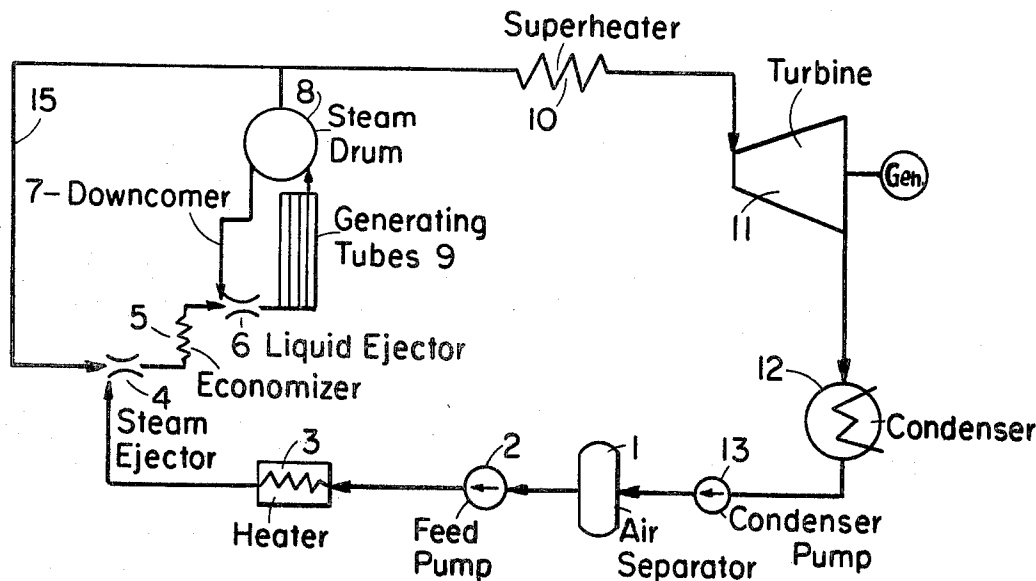


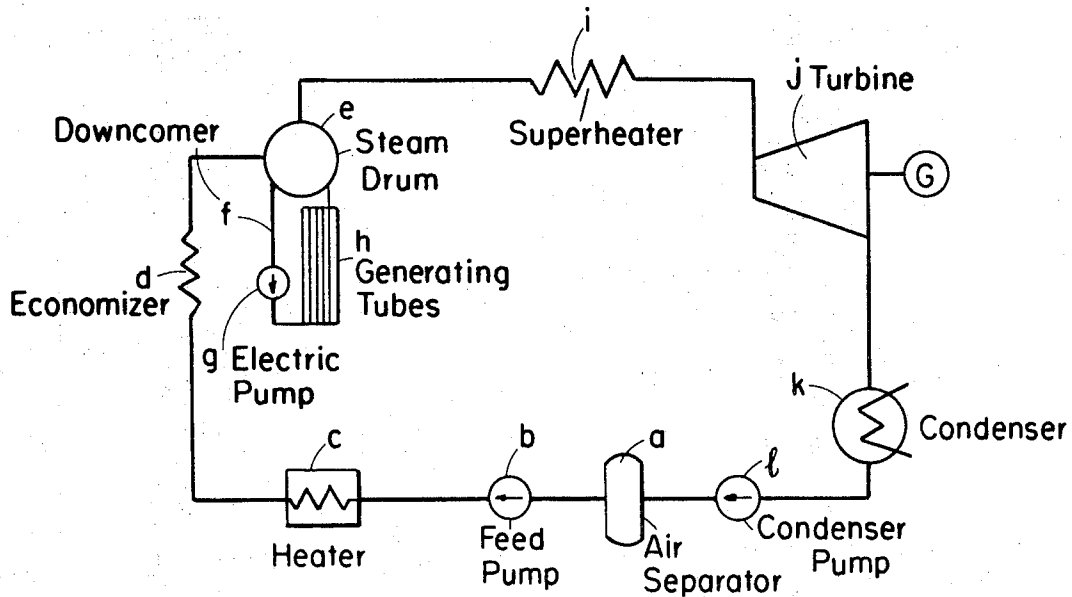
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[33] Japan
[31] 43/55264

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[54] VAPOR GENERATOR
6 Claims, 2 Drawing Figs.
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122/407
[51] Int. Cl..... F22d 7/04
[50] Field of Search..... 122/406,
406 (R), 407

ABSTRACT: A vapor generator includes a liquid ejector which is operated by the high-pressure water for circulating fluid within the generator. The apparatus also includes a steam ejector or condensation-type ejector which is operated by part of the vapor generated within the vapor generator to apply a pumping pressure to the feed liquid directed into the water ejector.





