

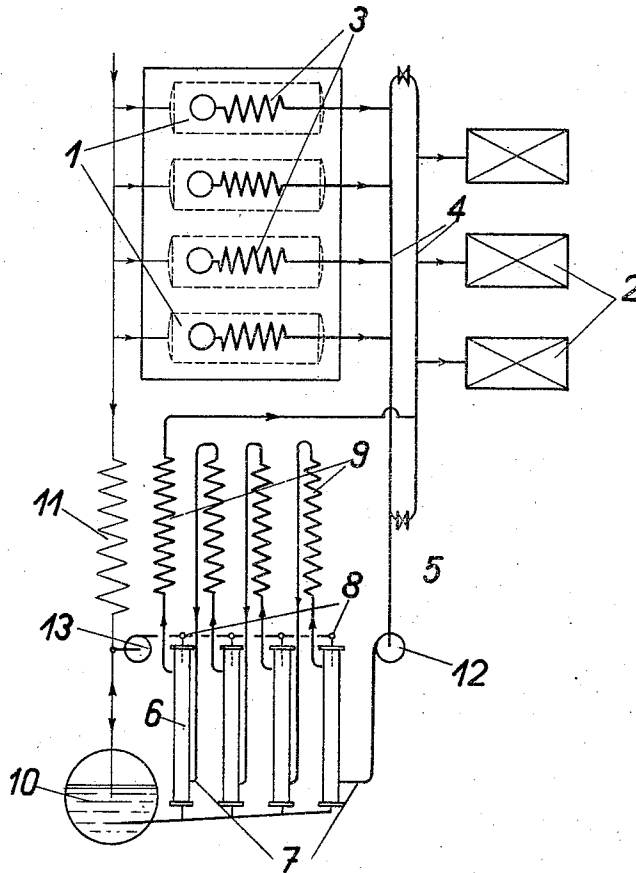
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STEAM GENERATOR

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STEAM GENERATOR

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This invention relates to steam generating plants, and has among its objects methods and arrangements for increasing the capacity of an existing plant equipped with directly fired steam boilers, to enable supply of over-loads having a steam demand exceeding the capacity of said boilers, by combining the directly fired steam boilers of the plant with a multiple of stages of serially arranged injection steam vaporizers in which the steam in each stage is generated through admixture of superheated steam supplied from a preceding stage to water supplied to each stage, and utilizing the steam generated in the boilers that supply the normal load as exciting steam for the injection vaporizer stages.

The objects of the invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawing illustrating diagrammatically a boiler plant made in accordance with the invention.

The provision of an additional steam supply to take care of sudden or expected load increases, is one of the most difficult problems in steam economics, and is still far from satisfactory solution. Most of the steam plants now in use employ high pressure boilers in which the fire and combustion gases are directly applied to the boiler walls on which the water is evaporated, and in order to be available at a moment's notice, they must, on account of their sluggishness, be always kept under steam. They are thus very expensive in construction as well as in operation, and make their practical use for taking up prolonged or short load peaks very costly and undesirable. These disadvantages apply also to the use of steam accumulators for supplying abnormal load peaks.

Accumulators have the further disadvantage that, in the case of power plants, they require special turbines which have an unfavorable steam consumption due to the fluctuation of the steam pressure, and thus further decrease the efficiency and increase the expense of operation.

According to the invention, steam generating plants having ordinary, directly fired boilers with a capacity sufficient to supply a limited, for instance, normal load, are arranged to supply additional steam for overloads of long or short duration, by diverting from the load all or a part of the steam generated by said boilers to a multi-stage injection steam vaporizer, and utilizing it as initial heating steam for producing in the vaporizer a multiple of the received steam and supplying the so produced steam to the load to take care of the excessive demand. Such multi-stage injection steam vaporizer is formed of a few serially connected stages of an injection steam generator as described in Farber U. S. Patent 1,723,340, each stage being arranged to receive superheated steam and admix it to preheated water, evaporating the water with the superheat present in the received steam, and thus generating fresh steam which with the cooled-down received superheated steam is then delivered to the succeeding stage, where the process is repeated. A single vaporization stage gives only a limited increase of steam, about 20 to 40% of the received steam, depending on pressure and temperature.

