Feb. 4, 1930. C. SCHWARTZ 1,745,816

PLANT FOR PRODUCING AND UTILIZING STEAM

Filed March 8, 1924 2 Sheets-Sheet 1

Fig 1

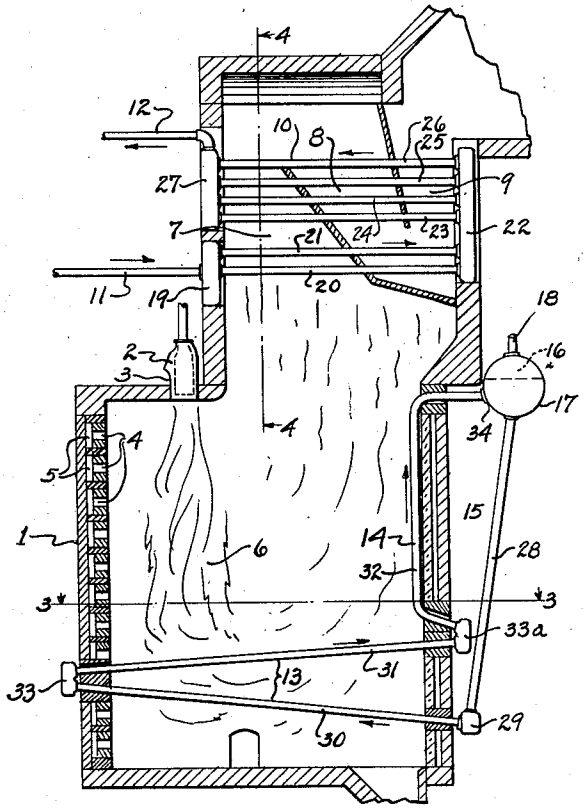


Fig 2

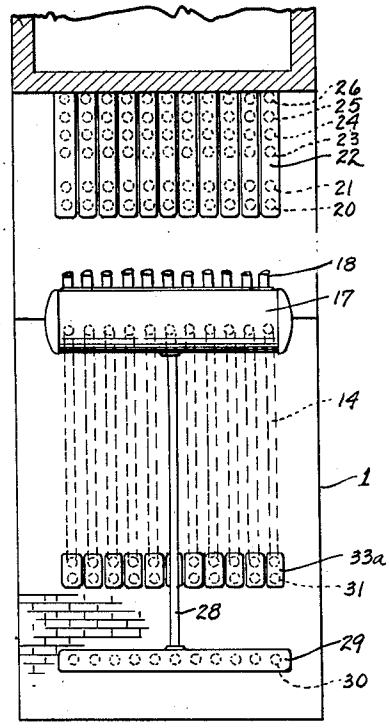


Fig 3

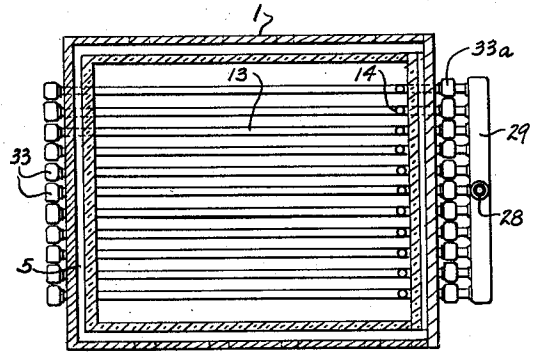
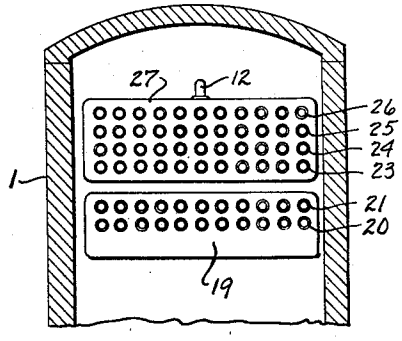


Fig 4



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PLANT FOR PRODUCING AND UTILIZING STEAM

