

Dec. 12, 1933.

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1,938,916

STEAM GENERATOR FED BY CENTRIFUGAL PUMPS

Filed Aug. 8, 1931

2 Sheets-Sheet 1

Fig. 1.

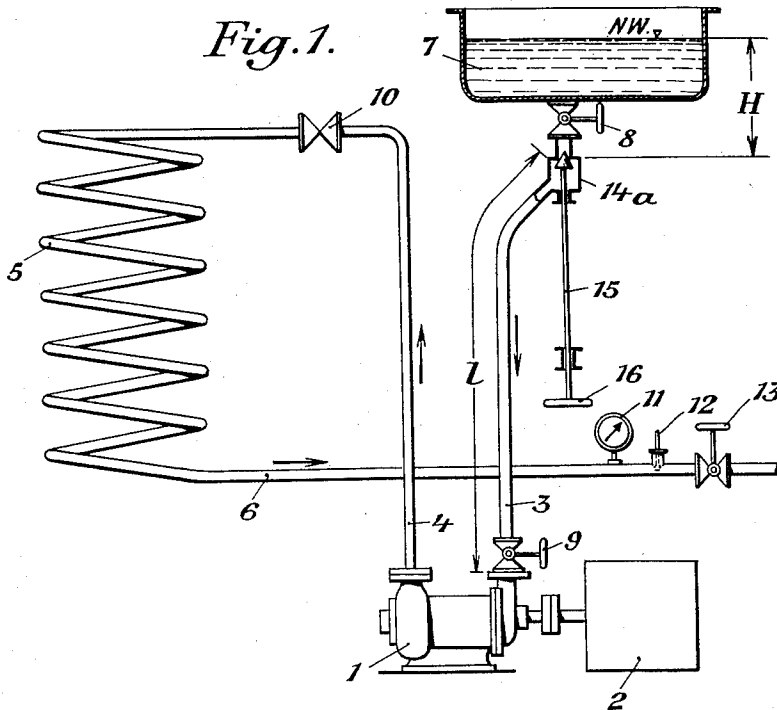
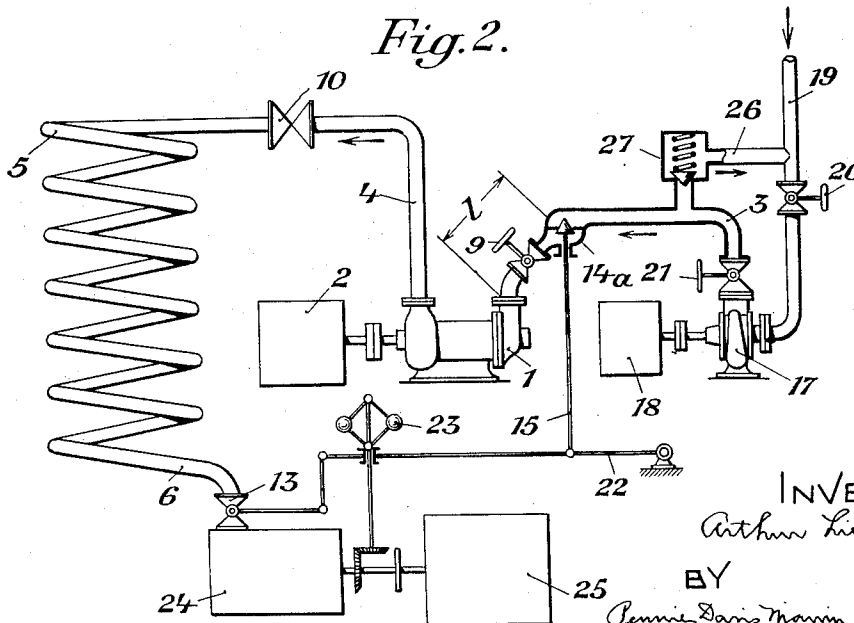


Fig. 2.