(Prior Art)

FIG. 1

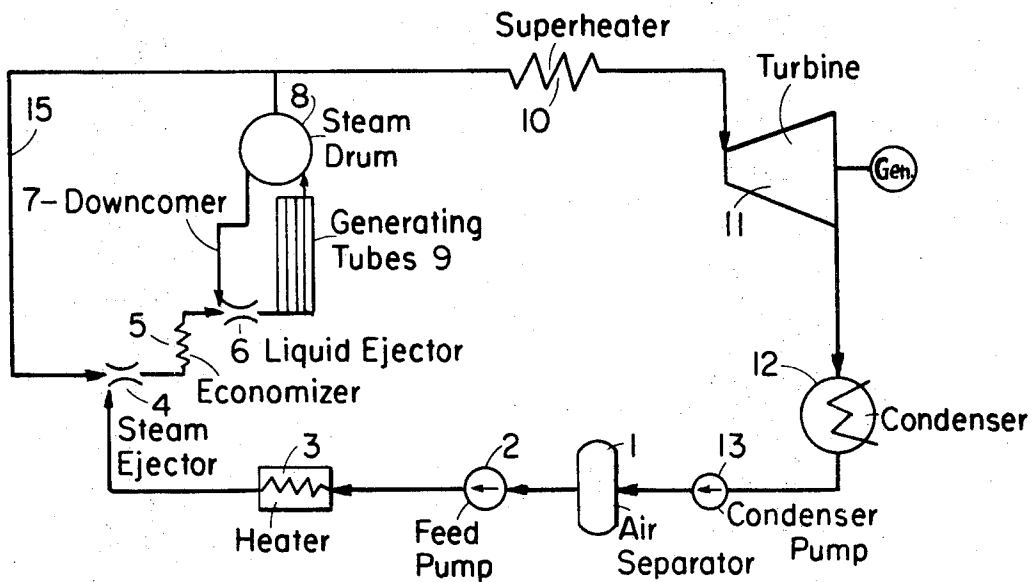


FIG. 2

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VAPOR GENERATOR

SUMMARY OF THE INVENTION

This invention relates in general to vapor generators and, in particular, to a new and useful steam generator having a liquid ejector for circulating fluid through the steam generating tubes and which also includes a steam ejector located between the feed water pump and the economizer for supplying feed water to the steam generator, the steam ejector being operated by steam supplied from the steam drum of the steam generator.

The present invention is an improvement over the conventional forced circulation-type boiler by the provision of forced circulating pump means which are operated by the high-pressure feed liquid to the steam generator and by the steam which is generated. The pump means imparts to the liquid an increased flow velocity for flow through the generating tubes and also provides a preheating of the liquid. The known force circulation boiler systems require a separate pump for example, which may be driven by an electric power source for circulating the water between the steam drum through one or more downcomers from the drum and upwardly through the generating tubes. This requires a separate driving power force and also in most instances it necessitates the expense of providing a spare pump which correspondingly increases the consumption of electricity and entails increased operating expenses.

With the present invention, a separately powered pump is not required but instead a condensation-type ejector is operated by the steam which is generated to increase the pressure of the feed water and in addition a separate liquid ejector is employed for aiding in the forced circulation of the liquid and steam through the generating tubes. The liquid ejector is operated by liquid from the economizer and thus no separate power source is required. By utilizing the generated steam and the high-pressure feed liquid for the operation of ejectors for forcing the liquid circulation, a more positive operation than the prior art is possible without the use of a separately powered circulating pump, and the apparatus is simple to arrange and involves a relatively low cost and does not involve the necessity for a spare pump. In addition, the apparatus which operates from the heat generated in the steam generator acts to impart a preheating to the feed water and in the condensation-type ejector provides a mixing of the steam with the feed water and the condensing of the steam during the flow. Thus, no additional energy is required for circulating the boiler water.