Filed March 8, 1924 2 Sheets-Sheet 2

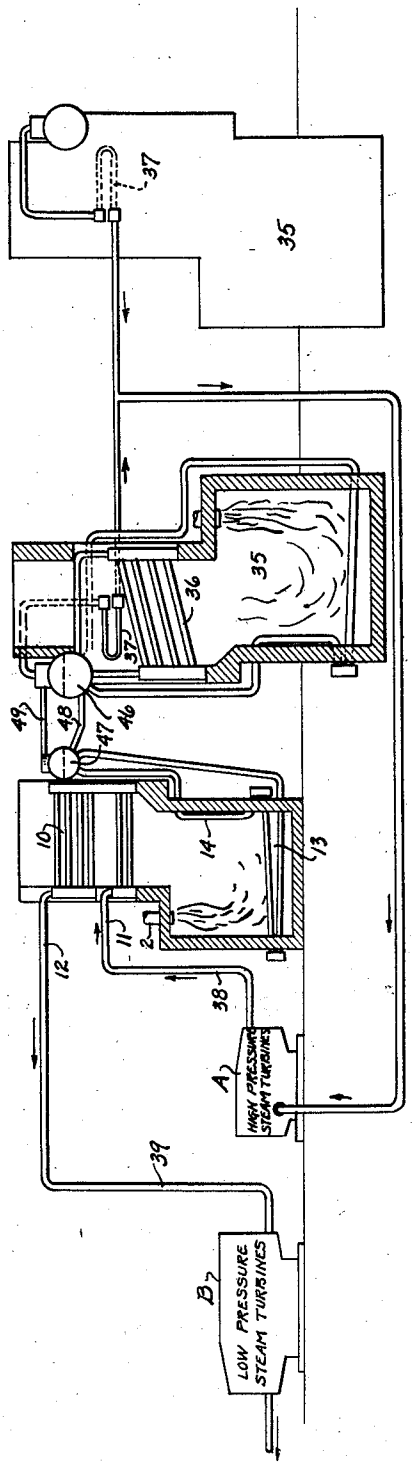


Fig. 6.

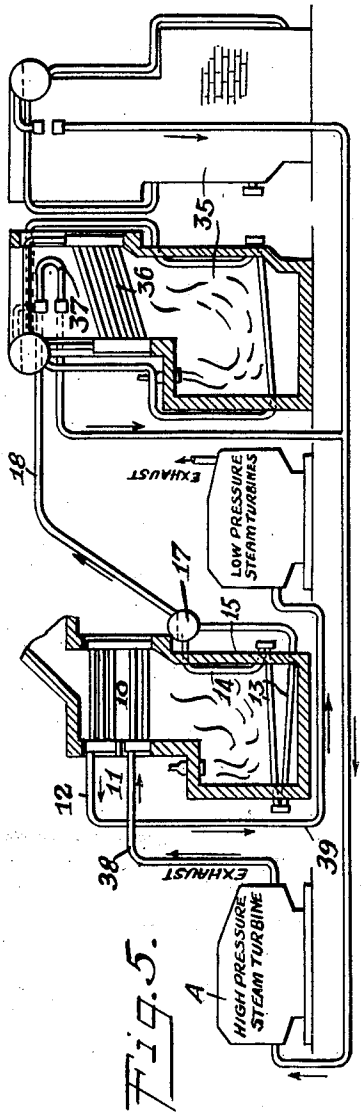


Fig. 5.

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UNITED STATES PATENT OFFICE

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PLANT FOR PRODUCING AND UTILIZING STEAM

Application filed March 8, 1924. Serial No. 697,699.

The invention relates to plants wherein steam is superheated and subsequently employed, to apparatus whereby the steam is superheated, and/or to the mode of employment and arrangement of steam superheating means in association with the functioning elements or device of a plant, such as above mentioned, or portions of such a plant.

The invention has various objects or aspects.

In many power plants of the present time there is employed a high pressure steam turbine, which may be considered as the primary engine or initial steam user, and the exhaust or used steam from the high pressure turbine is passed to a low pressure turbine to perform further work. The low pressure turbine may be referred to as the secondary engine, and is broadly means for further using steam that has been previously employed to perform some useful work as in a primary engine such as the high pressure turbine above referred to. In certain cases it is desirable from the point of view of power and efficiency to add heat to the steam exhausted from the primary engine—preferably enough heat should be added to substantially superheat the steam—prior to its introduction into the secondary engine, and certain aspects of the invention relate to the mode and arrangement for accomplishing this.

Also, in many of the large power plants of the present time steam is produced by the burning of fuel, as coal, in pulverized or finely divided form. In the burning of pulverized coal there is a tendency for the ash from the coal to deposit and form slag unless special modes or means are employed to effect the cooling of the ash whereby that which collects is in a condition to permit of ready handling. Certain aspects of the invention relate to the burning of pulverized fuel as the medium for reheating the steam exhausted from the primary engine whereby the secondary engine will receive the reheated steam in a superheated condition. Furthermore, certain aspects relate to the manner of combining or bringing in associated relationship means for cooling the ash with the superheating means or elements, as such means may be termed. Some aspects relate to a novel combining of the pulverized fuel furnace and superheater with the furnaces and boilers of the plant as a whole.

