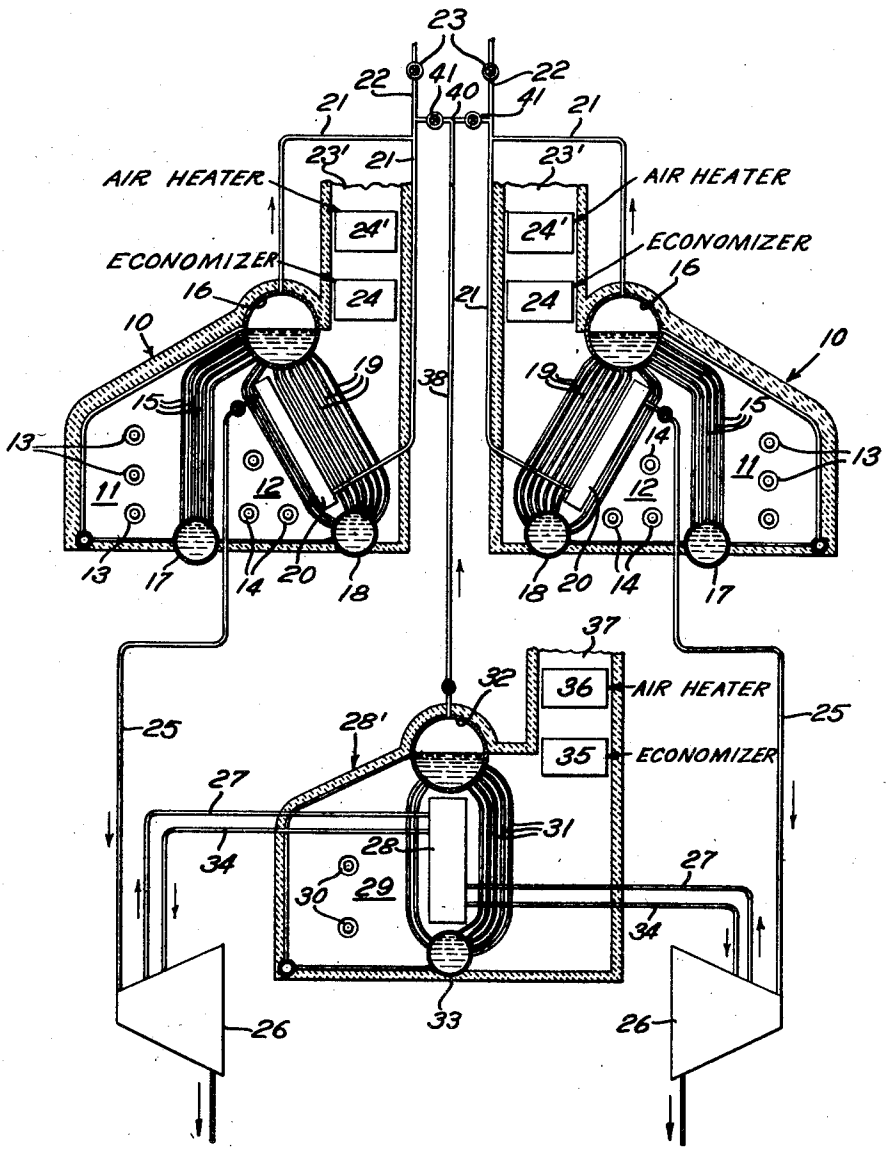
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STEAM POWER PLANT INCLUDING REHEAT BOILER CYCLE

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STEAM POWER PLANT INCLUDING REHEAT BOILER CYCLE

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The present invention relates to heat exchange systems and more particularly to a heat exchange system for power generators.

In the usual heat exchange system for power generators, superheated vapor is produced in a vapor generator after which it is passed to the high pressure stage of a turbine for use therein. Thereafter, the vapor from this high pressure turbine stage is reheated before it is passed to the low pressure stage of the turbine.

In accordance with the present invention, vapor is produced in a vapor generator which is provided with means for controlling the superheated vapor temperature, and the vapor is thereafter delivered to the high pressure stage of a turbine. The vapor from the high pressure stage is reheated in a vapor generator separate from the main or superheater vapor generator. The reheat vapor generator comprises a setting having two banks of vapor generating tubes which are arranged in series in the path of flow of the combustion gases and a convection reheater element is disposed between the tube banks and shielded from radiant heat by the tube bank nearer the furnace. The reheater element is connected to receive vapor from the high pressure turbine stage and to pass reheated vapor to the low pressure stage of the turbine. The vapor generating surface of the reheat vapor generator is connected to pass variable quantities of saturated vapor to the superheater of the main generator without upsetting the final superheated vapor temperature in the main generator.

