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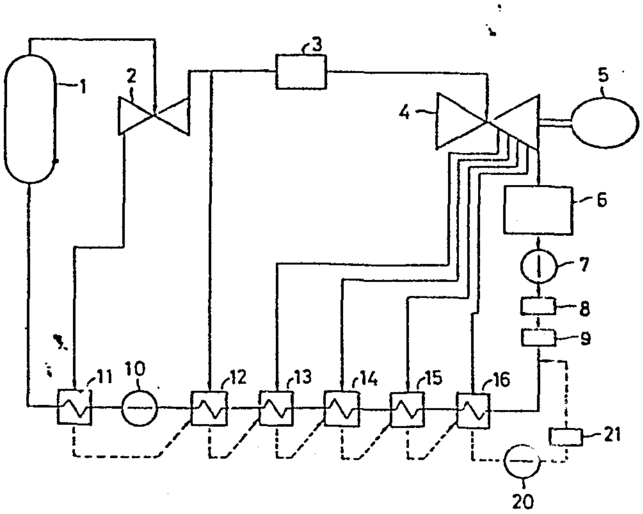
(54) **CONDENSATE FEED APPARATUS FOR STEAM GENERATOR.**

(57) A condensate feed apparatus such as that employed in nuclear power plants has a condenser (6), a desalting device (9) provided on the downstream side of the condenser, feed-water heaters (11) to (16) provided on the downstream side of the desalting device, and so forth. The condensate feed apparatus is provided with a duct for returning the condensate produced in the feed-water heaters (11) to (16) to a feed-water piping on the downstream side of the desalting device. Connecting the duct to the downstream side of the desalting device makes it possible to improve the heat efficiency of the plant as a whole.

Fig. 1



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DESCRIPTION

Title of the Invention:

CONDENSATE FEEDER FOR STEAM GENERATORS

Technical Field:

This invention relates to a condensate feeder for a steam generator which is used in a nuclear power plant and a thermal power plant, and more particularly to a condensate feeder for a steam generator which has a feed water heater, in which the steam extracted from a turbine is used to heat the feed water.

Background Art:

The background art of the present invention will now be described taking as an example a condensate feeder applied to a boiling water reactor.

The steam generated in a nuclear reactor drives a high-pressure turbine and a low-pressure turbine, and the resultant steam enters a condenser, in which the steam is subjected to gas-removing condensation. The pressure of the water thus produced by the condenser is increased by a condensing pump. The resultant water is passed through a condensate filtering over-desalter and a condensate desalter to remove the salt therefrom, and then through a plurality of series-connected feed water heaters to increase the temperature of the desalted water. The pressure of the feed water which has had its temperature increased, is increased by the feed water pump. The temperature of the resultant feed water is then increased again by a feed water heater (which will hereinafter be referred to as a final feed water heater), and this feed water is supplied to the nuclear reactor. Among the above-mentioned feed water heaters, a plurality of upstream feed water heaters which are close to the condenser are heated with the steam extracted from the low-pressure turbine, and the downstream feed water heaters with the steam extracted from a high-pressure steam system, such as the high-pressure turbine. The extracted steam which has thus increased the temperature of the feed water in the feed water heaters is condensed and returned to the condenser. An example of such a condensate feeder is disclosed in a Japanese patent laid-open publication (Japanese Patent Laid-open No. 22994/1976 dated February 24, 1976).

A condensate feeder constructed so that the condensate produced in the feed water heaters is returned to the condenser has two major problems as follows.

(1) The extracted steam is turned into condensate in the feed water heaters, and then supplied as the feed water to a nuclear reactor. This condensate consisting of the condensed, extracted steam accounts for about

40% of a total quantity of the feed water. The condensate thus generated still has a high temperature when it flows out from the most upstream feed water heater, the calorific power of this condensate reaching about 1.0 x 10^3 Kcal/h.

Since this extraordinary large calorific power is discharged to the condenser, the thermal loss is large, and the thermal efficiency is low.

(2) Unlike the condensate in the condenser, the above-mentioned condensate is not cooled with brine; it need not be desalted. However, in the above-described condensate feeder, the condensate is returned to the condenser, so that the condensate is also supplied to the nuclear reactor through the desalter. Therefore, the desalter in use is formed to a very large capacity.