By connecting several stages in series, the initial steam, diverted from the boilers and received by the first stage, will thus be multiplied in the first stage, and the steam from the first stage in the second, and in this way, large steam quantities can be produced at the last stage, from where it is, after superheating, supplied to the load. The final quantity of steam thus generated in the multi-stage injection vaporizer is given by the formula $Q = G(1+a)^n$ where G is the initial steam quantity in kilograms, designated as exciting steam, received by the first stage, a is the quantity in kg. of new steam generated in one

stage by one kilogram superheated steam, and n is the number of the injection vaporizer stages in series.

5 set of steam boilers generates the steam needed for the normal load and supplies it directly to the consuming devices. The additional quickly acting injection steam vaporizers may be left inactive during such normal operating conditions.

10 However, if at some moment there appears a demand for steam to supply temporary or prolonged peak loads beyond the capacity of the directly fired boiler set, a part, or all, of the steam from the boiler set, instead of being sent directly to the consuming devices, is sent as exciting steam into the multi-stage injection steam vaporizer which, through the instantaneous readiness for operation, forth-
15 with starts converting the received exciting steam into a multiple thereof, delivering it to the consuming devices. Since the quantity of steam required for peak conditions in most cases does not exceed two to three times the normal steam demand, an injection steam vaporizer with three or five stages, depending on the pressure and the temperature of the steam, will be sufficient for most cases. Furthermore, since these injection steam vaporizers have small masses, thin superheater tubes, and, with proper firing, are quick to start supplying additional steam, they are always ready for operation and can immediately start to supply the additional demand.

25 In the accompanying drawing, illustrating an exemplification of the invention, there is shown a set of ordinary boilers 1 requiring heating of large water masses for generating steam, such as directly fired boilers of an existing plant, which deliver steam for driving the steam turbines 2, after passing the steam through superheaters 3 and therefrom through a steam distributing pipe system 4 to which the turbines 2 are connected. This
35 set of boilers 1 serves to supply the normal steam demand of the turbines. With this set of ordinary boilers is combined a multi-stage injection steam vaporizer 5 comprising a plurality of serially connected vaporizer stages, each having a vaporizer vessel 6 with a steam inlet 7 and a water inlet 8, and a superheater coil 9. The injection water for the vaporizer vessel that is to be converted into steam is taken from a reservoir 10 holding a quantity of water and having a pipe connection to the water inlets 8 of the vaporizer vessel 6, the excess water from the vaporizer vessels flowing back to the reservoir 10 through a common pipe connected to the bottoms of the vaporizer vessels. In the superheater coils 9 relatively cool, as heat-carrier acting, steam from the preceding vessel is superheated and brought into the adjacent vaporizer vessel, where the water injected at the inlet 8 mixes with the steam and becomes evaporated by

the heat of the admitted superheated steam. The fresh generated steam and the cooled down received superheated steam pass into the next superheater coil 9 and after superheating enter into the next vessel, as indicated by the arrows in the drawing.

70 The water injected into the vaporizer vessels at 8 may be preheated by suitable preheaters, such as 11. The injection water may also be taken in preheated condition through a pipe connection with the water spaces of the set of ordinary boilers 1. The reservoir 10 may, with advantage, be used as a hot water accumulator.

80 The set of boilers 1 is provided with its usual firing equipment, and the superheater coils 3 of these boilers, and the superheater coils 9 of the injection vaporizers 5 are suitably arranged to be heated for superheating the steam passing therethrough. To operate the injection vaporizer, superheated steam generated by the set of boilers 1 is supplied from pipe system 4 through a compressor 2 to the first vaporizer stage, and the received steam is multiplied in the successive stages, being delivered from the last vaporizer stage back to the pipe system. In this manner the total quantity of steam available for the turbines can be increased by converting in the injection steam vaporizer a quantity of steam taken from the pipe system 4 into a multiple thereof. The flow of the steam through the series of vaporizer vessels and superheater coils of the injection vaporizers is accompanied by a certain pressure drop. The compressor 12 in the line of steam supply from the pipe system 4 to the first stage of the injection vaporizer 15 serves to supply this pressure. This pressure drop can also be secured by raising slightly above normal the working pressure of the boilers 1, the pipe system 4 having valves 4a for segregating the section to which the boilers 1 and inlet 7 of the first vaporizer stage is connected from the section to which the last vaporizer stage and the turbines 2 are connected.