Accordingly, it is an object of the invention to provide an improved vapor generator which includes at least one ejector for supplying water to or circulating water within the generator and which is operated by the energy of the vapor or liquid employed in the generator itself.

A further object of the invention is to provide an improved steam generator which includes a feed water pump, heater, and economizer which are connected in series to supply feed water to the generating tubes of a steam generator and wherein a liquid ejector is located between the drum and the generating tubes and is operated by liquid supplied through a connection thereto from the economizer, and wherein the water is circulated to the economizer by means of a steam ejector which is operated from the energy supplied by steam from the steam drum.

A further object of the invention is to provide a vapor generator which is simple in design, rugged in construction, and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a schematic representation of a steam generating system of the prior art; and

FIG. 2 is a schematic representation of a steam generating system constructed in accordance with the invention.

GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENT

The conventional power system indicated in FIG. 1 includes a forced circulation boiler having a steam drum *e*, generating tubes *h*, and a downcomer *f*, extending from the steam drum to the generator tubes, and which includes an electric pump *g* for circulating the boiler water through the generator. Steam which is generated in the steam drum *e* is directed through a superheater *i* and then to a turbine *j* where the energy of the steam is employed to drive in the turbine. Steam is then delivered from the turbine to a condenser *k*. A condensate pump *1* withdraws the condensate from the condenser *k* and delivers it to a deaerator *a*. A feed pump *b* circulates the water from the deaerator to a heater *c* and then to an economizer *d* which, in turn, leads to the steam drum *e*. With the prior art arrangement, circulating pressure is applied to the boiler water and gases in the boiler by means of an electrically driven pump *g*. Such an arrangement has a disadvantage that the pump must be driven from an outside power source and in addition a spare pump must be provided requiring a corresponding increase and installation and operational costs.

Referring to FIG. 2 of the drawing the invention embodied therein comprises an improvement over the prior art particularly in respect to the use of circulating means which are operated by the energy generated in the steam generator and which also imparts a heat to the water being generated so that the efficiency of the generator is increased. The circulating means of the invention includes a water ejector located between the downcomer *7* and the evaporating tubes *9* for forcing the steam and water through the steam generator for the generation of steam in a drum *8*. The water ejector *6* is operated by the high-pressure feed water delivered from the economizer *5*. The invention arrangement also includes a steam ejector or condensate-type ejector *4* located between a feed water heater *3* and economizer *5* which is connected to discharge to the water ejector *6*. The ejector *4* is a condensation type which is operated by the use of a part of the steam which is generated in the steam drum *8* and which is delivered to the ejector *4* through a connection or conduit *15*. In other respects, the steam system indicated in FIG. 2 is conventional and includes a superheater *10*, turbine *11*, condenser *12*, condensate pump *13*, deaerator *1*, feed pump *2*, and heater *3*.

The feature of the invention is that the ejector *4* which is operated by use of the part of the steam generated in the boiler as a driving fluid converts a part of the heat energy of the steam into velocity energy to thereby accelerate the feed water delivered from the feed water heater and enter to the economizer *5*. In addition, the feed water directly cools and condenses the steam and converts the energy of velocity into pressure. Therefore, differently from ejectors in general use, a discharge pressure becomes higher than the steam and feed water pressure of the ejector inlet.

The ejector *6* which is operated by the high-pressure feed water as the driving fluid applies a pressure to the boiler water from the drum *8* which is sucked into the liquid ejector *6*, and imparts, to the boiler water, a pressure necessary to circulate through the steam drum *8*, the downcomer *7* and evaporating tubes *9*. The steam generated is in part used as a driving steam for the condensation-type ejector *4*. The greater part of the steam from the drum *8* is fed to the turbine *11* which drives generator *G*. The steam from the turbine *11* is condensed in the condenser *12* and is fed back to the deaerator *1*.