The invention will be better understood from the following description when considered in connection with the accompanying diagrammatic drawing showing the invention for purposes of illustration as used in a marine installation.

Like characters of reference refer to the same parts throughout the drawing.

Referring to the drawing, the reference character **10** designates the setting of two steam generators each comprising steam generating furnaces **11** and **12**. The furnace **11** is lined with water wall tubes and fired by burners **13** while the furnace **12** is fired by burners **14**. A group of steam generating tubes **15** extends between an upper steam and water drum **16** and a lower water drum **17** and the tubes are arranged to separate the furnaces. Tubes **15** are spaced apart from one another to permit gases to pass from furnace **11** into the furnace **12**. The drum **16** is connected to a lower drum **18** by a vertically inclined main bank of steam generating tubes **19**. As shown, a superheater **20** is positioned in the tube bank **19**. A saturated steam line **21**, extending outside the setting, is connected to drum **16** and superheater **20** to communicate the drum **16** with the superheater. Steam line **21** is in communication with auxiliary steam consuming equipment (not shown) by an auxiliary steam line **22**. Line **22** is provided with a control valve **23**. The steam generator illustrated is provided with a single flue outlet **23'** for the gases from both furnaces. The arrangement of the steam generator is such that the gases

from the furnace **11** flow over the tube group **15** into the furnace **12** and such gases, together with the gases produced in furnace **12**, pass over the bank of tubes **19** and enter the flue **23'**. Heat recovery apparatus, such as an economizer **24** and an air heater **24'** are disposed in the flue **23'**. Steam to be superheated is withdrawn from drum **16** through line **21** and delivered to the superheater.

The superheater **20** of each vapor generator is connected by a conduit **25** to the high pressure stage of a steam turbine **26**. An exhaust conduit **27** connects the high pressure stage of turbine **26** to a reheat element **28** of a reheat generator **28'**, which reheat element **28** may be a conventional type heat exchanger comprising a tubular coil.

Reheat generator **28'** comprises a furnace **29** lined with water wall tubes and fired by burners **30**. A group of steam generating tubes **31** extends between an upper steam and water drum **32** and a lower water drum **33**. Reheat element **28** is disposed in tube bank **31** and is shielded from radiant heat by the portion of tube bank **31** nearer the furnace. Outlet conduits **34** connect reheat element **28** with the low pressure stage inlet of each turbine **26**. An economizer **35** and an air heater **36** are disposed in a flue **37** of the reheat generator. A saturated steam line **38** is connected to drum **32** and communicates with the auxiliary steam line **22** of each main generator through a connecting pipe **40**. Valves **41** are provided in pipe **40** between line **38** and steam line **22** to control the quantity of saturated steam delivered to each steam line **22**.

In operation, gases of combustion produced in each furnace **11**, pass in heat exchange relationship with tube banks **15** to cause generation of steam which passes into drums **16**. Thereafter, the gases of combustion from furnaces **11** pass into furnaces **12** to join the combustion gases produced in furnaces **12**. Gases of combustion, in furnaces **12**, pass in heat exchange relationship with tube banks **19** to cause generation of steam in the latter, which steam passes into drums **16**. The steam from drums **16** flows through lines **21** and into superheaters **20** where the steam is superheated by the gases of combustion flowing thereover. The desired superheat steam temperature is maintained in superheaters **20** by controlling the firing of burners **14** in furnaces **12**. Superheated steam from superheater **20** flows into the high pressure stage of turbine **26** through conduit **25** and passes therefrom through the exhaust conduit **27** of the turbine into the reheat element **28** of the reheat vapor generator in the cycle. Gases of combustion in furnace **29** of the reheat boiler pass in heat exchange relationship with reheat element **28** to reheat steam from the high pressure stage of the turbine. The combustion gases also pass over tube bank **31** to generate saturated steam which passes into drum **32**. The reheated steam from reheat element **28** thereafter passes into the low pressure stage of each turbine **26** through conduits **34**. The saturated steam from drum **32** passes into the superheater **20** of each main boiler through line **38** and connecting pipe **40** thus providing an additional quantity of steam to the system from the reheat boiler. Since separately fired furnaces are provided in each main boiler, positive control of superheat is provided and accordingly the additional steam from drum **32** may be passed to the superheaters **20** without upsetting the final steam temperature in the main boilers.

If desired, the saturated steam produced in the reheat boiler may be used for auxiliary plant purposes by opening valve **23** in the steam line **22** of each main boiler which line communicates with auxiliary equipment, not shown.