100 The set of ordinary boilers 1 takes care of the ordinary steam demand, the boilers supplying the steam to the steam turbines 2 through the pipe system 4. The injection vaporizers 5 may then be left inactive. In case of an overload which calls for a longer or shorter demand of extra steam beyond the capacity of the set of ordinary boilers 1, the injection vaporizers are called into action. A part or all of the steam produced by the boilers 1 is then supplied from the manifold 4 to the injection vaporizer, where it is multiplied by the series of vaporizations in the individual stages and a multiple of the received amount returned to the pipe system 4. When the overload is very large, all the steam from boilers 1 may be used as exciting steam, one section of pipe system 4 receiving the steam from the boilers 1 and delivering it to

the inlet of the injection vaporizer 5, and another section receiving the steam from the outlet of the vaporizer and delivering it to the turbines.

5 Instead of sending the steam from the set of boilers 1 to a common injection vaporizer 5, each boiler may be provided with a separate injection vaporizer. In case these boilers are of low pressure, for instance, for 15 atmospheres, and 350-375° C. superheat, and if the steam in the injection vaporizers is superheated to 400° C., it is possible to obtain with a four stage steam injection vaporizer 2.3 of the boiler steam, this being sufficient for most peaks. In order to secure an instantaneous increase of steam generation, which requires supply of heat to the superheater coils of the injection vaporizers, combustion oil, gas, or coal powder are preferably used for firing, these fuels enabling ready adaptation of the firing to the variations of the steam demand.

Wherever the term injection vaporizer, or injection steam vaporizer, is used in the specification or in the claims, it is intended to designate one vaporizer stage, or a plurality serially arranged vaporizer stages, such stage comprising a vaporizer vessel arranged to receive superheated steam, admix it with water, either by injection of the steam into the water, or the water into the steam, evaporate the water with the superheat present in the received superheated steam, and deliver at the outlet from said vessel the cooled-down superheated steam with an additional volume of fresh steam generated in the vessel.

The invention claimed is:

1. The method of obtaining excess steam for supplying overloads of short or long duration from an existing boiler aggregate of a capacity insufficient to supply the overloads, which comprises supplying the steam from said boiler aggregate to the load during absence of overload, and, in case of overload demand, diverting all or a part of the steam generated by said boiler aggregate from the load and passing it as exciting steam into a multi-stage injection steam vaporizer producing therein additional steam, and delivering the steam so produced in the vaporizer to the load to supply the overload demand.

2. The method of obtaining excess steam for supplying transient overload peaks of short or long duration from a boiler aggregate of a capacity insufficient to supply the peak loads, and a multi-stage injection steam vaporizer, which comprises supplying the steam from said boiler aggregate to the load during absence of peak load, while maintaining said vaporizer inactive, and, in case of peak load demand, diverting all or a part of the steam generated by said boiler aggregate from the load and passing it as exciting steam into said multi-stage injection steam vaporizer producing therein additional steam, and delivering the steam so produced

in the vaporizer to the load to supply the peak demand.

3. The method of obtaining excess steam for supplying transient overload peaks of short or long duration from a directly fired boiler aggregate of a capacity insufficient to supply the peak loads, and a multi-stage injection steam vaporizer, which comprises supplying the steam from said boiler aggregate to the load during absence of peak load, while maintaining said vaporizer inactive, and, in case of peak load demand, diverting all or a part of the steam generated by said boiler aggregate from the load and passing it as exciting steam into said multi-stage injection steam vaporizer producing therein additional steam, and delivering the steam so produced in the vaporizer to the load to supply the peak demand.