The furnaces for burning of pulverized fuel, as diagrammatically illustrated herein, preferably employ series of spaced cooling tubes constituting a screen or screens for protecting certain portions of the furnace structure and cooling the ash. An important function of such a screen is to cool the ash particles leaving the fuel and flame stream preferably below the point of coalescence prior to the ash striking a recipient surface. Precipitated ash particles thus cooled deposit in a fine floury condition. Such a screen formed of spaced pipes is shown as arranged between the fuel and flame stream and the recipient surface and in the constructions illustrated these spaced pipes are in the circulation of or constitute a part of a steam generating boiler. Certain aspects of the present invention contemplate novel combinations of the cooling screen or boiler comprising such on the one hand with the superheater or the elements for superheating the exhaust steam on the other hand.

The invention comprises many objects or aspects other than those mentioned as will readily appear from the description and claims constituting part of the specification and particularly when considered in conjunction with the accompanying drawings constituting a part of the specification and that illustrate some specific embodiments in which the invention may be realized.

In said drawings:—

Figures 1 to 4 show a pulverized fuel furnace having a superheater in the off take passageway of the furnace and a boiler comprising in the circulation thereof spaced pipes constituting water screens in the lower and rear portions of the furnace; Figure 1 being a vertical sectional view, Figure 2 a rear elevation, Figure 3 a horizontal sectional view as on the line 3—3 of Figure 1 looking in the direction of the arrows, and Figure 4 a partial vertical sectional view taken as on the

line 4—4 of Figure 1 looking in the direction of the arrows.

Figure 5 illustrates a plant arrangement wherein a battery of boilers supplies steam that passes in succession to a high pressure steam turbine, thence into a superheater heated by the burning of pulverized fuel, and ultimately into a low pressure steam turbine.

According to the construction of Figure 5 the pulverized fuel furnace for heating the superheater has in association therewith the cooling tubes of a water screen that in effect constitute part of a boiler which is connected so as to deliver steam to the steam delivery system leading from the high pressure boilers to the high pressure steam turbine.

Figure 6 illustrates an arrangement wherein high pressure steam is delivered from a battery of boilers to a high pressure steam turbine and passes therefrom into a superheater and thence to a low pressure turbine. In the arrangement of Figure 6 the superheater mentioned is heated by the burning of pulverized coal in a furnace within the off-take of which the superheater is arranged but which furnace has cooling screens constituting parts of a boiler which may be considered in effect part of a boiler of the battery of boilers for the primary engine.

A detailed description follows in respect to each of the structures and arrangements above referred to.

Referring to the structure of Figures 1 to 4 the reference character 1 designates a pulverized fuel furnace having a burner 2 by which pulverized fuel is fed in a suitable manner in a downward direction and burned by air, some of which is admitted with the fuel as through the burner casing 3 and some of which is admitted through a series of vertical openings 4 after passing through spaces or ducts 5 that provide the dual function of heating the air and the cooling to a certain extent by the air of the vertical walls of the furnace that are exposed to the heat resulting from the combustion of the fuel. The fuel fed and burned in this manner produces a reverting fuel and flame stream 6 and the products of combustion pass from the furnace through the off-take passageways 7, 8 and 9 collectively constituting what may be considered as the off-take portion of the furnace. In this off-take portion there is located a steam superheater 10, or steam superheating element as this may be referred to, which is constructed so that it can receive steam from an outside source, as by piping 11—for example, exhaust or used steam from a high pressure turbine or other primary engine—and so as to deliver, as by piping 12, such steam when reheated and in a superheated condition to a secondary engine where such reheated steam is further employed.

In the burning of fuel when in finely divided or pulverized form, and particularly pulverized coal, certain portions of the furnace are subjected to intense heat; moreover, ash particles leaving the fuel and flame stream have a tendency to collect as a mass of slag unless some means or instrumentality is employed to cool the ash particles before depositing to a temperature sufficiently low to prevent this and to that end the furnace is provided with a series of spaced relatively horizontally extending cooling tubes 13 and a series of spaced relatively vertically extending tubes 14 arranged so as to form protecting cooling screens.

The relatively horizontally extending cooling tubes 13 provide a cooling screen between the fuel and flame stream on the one hand and the ash receiving zone or depositing surface of the ash on the other, while the cooling screen of vertically extending tubes 14 is located between the fuel and flame stream on the one hand and the vertical rear wall of the furnace on the other. Each of these screens is constructed and arranged so as to cool ash particles precipitating or leaving the fuel and flame stream to a point sufficiently low to avoid objectionable slag formation where the ash particles lodge or strike.