Disclosure of the Invention:

An object of the present invention is to provide a condensate feeder which is capable of both improving the thermal efficiency of a steam generator and minimizing the capacity of a desalter.

The characteristics of the present invention reside in a condensate feeder for power plants, having a steam generator, a turbine adapted to be driven by the steam produced in the steam generator, a condenser provided on the downstream side of the turbine, a desalter provided on the downstream side of the condenser, and feed water heaters provided on the downstream side of the desalter, comprising a pipe through which the condensate produced in the feed water heaters is returned to a feed water pipe provided on the downstream side of the desalter, and a filter provided in the pipe.

The present invention having the above-mentioned constructional characteristics has the following effects and advantages.

(1) Improvement of thermal efficiency:

According to the present invention, which has been developed in view of the fact that, in a conventional condensate feeder, the calorific power of the condensate produced in the feed water heaters is discharged to the condenser, the condensate is returned directly to a feed water pipe provided on the downstream side of a desalter, to increase the temperature of the feed water. Therefore, the calorific power in the system can be utilized effectively, and the thermal efficiency can be improved.

(2) Reduction of capacity of the desalter:

A conventional condensate feeder requires a desalter having a capacity (100%) large enough to desalt a total quantity of feed water.

Since it has been ascertained that the condensate produced in the feed water heaters need not be passed through the desalter, the present invention is constructed so that, out of a total quantity of feed water, only the portion thereof which is supplied from the condenser is passed through the desalter.

Therefore, according to the present invention, the capacity of the condensate desalter may be in the level which enables only the feed water supplied from the condenser to be desalted.

Accordingly, the capacity of the desalter can be reduced (by 40%).

The condensate produced by the feed water heaters contains a large quantity of clad. The clad is removed by a filter (to be used at normal temperature) provided in a pipe which returns the condensate to the feed water pipe.

According to the present invention, the capacity of the desalter can be reduced with the low-temperature filter left used.

Brief Description of the Drawings:

Fig. 1 is a general construction diagram of the steam generator having an embodiment of the condensate feeder according to the present invention;

Fig. 2 shows only the portion of the general construction diagram of Fig. 1 which corresponds to the condensate feeder according to the present invention;

Fig. 3 is a diagram, which is similar to Fig. 2, of the construction of a conventional condensate feeder;

Fig. 4 is a calorific power calculation diagram to describe the thermal efficiency of a steam generator with conventional condensate feeder shown in Fig. 3;

Fig. 5 is a calorific power calculation diagram to describe the thermal efficiency of a steam generator having the condensate feeder according to the present invention shown in Fig. 2; and

Fig. 6 illustrates another embodiment of the present invention.

Best Mode for Carrying Out the Invention:

The best mode of practicing the invention will be described with reference to Figs. 1-3. Fig. 3 shows the construction of a conventional condensate feeder.

The steam generated in a nuclear reactor 1 is introduced into a condenser 6 through a high-pressure turbine 2, a moisture separator 3 and a low-pressure turbine 4. Reference numeral 5 denotes an electric generator. The steam is converted into water in the condenser 6, and the water then flows through a condensing pump 7, normal temperature filter 8 and a desalter 9. In a feed water heater 16 (first feed water heater) to a feed water heater 11 (final feed water heater), the temperature of the water is increased, and the resultant water is returned to the nuclear reactor 1. Reference numeral 10 denotes a feed water pump. The feed water heaters 11, 12 are heated with the steam extracted from a high-pressure steam system, such as the high-pressure turbine 2. The feed water heaters 12-16 are heated with the steam extracted from the low-pressure turbine 4. An embodiment, which has the above-mentioned construction, of the present invention will be described.

In the conventional condensate feeder, the condensate flowing out from the feed water heater 16 enters the condenser 6 as shown in Fig. 6. According to the present invention, a drain pump 20 and a filter 21 are provided as shown in Figs. 1 and 2, so as to enable the condensate to be returned to the feed water pipe at the downstream side of the condensate desalter 9.

The drain pump 20 is provided to increase the pressure of the condensate, passing the resultant condensate through the normal-temperature filter 21, then supplying the condensate smoothly into the feed water, the pressure of which has been increased by the condensate pump 7.

The normal temperature filter 21 is provided to remove the clad mixed in the condensate from the feed water heaters 11-16.

The above embodiment of the present invention has the following effects.