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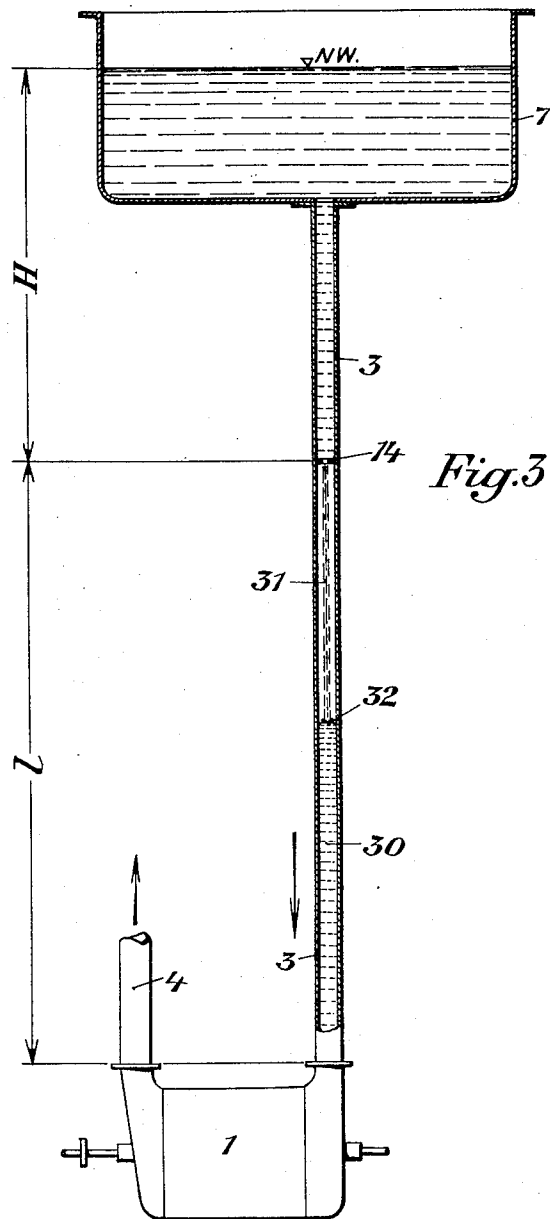
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1,938,916

STEAM GENERATOR FED BY CENTRIFUGAL PUMPS

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Application August 8, 1931, Serial No. 555,908, and in Switzerland July 16, 1930

5 Claims. (Cl. 122—451)

It has been found that the use of centrifugal pumps for feeding steam generators has the disadvantage that the quantity of the feed liquid can only be regulated to a limited extent corresponding to the stable range of the pump characteristic without producing fluctuations in the quantity of liquid. Moreover the back pressure of a steam generator is itself very variable in accordance with the working conditions. These variations are transmitted to the delivery side of the pump and cause great changes in the quantity of feed liquid delivered.

In the case of high pressure generators which mostly contain only small quantities of liquid, such fluctuations in the quantity delivered persist up to the evaporation of the liquid and are amplified by the steam generator itself, so that the quantity and state of the steam generated are subject to large variations.

In centrifugal pumps it is already known to arrange around the spindle directly in front of the impeller wheels, guiding apparatus or annular discs by means of which the cross-sectional area of the flow passage can be varied. The conditions of flow however in such a case have always been chosen in such a way as to avoid any break in the liquid column, so that the pressure difference produced by the throttling action of such a regulating device is always liable to large variations, and therefore the quantity flowing through cannot be regulated in accordance with the free cross-sectional area alone. On the contrary, for such a regulation it has always been necessary also to take into account the conditions of flow and the pressure difference resulting therefrom, in order accurately to determine the quantity of liquid passing.

Finally it is also known to arrange slides or valves in the supply pipes to the centrifugal pumps to constitute closing members, by means of which the supply pipe can be closed so that in the case of any maintenance work and the like no liquid can flow through the supply pipe into the pump and thence escape through any open points. The quantity flowing through cannot however be regulated or at the most can only be regulated to an insufficient extent by means of closing members, as the cross-sectional passage areas of closing members must be made very large in order to avoid great resistance to flow, that is to say throttling. As a result the full quantity of liquid can pass even if the members are only slightly opened.

