means for heating said heater by the steam generated in the low pressure boiler, and means for feeding water from the primary boiler to the low pressure boiler.

4. A steam boiler plant comprising a primary boiler, a secondary boiler run at a lower steam pressure than the primary boiler and heated by the waste gases from the primary boiler, and means for feeding water from the primary to the secondary or low pressure boiler.

5. A steam boiler plant comprising a primary boiler, a secondary boiler and means for heating the same by the waste gases from the primary boiler, a feed water heater and means for heating the same by the steam generated in the secondary or waste heat boiler, and means for conducting the hot feed water to the primary boiler.

6. A steam boiler plant comprising a primary boiler, a secondary boiler and means for heating the same by the waste gases from the primary boiler, a feed water heater and means for heating the same by the steam generated in the secondary or waste heat boiler, and means for conducting the hot feed water to the primary boiler, and means for equalizing the steam pressure in said heater.

7. A steam boiler plant comprising a primary boiler, a secondary boiler connected thereto so as to be heated by the waste gases from the primary boiler, a feed water heater and means for heating the same by the steam generated in the secondary boiler, means for conducting the hot feed water to the primary boiler and means for feeding water from the primary boiler to the secondary boiler.

8. A steam boiler plant comprising a primary boiler, a secondary boiler or boilers, and means for heating the same by the waste gases from the primary boiler, and means for regulating the steam pressure in the secondary boiler or boilers by equalizing with the atmosphere or with a low pressure steam chamber.

9. A steam boiler plant comprising a primary boiler, a secondary boiler run at a lower steam pressure than the primary boiler and heated by the waste gases from the primary boiler, the make-up-water for the plant being supplied either in whole or in part by feeding it into the secondary boiler.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

DAVID S. JACOBUS.

Witnesses:
E. CAMP,
E. P. TERRY.