(i) Thermal efficiency improving effect:

Fig. 4 is a diagram showing calculated calorific power in the conventional condensate feeder, and Fig. 5 a similar diagram showing calculated calorific power in the embodiment of the present invention.

The numerical values in the calorific power calculation diagrams are based on the rough values of the calorific power in a nuclear reactor in the class of 1100000 kilowatts which is the level of a standard electric output from a boiling water nuclear power plant operated at present.

Referring to the above two drawings, the conditions of the outlet steam in the nuclear reactors 1, the calorific power consumed for the heating of the feed water, and the conditions of the outlet feed water in the condensers 6 shall be the same.

If no heat is inputted between the condenser 6 and the sixth feed water heater 16 during a water feeding operation in the conventional condensate feeder (Fig. 4), the temperature and enthalpy at the inlet of the sixth feed water heater 16 are 33°C and 33 Kcal/kg, respectively. The temperature of the feed water is then increased by the six heaters, and the temperature and enthalpy of the feed water at the outlet of the first feed water heater 11 become 215°C and 221 Kcal/kg, respectively. In this case, the calorific power for heating the feed water with respect to the calorific power of steam at the outlet of the nuclear reactor, i.e. the heat recovery rate is 33.4%.

According to the present invention (Fig. 5), the water feeding conditions at the outlet of the condenser 6 are the same as those in the conventional condensate feeder but the condensate (having a temperature of 42°C and the enthalpy of 42 Kca/lg) produced by the feed water heaters 11-16 and accounting for about 40% of the total quantity of the feed water is applied to the portion of the water passage which is on the downstream side of the desalter 9. Accordingly, the temperature and enthalpy at the inlet of the sixth feed water heater 16 are 37°C and 37 Kca/kg, respectively, and those at the outlet of the first feed water heater 11 219°C and 225 Kcal/kg, respectively. In this case, the heat recovery rate is 34.0%.

The above results show that the heat recovery rate increases from 33.4% to 34.0%. They can be expressed in terms of calorific power as follows.

Recovered calorific power in the conventional condensate feeder: 6410G x 221 h

Recovered calorific power in the present invention:

6410G x 225 h

(G: flow rate, enthalpy: (water))

Therefore, the difference in the recovered calorific power is 25640 x 10^3 Kcal/h, which is equivalent to about 30000 KW. This wattage is a little less than 3% of the electric output of 1100000 KW.

The reference letters in Figs. 4 and 5 represent the following.

G: flow rate (ton/hr), H: enthalpy (Kcal/kg)(steam),

h: enthalpy (Kcal/kg)(water).

(ii) Reduction of capacity of the desalter:

Let the capacities of the filter 8 and desalter 9 in the conventional condensate feeder (Fig. 3) be 100%, respectively. According to the present invention (Fig. 2), the desalter 9 is required for the desalting of only the feed water from the condenser 6. Hence, the capacity of the desalter 9 can be reduced to 60%.

The filter requires a capacity corresponding to the total quantity of the feed water. If this capacity is divided into 60%, of which the filter B is formed, and 40%, of which the filter 21 is formed, the total capacity becomes 100% which is equal to the capacity of the filter in the conventional condensate feeder.

The present invention is characterized in that a low-temperature filter reduces the capacity of the desalter 9.

(iii) Reduction of capacity of the condensing pump:

The present invention is also provided with the drain pump 20 additionally. Let 100% equal the total quantity of the feed water in the conventional condensate feeder. If two condensing pumps 7 are operated with one condensing pump 7 provided in reserve in this condensate feeder, these pumps require a capacity of 3 x 50% = 150%. If the total quantity of the feed water in the conventional condensate feeder is 100%, the total quantity of the feed water in the present invention is 60%. Accordingly, if two condensing pumps are operated with one condensing pump provided in reserve in the invention, the capacity of the pumps is 3 x 30% = 90%, so that the capacity of the condensing pumps can be reduced.

Another embodiment of the present invention will now be described with reference to Fig. 7.

This embodiment differs from the embodiment of Fig. 1 in that, in the former, the condensate produced by a high-temperature-side feed water heater 11 is passed through a high-temperature-resisting filter 22 and returned to a feed water pipe on the suction side of a feed water pump 10.