Even in the event of it being still possible to throttle the liquid which is passing, the quantity

of liquid flowing through depends on many constructional details of the closing members, for instance the valve cones may be loose on their spindles and thus begin to chatter in the liquid stream, or the slides when only slightly open may not be clamped, but may also be loose on their spindles and themselves take part in the oscillations of the liquid and in their turn assist the oscillations of the liquid.

This invention aims at avoiding the disadvantages described above. According to the invention the feed liquid is delivered at an approximately constant pressure, which is higher than atmospheric pressure through an adjustable throttling point into the supply pipe of the pump and a break is maintained in the liquid column in the pipe between the throttling point and the pump. The dimensions, i. e. the length and cross-section, of the supply pipe are suitably chosen for this purpose. In this way a constant pressure drop is obtained owing to break in the liquid column after the regulating throttle.

The regulating throttle member is preferably arranged between a high level tank and the centrifugal pump or between an auxiliary pump and the centrifugal pump. Finally the effective cross-sectional area at the regulating throttling point may with advantage be regulated automatically in accordance with the steam consumption.

Two constructions according to the invention are diagrammatically illustrated by way of example in the accompanying drawings, in which

Figure 1 shows a system for feeding a high pressure steam generator to which the feed liquid is supplied from a high level tank,

Figure 2 shows a system for feeding another high pressure steam generator to which the feed liquid is supplied by an auxiliary pump, and

Figure 3 shows a longitudinal section through the supply pipe of a feed water system.

In Figure 1 a centrifugal pump 1 is driven by an engine 2 and delivers the feed liquid arriving by a pipe 3 through a pipe 4 into a pipe system 5 of a steam generator, from which the evaporated liquid is supplied through a pipe 6 to the points of consumption. Close beneath a high level tank 7 for the feed liquid is arranged a stop cock 8 by means of which the tank can be shut off during work on the pipes 3. In the same way, a stop cock 9 is provided for use when any work is done on the pump.

A non-return valve 10 is placed in the feed pipe 4 in order to prevent any liquid or steam from flowing back from the steam generator. In the pipe 6 there are placed a pressure gauge 11 for

use in observing the pressure and a thermometer 12 for use in determining the steam temperature, and finally a stop cock 13 for shutting off the pipe.

5 The feed liquid, which is under a head H is in accordance with the invention supplied to the centrifugal pump 1 through a throttling point 14 controlled by a throttle member 14a. In order to keep the head H invariable during operation a
10 device such for instance as a float valve or the like may be provided in the tank 7 so as to keep the feed water always at the same level NW.

The throttle member 14a is regulated in accordance with the steam consumption and the condition of the steam by means of a spindle 15
15 and a hand wheel 16 arranged immediately adjacent the instruments for measuring the pressure and temperature, so that the quantity of the feed liquid supplied to the steam generator can be regulated within any limits without causing
20 fluctuations and without being dependent on the working peculiarities of the pump and the steam generator.

In order to prevent the supply pipe 3 filling completely with liquid after the throttling point when quick changes take place in the amount of steam used during working, the length l of the pipe between the throttling point 14 and the centrifugal pump 1 is made so large that it will always
25 contain a space filled with steam into which the feed liquid is introduced past the throttling point in the form of a free jet. This ensures that the quantity of feed liquid passing the throttling point can be affected to an immaterial extent
30 only by the conditions on the side after the throttling point.

The feed pump 1 which is designed as a centrifugal pump, is so dimensioned with respect to the feed pressure of the steam generator 5 that the pressure which it is able to generate is greater
40 than the feed pressure and the capacity of absorption of the said feed pump is greater than the highest amount of feed fluid to be conveyed; there therefore occurs, according to the regulating member 14, a fracture and/or disruption of the liquid column in the conduit provided between the member and the feed pump.