The ejector *4* may be located at any place between the outlet of the feed water pump *2* and the outlet of the fuel economizer *5*. When the ejector *4* is disposed at the outlet of

the fuel economizer 5, the condensation-type ejector 4 and the water ejector 6 can be formed and manufactured integrally as single forced recirculation means. In addition the driving steam connection for the condensate-type ejector is not limited to a connection to the steam drum 8 but may provide any connection between a steam supply source in the system between the steam drum 8 and the high-pressure outlet of the steam turbine 11.

Comparison was made of the performance between the boiler water circulating device of the conventional type in which an electric pump for circulating boiler water is used as indicated in FIG. 1 and that of the present invention as indicated in FIG. 2. This comparison was made in connection with a steam power station having a plant output of 265,000 kilowatts with a boiler evaporation of 900 tons of steam per hour and a pressure of 200 atmospheres absolute. The circulation rate of boiler water was 3600 tons per hour and the results of the comparison are shown in the following table:

Performances	Circulation system	
	Circulation by electric pump	Circulation by ejector
Required water head of electric pump for circulating boiler-water (m.)	28	28
Required water head of water ejector (m.)		28
Required water head of condensation-type ejector (m.)		300
Evaporation necessary for condensation-type ejector (ton/h.)		60
Driving power of electric pump for circulating boiler-water (kw.)	600	
Extra amount of fuel-heat input necessary for circulation of boiler-water (k cal./h.)	1×10 ⁶	0.0
Increase and decrease in plant efficiency (percent)	1.0	20.4

¹ Reference. ² Increase.

As described above, the apparatus provided by the present invention can dispense with the power for circulating boiler water and the extra amount of fuel heat input for the circulation of this water with the result that the plant efficiency is raised.

We claim:

1. A steam generator, comprising a steam drum, a plurality of vapor generating tubes connected to said steam drum, a downcomer connected between said steam drum and said vapor generating tubes, a liquid ejector located in the connection between said downcomer and said generating

tubes and adapted to force the liquid through said generating tubes, a feed water supply, a steam ejector connected between said feed water supply and said liquid ejector for forcing feed water to said liquid ejector, means for directing liquid which has been heated by said generating tubes to said liquid ejector for inducing recirculation of heated water through said liquid ejector, an economizer located between said steam ejector and said liquid ejector, and means connected to said steam drum for delivering steam from said drum to said steam ejector for forcing feed water through said steam ejector.

2. A steam generator, according to claim 1, including a feed pump connected to said feed liquid supply for circulating feed liquid to said vapor generator, and a feed water heater connected to the discharge of said feed pump and connected as its discharge end to said steam ejector.

3. A vapor generator comprising vapor generating tubes connected to said vapor drum, vapor drum means for collecting vapor from said generating tubes for supply to a vapor operated device, downcomer means between said vapor drum and said vapor generating tubes, a feed liquid supply condensation-type ejector means for increasing pressure of the feed liquid supplied by said feed liquid supply, and liquid ejector means for circulating said feed liquid to said vapor generating tubes through said downcomer means, said condensation-type ejector being operated by the use of a part of the vapor generated in said vapor drum, and said liquid ejector being operated by the use of feed liquid pressure increased in said condensation-type ejector means.

4. A vapor generator, according to claim 3, wherein said feed liquid supply includes a feed pump, an economizer connected to the discharge of said pump and to said vapor generator tube, said liquid ejector being located between said economizer and said vapor generating tube and said condensation-type ejector being located between said pump and said economizer.

5. A vapor generator, according to claim 1, wherein said liquid ejector has a discharge connected to said generating tube, and means supplying liquid from said drum to said liquid ejector for inducing flow through said ejector.

6. A vapor generator, according to claim 1, wherein said condensate-type ejector having a discharge connected to said liquid ejector, and means for connecting said condensate-type ejector to said vapor drum means for directing vapor from said vapor drum means to said condensate-type ejector for forcing the feed liquid therethrough.