The pressure of the condensate produced by the low-temperature-side feed water heaters 12-16 is increased by a drain pump 20, and the resultant condensate is passed through a filter 21. The condensate is then supplied smoothly into the feed water the pressure of which has been increased by a condensing pump 7. This operation is carried out in the same manner as in the embodiment of Fig. 1.

The filters 21, 22 provided in a condensate returning pipe is adapted to remove the clad, which is mixed in the condensate in the feed water heaters 11-16, and thereby maintain the good quality of the condensate as the feed water.

The effects of the second embodiment of the present invention will be described.

(i) Reduction of capacity of the drain pump:

Since the condensate produced by the high-temperature-side feed water heater 11 is returned to a feed water pipe on the suction side of a feed water pump 10 as shown in Fig. 6, no additional drain pipes need be provided.

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Accordingly, the capacity of the drain pump 20 can be reduced as compared with that shown in Fig. 5, to such an extent that corresponds to the quantity of the condensate produced in the high-temperature-side feed water heater 11.

WHAT IS CLAIMED IS:

1. A condensate feeder for steam generators, having a condenser for condensing the steam obtained in a steam generator, a desalter provided on the downstream side of said condenser, a plurality of feed water heaters provided on the downstream side of said desalter, and a feed water pipe connecting said condenser, said desalter and said feed water heaters together, characterized in that said condensate feeder includes a pipe through which the condensate produced by said feed water heaters is returned to the portion of said feed water pipe which is on the downstream side of said desalter.

2. A condensate feeder for steam generators according to Claim 1, wherein said pipe is provided with a clad-removing filter therein.

3. A condensate feeder for steam generators according to Claim 2, wherein said pipe is provided with a drain pipe therein.

4. A condensate feeder for steam generators according to Claim 2 or 3, wherein said pipe is provided so as to extend from a first feed water heater and be joined to the portion of said feed water pipe which is between said first feed water heater and said desalter.

5. A condensate feeder for steam generators, having

a condenser for condensing the steam obtained in a steam generator, a desalter provided on the down-stream side of said condenser, a plurality of feed water heaters provided on the downstream side of said desalter, a feed water pipe connecting said condenser, said desalter and said feed water heaters together, and a feed water pump provided between some of said feed water heaters, characterized in that said condensate feeder includes a first pipe through which the condensate produced by a feed water heater on the upstream side of said feed water pump is returned to the portion of said feed water pipe which is on the downstream side of said desalter, and a second pipe through which the condensate produced by a feed water heater on the downstream side of said feed water pump is returned to the portion of said feed water pipe which is on the inlet side of said pump.

6. A condensate feeder for steam generators according to Claim 5, wherein each of said first and second pipes is provided with a clad-removing filter.