4. The method of obtaining excess steam for supplying transient overload peaks of short or long duration from a boiler aggregate of a capacity insufficient to supply the peak loads, and a multi-stage injection steam vaporizer, which comprises supplying the steam from said boiler aggregate to the load during absence of peak load, while maintaining said vaporizer inactive, and, in case of peak load demand, raising the pressure of the steam generated by said boiler aggregate, diverting steam generated by said boiler aggregate from the load and under the action of the additional pressure passing it as exciting steam into said multi-stage injection steam vaporizer producing therein additional steam, and delivering the steam so produced in the vaporizer to the load to supply the peak demand.

5. The method of obtaining excess steam for supplying transient overload peaks of short or long duration from a boiler aggregate of a capacity insufficient to supply the peak loads, and a multi-stage injection steam vaporizer, which comprises supplying the steam from said boiler aggregate to the load during absence of peak load, while maintaining said vaporizer inactive, and, in case of peak load demand, diverting all or a part of the steam generated by said boiler aggregate from the load, additionally compressing the diverted steam and under the action of the additional pressure passing it as exciting steam into said multi-stage injection steam vaporizer producing therein additional steam, and delivering the steam so produced in the vaporizer to the load to supply the peak demand.

6. In a steam plant, a slowly responsive sluggishly acting boiler aggregate, a steam consuming load, a steam distributing pipe system, a quickly responsive instantaneously acting injection steam vaporizer, and means for diverting all or a part of the steam generated by said aggregate from said load and passing it as exciting steam into said injection

tion vaporizer to produce additional steam and deliver it to the load.

7. In a steam plant, a slowly responsive sluggishly acting directly fired boiler aggregate, a steam consuming load, a steam distributing pipe system, a quickly responsive instantaneously acting injection steam vaporizer, and means on said pipe system for diverting all or a part of the steam generated by said aggregate from said load and passing it as exciting steam into said injection vaporizer to produce additional steam and deliver it to the load for peak load supply.

8. In a steam plant, a slowly responsive sluggishly acting boiler aggregate, a steam consuming load, a steam distributing pipe system, a quickly responsive instantaneously acting injection steam vaporizer, means for diverting all or a part of the steam generated by said aggregate from said load and passing it as exciting steam into said injection vaporizer to produce steam and deliver it to the load, and means for raising the pressure of the exciting steam diverted to said injection vaporizer to drive the steam therethrough.

9. In a steam plant, a slowly responsive sluggishly acting directly fired boiler aggregate, a steam consuming load, a steam distributing pipe system having a plurality of sections arranged to be interconnected or disconnected, connections from said boiler aggregate and said load to different sections of said pipe system for supplying the steam generated in said boiler aggregate to said load, a quickly responsive instantaneously acting injection steam vaporizer, means connecting the inlet side of said injection steam vaporizer to the pipe system section connected to said boiler aggregate for predeterminedly diverting steam generated therein as exciting steam into said injection vaporizer to produce therein additional steam, and means connecting the outlet side of said injection vaporizer to the section of said pipe system connected to the load for predeterminedly delivering the steam from said vaporizer to the load.

10. In a steam plant, a slowly responsive sluggishly acting directly fired boiler aggregate, a steam consuming load, a steam distributing pipe system having a plurality of sections arranged to be interconnected or disconnected, connections from said boiler aggregate and said load to different sections of said pipe system for supplying the steam generated in said boiler aggregate to said load, a quickly responsive instantaneously acting injection steam vaporizer, means connecting the inlet side of said injection steam vaporizer to the pipe system section connected to said boiler aggregate for predeterminedly diverting steam generated therein as exciting steam into said injection vaporizer to produce therein additional steam, means connecting the outlet side of said injection vaporizer to

the section of said pipe system connected to the load for predeterminedly delivering the steam from said vaporizer to the load, and compressor means in the connection to the inlet side of said injection vaporizer for raising the pressure of the exciting steam diverted to said injection vaporizer to drive the steam therethrough.

In testimony whereof I have hereunto subscribed my name this 14th day of February A. D. 1929.

WALTER GUSTAV NOACK.

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CERTIFICATE OF CORRECTION.

Patent No. 1,890,468.

December 13, 1932.

WALTER GUSTAV NOACK.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 4, strike out the words "set of steam boilers generates the steam need-" and insert instead "With such arrangement the directly fired"; page 3, line 61, claim 2, for the misspelled word "bolier" read "boiler"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of February, A. D. 1933.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.