An inspection of said Figures 1 to 4 will show the arrangement of the spaced tubes whereby the screens are formed and will also show that such tubes constitute essential elements in the circulatory system of a boiler 15 and are in effect a part of the boiler. The steam space 16 of the boiler which is in the drum 17 is in communication through piping 18 with another boiler as will be hereinafter described.

The superheater 10 has a common header or drum 19 into which the steam from the piping 11 is delivered and said header 19 in effect constitutes a distributing drum whereby the used steam is distributed relatively uniformly to tubes 20 and 21 of the superheater.

An inspection of Figure 2 will show that there are several tubes 20 and 21 and that said tubes are arranged in sets or pairs with the tubes 20 and 21 of each set being connected to a vertical connector or header 22 to which in turn there is connected a set of pipes 23, 24, 25 and 26, there being a set of such pipes for each vertical header. The delivery ends of the several sets of pipes 23, 24, 25, 26 are all connected to a common header or drum 27 that serves to collect the superheated steam and from which the collected steam is conducted by the piping 12.

Reverting to the boiler 15, it will be observed that the circulation thereof is from the drum 17 downwardly through piping 28 into a common header 29, thence upwardly through the lowermost tubes 30 and the uppermost tubes 31 of the relatively horizontal cooling tubes or screen 13, and ultimately back to the drum through vertical

tubes 32, of the vertical cooling tubes or screen 14, that are connected to the water space of the boiler at 34.

Each lowermost tube 30 is connected to its corresponding uppermost tube 31 by a suitable fitting 33, and likewise each tube 31 is in turn connected to its corresponding vertical tube 32 by a special fitting 33a. It will therefore be seen that the arrangement is such that effective thermal circulation is insured for each horizontal and vertical screen tube thus connected.

The furnace boiler and preheater arrangement of Figures 1 to 4 has been embodied in a plant arrangement diagrammatically illustrated in Figure 5 and the description above given, when borne in mind with the descriptions hereafter appearing in respect to Figure 6, will make clear the construction of the superheater furnace and boiler of said figures.

According to the construction of Figure 5 there is a boiler 15, but the steam space thereof is connected to one of the superheaters 37, by means of pipes 18, or in other words to the steam delivering system leading from the main battery of boilers to the high pressure steam turbine A and it will be manifest that with boiler 15 thus connected such boiler must be constructed for high pressure work and may be considered as a part of the main battery.

The construction of Figure 6 will now be considered. In said figure, 35 indicates a pulverized fuel burning furnace for primary boilers, as 36, and according to the construction of this figure the high pressure steam passes from the boilers 36 through a superheater element, as 37, to a high pressure steam turbine A, and the exhaust steam from this turbine passes by piping 38 and 11 to a superheater 10 that is heated by the burning of pulverized coal, and this reheated steam in a superheated condition passes by means of piping 12 and 39 to low pressure turbine B.

In the construction of Figure 6 the series of cooling tubes or screens 13 and 14 are a part of a boiler which in turn may be considered in effect part of boiler 36 because the large steam drum 46 and the smaller drum 47 are arranged relatively to each other and are connected in such a way that they function as two drums of the same boiler, the water spaces of the drum 47 and drum 46 being connected by piping 48 and the steam spaces being in communication by the piping 49. A portion of the feed water in each instance will be admitted to the drum 17 or 47 of Figs. 5 and 6, respectively, and the remainder of the feed water will be admitted to the drum of the main boiler 36.

It will be manifest that the invention herein described is not limited to the precise mode and arrangement of the several elements or operative parts as herein set forth and that the invention is susceptible to be embodied in various forms and modifications without departing from the spirit and scope thereof.

What is claimed is:

1. In combination a first steam using device, a second steam using device, a steam reheating element in the form of a steam superheater, said steam reheating element having piping for conducting exhaust steam thereto from said first device and also having piping for conducting the reheated steam therefrom to said second steam using device, a pulverized fuel burning furnace for heating said steam reheating element, cooling tubes in the furnace for cooling certain parts of the furnace structure and for cooling precipitating ash, another furnace having a steam boiler that delivers steam for use to said first device prior to its being reheated by said steam reheating element, the said cooling tubes being connected to said boiler.

2. In combination a first steam using device, second steam using device, a steam superheater having piping for conducting exhaust steam thereto from said first device and also having piping for conducting the reheated steam therefrom to said second steam using device, a pulverized fuel burning furnace for heating said superheater, tubes for cooling certain parts of the furnace structure and for cooling ash, another furnace having a steam boiler that delivers steam for use to said first device prior to its being reheated by said superheater, the said cooling tubes being connected to said boiler.

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