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Fig. 1

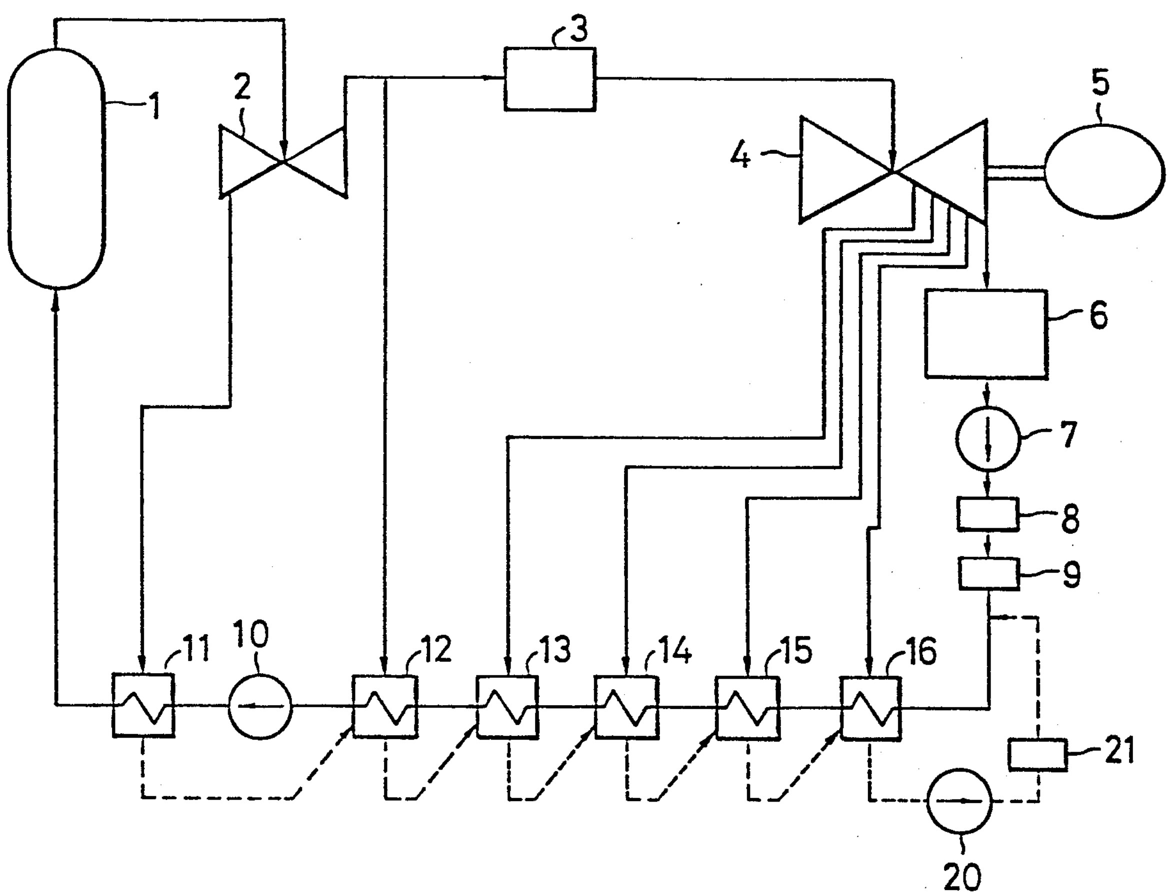


Fig. 2

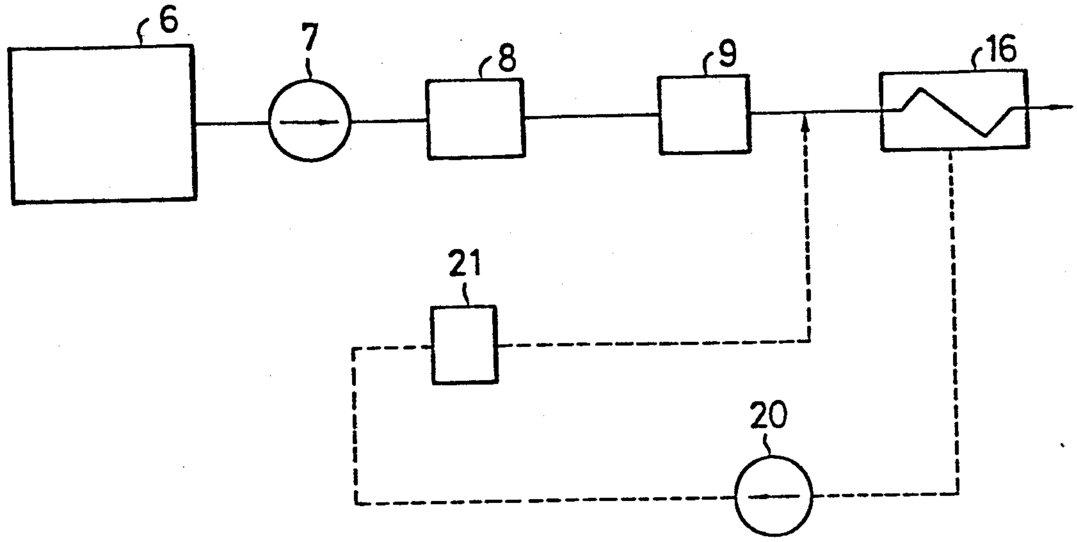


Fig. 3

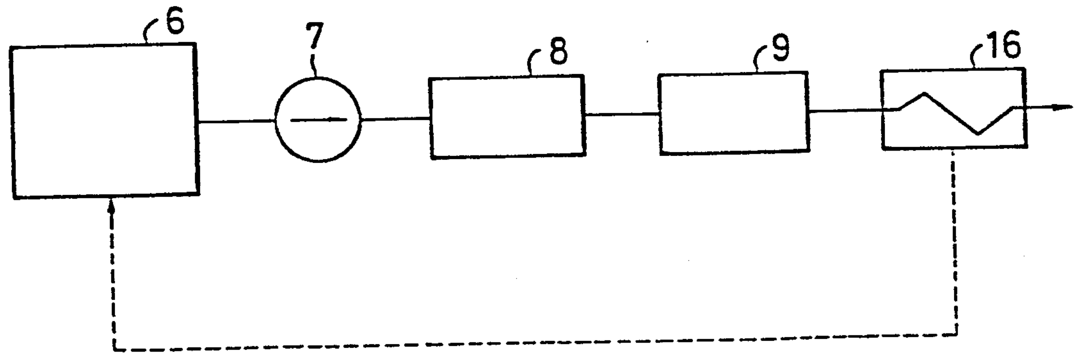


Fig. 4

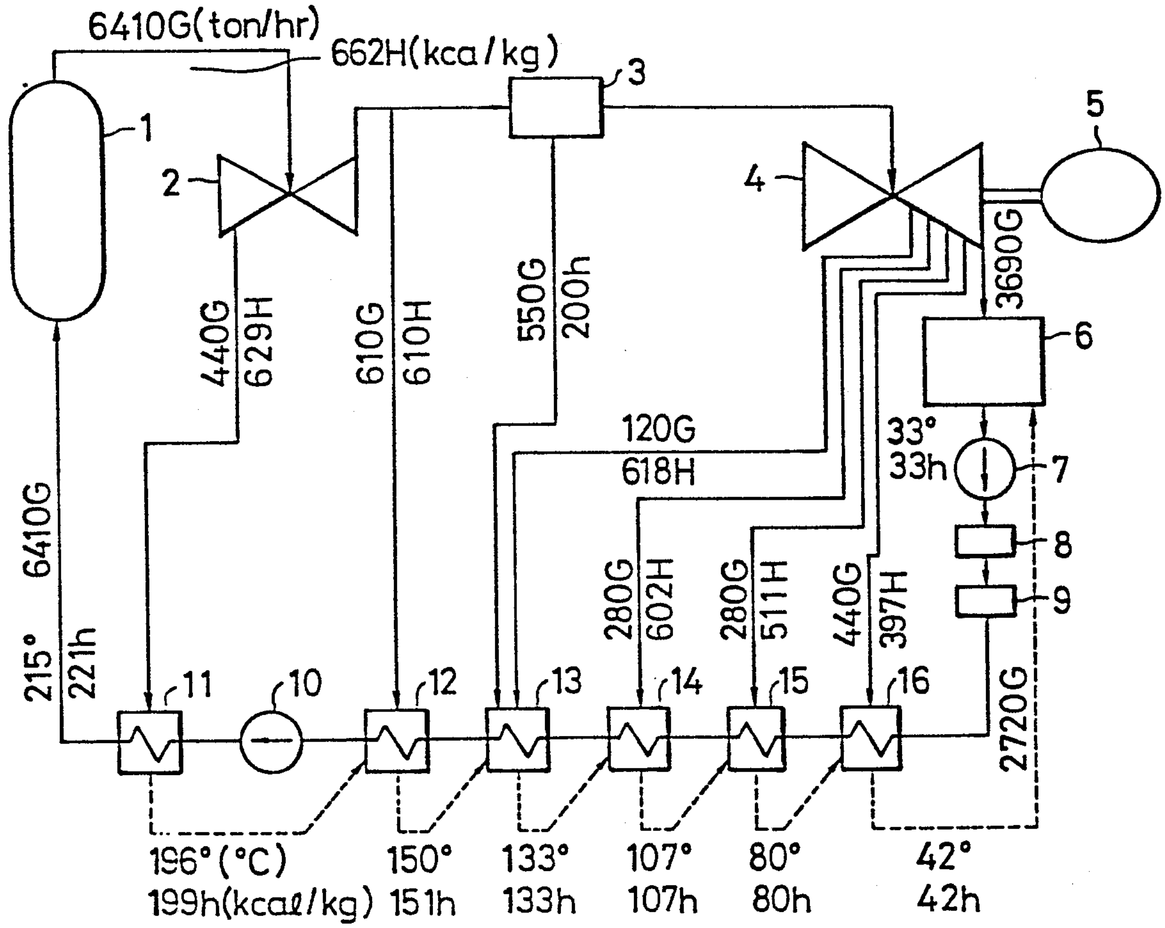

6410G(ton/hr)
662H(kca/kg)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
440G
629H
610G
610H
550G
200h
3690G
120G
618H
33°
33h
6410G
215°
221h
280G
602H
280G
511H
440G
397H
2720G
196°(°C)
199h(kcal/kg)
150°
151h
133°
133h
107°
107h
80°
80h
42°
42h