Thus, in the present invention when the auxiliary steam

demand is less than the output of the reheat boiler, the balance of the saturated steam produced in the reheat boiler can be passed through the main boiler superheaters. On the other hand, if the reheat boiler is not producing enough steam to meet the auxiliary demand then the difference can be made up from the main boilers and as that difference will be relatively small, it will not prejudice the output of the main boilers in respect to the demand made on the latter by the steam consuming apparatus, for example, the main engines (not shown) in a marine installation.

Inasmuch as various modifications may be made in the embodiment of the invention herein disclosed without departing from the principles thereof, it will be understood that the invention is not to be limited excepting by the scope of the appended claims.

What is claimed is:

1. In combination, a plurality of vapor generators, a superheater and a vapor generating surface disposed in each vapor generator, means for controlling the superheated vapor temperature of each vapor generator, a plurality of turbines each having a high pressure stage and a low pressure stage, conduit means in communication with the superheater of one of said vapor generators and with the high pressure stage of one of said turbines, other conduit means in communication with the superheater of another of said vapor generators and the high pressure stage of another of said turbines, a reheat vapor generator, burner means for firing said reheat vapor generator, a reheat element and saturated vapor generating surface disposed in said reheat generator, conduit means in communication with the reheat vapor generator and each of said plurality of vapor generators to pass vapor generated in the reheat vapor generator into admixture with vapor generated in each of said plurality of vapor generators, control means for apportioning flow of vapor generated in said reheat generator between said plurality of vapor generators exhaust conduit means in communication with the high pressure stage of said one turbine and said reheat element, other exhaust conduit means in communication with the high pressure stage of said other turbine and said reheat element, reheat conduit means in communication with said reheat element and the low pressure stage of said one turbine, other reheat conduit means in communication with said reheat element and the low pressure stage of said other turbine, and vapor conduit means for each of said plurality of vapor generators in communication with said saturated vapor generating surface and the superheater of each of said plurality of vapor generators.

2. In combination, a plurality of vapor generators, a plurality of furnace chambers in each of said vapor generators, burner means disposed in each chamber, a superheater disposed in one of the chambers of each vapor generator, a vapor generating surface in each of said plurality of vapor generators, a plurality of turbines each having a high pressure stage and a low pressure stage, conduit means in communication with the superheater of one of said vapor generators and with the high pressure stage of one of said turbines, other conduit means in communication with the superheater of another of said vapor generators and the high pressure stage of another of said turbines, a reheat vapor generator, burner means for firing said reheat vapor generator, a reheat element and saturated vapor generating surface disposed in said reheat generator, conduit means in communication with the reheat vapor generator and each of said plurality of vapor generators to pass vapor generated in the reheat vapor generator into admixture with vapor generated in each of said plurality of vapor generators, control means for apportioning flow of vapor generated in said reheat generator between said plurality of vapor generators exhause conduit means in communication with the high pressure stage of said one turbine and with said reheat element, other exhaust conduit means in communication with the high pressure stage of said other turbine and with said reheat element, reheat conduit means in communication with said reheat element and with the low pressure stage of said one turbine, other reheat conduit means in communication with said reheat element and with the low pressure stage of said other turbine, and vapor conduit means for each of said plurality of vapor generators in communication with said saturated vapor generating surface and the superheater of each of said plurality of vapor generators.

3. In combination, a plurality of vapor generators each comprising a setting, a plurality of furnace chambers in said setting, independently controlled burner means for separately firing each chamber, a steam and water drum and a water drum positioned in said setting, a bank of tubular members disposed in said setting and connected to said steam and water drum and to said water drum, a superheater positioned in said bank of tubular members, a saturated steam conduit connected to said steam and water drum and to said superheater, a plurality of turbines each having a high pressure stage and a low pressure stage, a superheated steam conduit connected to the superheater of one of said vapor generators and to the high pressure stage of one of said turbines, another superheated steam conduit connected to the superheater of another of said vapor generators and to the high pressure stage of another of said turbines, a reheat vapor generator, other burner means for firing said reheat vapor generator, a reheat element and saturated vapor generating surface disposed in said reheat generator, a saturated steam conduit communicating at one end to said reheat generator to receive saturated steam generated therein and at the other end communicating with each of said plurality of vapor generators to deliver saturated steam from the reheat generator into admixture with the saturated steam generated in each of said plurality of vapor generators, control means in said saturated steam conduit for apportioning saturated steam generated in said reheat generator between each of the plurality of vapor generators an exhaust steam conduit connected to the high pressure stage of said one turbine and to said reheat element, another exhaust steam conduit connected to the high pressure stage of said other turbine and said reheat element, a reheated steam conduit connected to said reheat element and the low pressure stage of said one turbine, another reheated steam conduit connected to said reheat element and the low pressure stage of said other turbine, and an auxiliary steam outlet conduit connected to the saturated steam conduit of each of said vapor generators.

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