Fig. 5

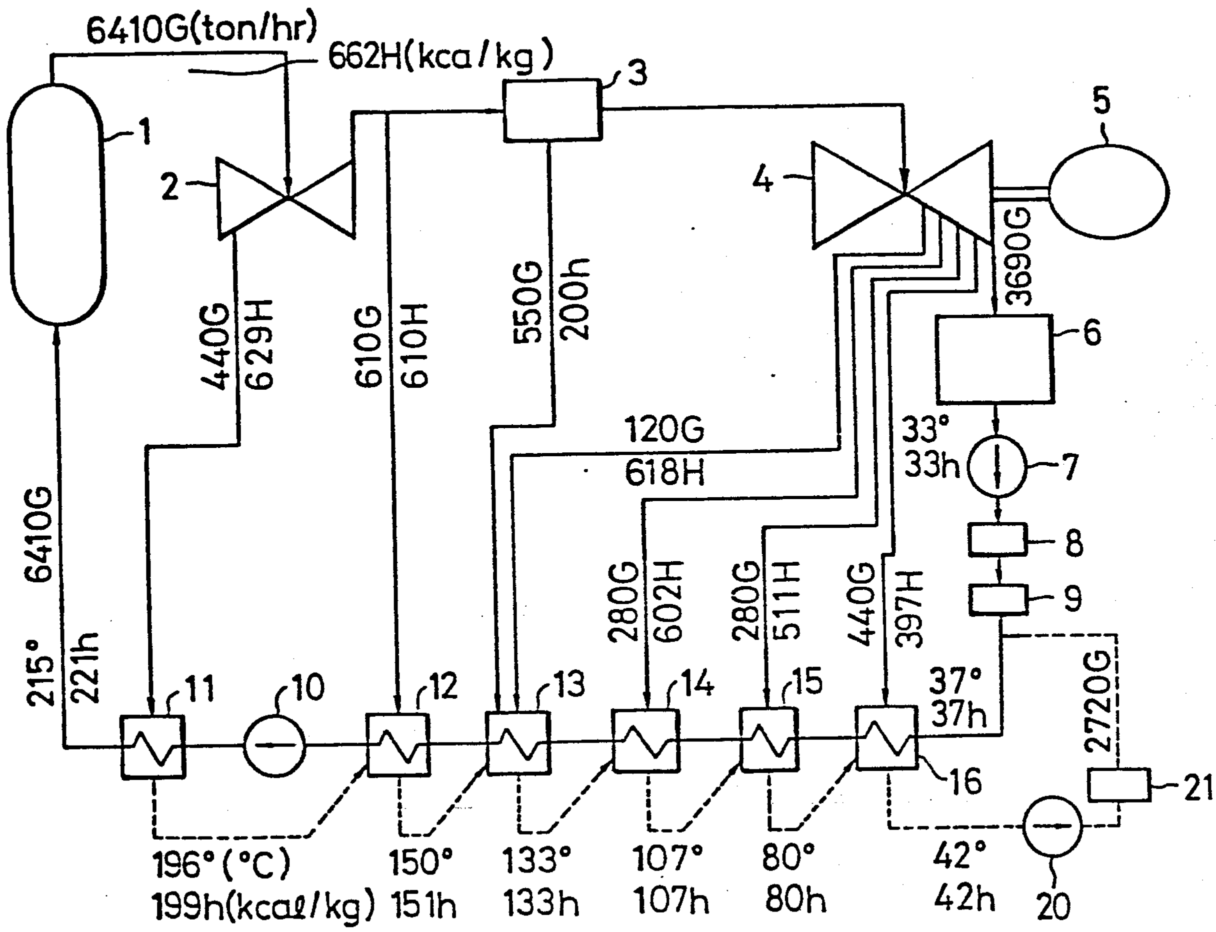
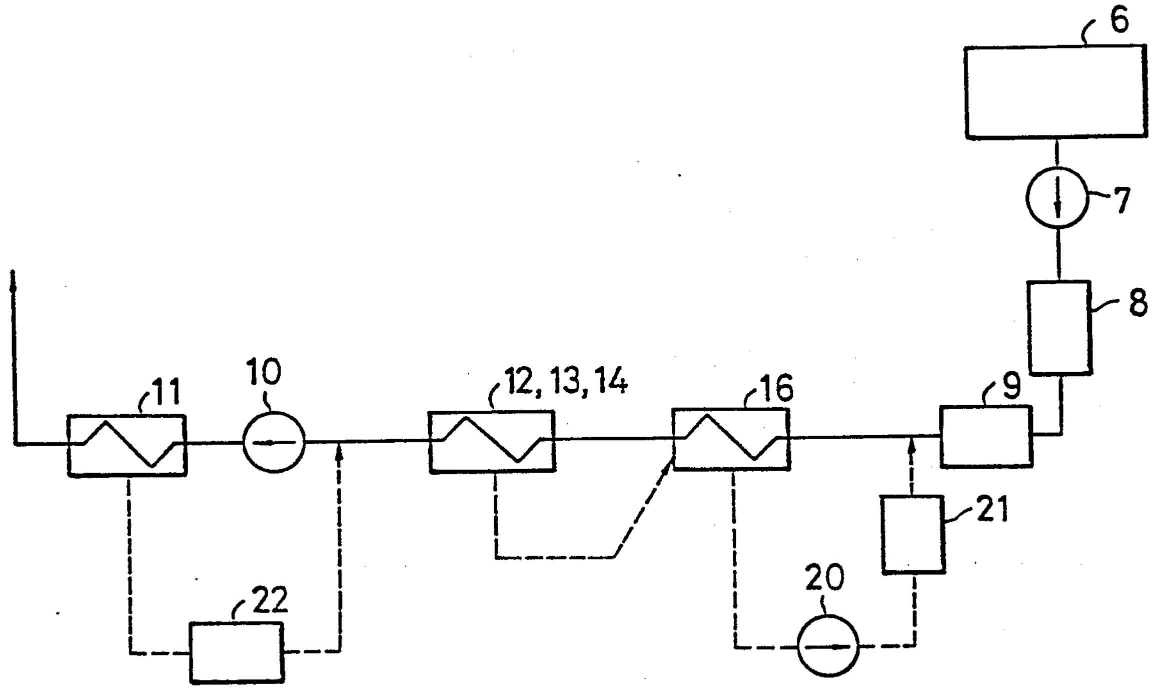

6410G(ton/hr)
662H(kca/kg)
1
2
3
4
5
440G
629H
610G
610H
550G
200h
3690G
6
120G
618H
33°
33h
7
8
9
6410G
215°
221h
280G
602H
280G
511H
440G
397H
37°
37h
2720G
11
10
12
13
14
15
16
21
196°(°C)
199h(kcal/kg)
150°
151h
133°
133h
107°
107h
80°
80h
42°
42h
20

Fig. 6



INTERNATIONAL SEARCH REPORT

International Application No. PCT/JP84/00279 0149677

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl^3 F22D 1/34

II. FIELDS SEARCHED

Minimum Documentation Searched[4]

Classification System	Classification Symbols
IPC	F22D 1/32, 1/34

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[5]

Jitsuyo Shinan Koho 1926 - 1983
Kokai Jitsuyo Shinan Koho 1971 - 1983

III. DOCUMENTS CONSIDERED TO BE RELEVANT[14]

Category*	Citation of Document,[16] with indication, where appropriate, of the relevant passages[17]	Relevant to Claim No.[18]
Y	JP, U, 56-47311 (Toshiba Corp.) 27 April, 1981 (27.04.81)	1 - 6
Y	JP, U, 54-44802 (Hitachi, Ltd.) 28 March, 1979 (28.03.79)	5 - 6
A	Nippon Boiler Kyokai-hen "Boiler no Mizu Kanri" Boiler Gijutsu Koza 6 5 October, 1969 (05.10.69) Kyoritsu Shuppan (Tokyo) P130-132	1 - 6

* Special categories of cited documents:[15]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search[2]	Date of Mailing of this International Search Report[2]
August 23, 1984 (23.08.84)	September 3, 1984 (03.09.84)
International Searching Authority[1]	Signature of Authorized Officer[20]
Japanese Patent Office	

Form PCT/ISA/210 (second sheet) (October 1981)