If the feed pump 1 which is designed as a centrifugal pump has such dimensions that its elevating pressure is higher than the highest feed pressure in existence and its volume of discharge is greater than the greatest amount of feed in existence and a regulating member 14 is provided
50 in the conduit supplying the feed pump, in any operation a rupture of the liquid column in the conduit supplying the feed pump will take place. The real reason for the rupture of the liquid column is that due to its dimensions the feed pump endeavors to draw more than it actually receives so that it "pumps out" the supply conduit. As air cannot enter the supply conduit, the pressure prevailing during the "pumping out" in the supply conduit will drop at all events so far—even below atmospheric pressure—that owing to the
65 decrease in pressure the feed liquid begins to boil. It is a well-known fact that boiling takes place at normal room temperature at a pressure of approximately 0.02 atm. But if, as generally is the case, partly preheated water is used for feeding, the result will be a pressure of one atm. approximately, if, for example, the preheating temperature is 100° C. But at all events the pressure registered in pumping out remains invariable during the operation because it only depends upon
70 the preheating temperature. If the preheating

temperatures are above 100° C., a plant provided with a feed pump, similar to Fig. 2 will have to be considered. In plants having lower preheating temperatures, installations having a natural supply to the throttling place, as in Fig. 1, can be
80 employed.

If the supply conduit is pumped out, there will appear unconditionally a discontinuity, such as represented, for example, in Fig. 3, the water flowing in through the throttling place will be
85 thrown out into the steam space in the fashion of a jet of liquid so that a reduction in the cross-section of liquid flow will result causing a reduction in the cross-section of liquid flow immediately posterior to the throttling point. This contraction also can be distinctly derived from Fig. 3 of the drawings accompanying this application.

Referring now to Figure 2, the steam generated in the pipe system 5 is supplied through the pipe 6 to an engine 24 which drives a machine 25. The feed liquid is supplied to the feed pump 1 under constant pressure by an auxiliary pump 17 which is driven by an engine 18. The liquid to be delivered by the auxiliary pump 17 flows into the latter through a supply pipe 19 in which is provided a stop cock 20, and is delivered to the feed pump 1 through a pipe 3 in which are placed stop
95 cocks 9 and 21.

In the supply pipe 3 is mounted a throttling member 14a, which is moved through a rod 15 and lever 22 by the governor 23 of the engine 24, so as to regulate the effective cross-sectional area at the throttling point 14. In order to keep the pressure in the supply pipe 3 in front of the throttling member 14 constant, a return pipe 26
100 leading back to the supply pipe 19 and containing a valve 27 is provided, so that the quantity of liquid to be fed is supplied under constant pressure through the throttling point 14 to the centrifugal pump 1 by the auxiliary pump 17. With this arrangement the result is obtained that the quantity of feed liquid is regulated directly by the load on the engine 24 without any fluctuations taking place in the quantity or condition of the steam generated in the pipe system 5, and the regulation remains independent of the working peculiarities of the centrifugal pump and the steam generator.

The high level tank 7 shown in Figure 3 supplies water through the pipe 3 to the throttling point 14, from which it is supplied to a centrifugal pump 1 feeding a steam generator not shown in the drawings. The ratio of the cross-sectional area at the throttling point 14 to the output capacity of the feed pump is so chosen that the liquid column 30 in the supply pipe 3 of the pump 1 is always broken after the throttling point, so that the pipe can never run quite full after the throttling point and thus there is always a constant pressure difference at the throttling point.
125 Owing to this, the liquid passing through the throttling point 14 falls in the form of a free jet 31 under the pressure in the space after the throttling point, which pressure corresponds to the temperature of the liquid at the surface 32 of the column of liquid 30.

This arrangement has the advantage that, whatever be the degree of throttling, a constant or at least approximately constant pressure difference is produced on the two sides of the throttling point in the supply pipe to the feed pump, so that the quantity of liquid flowing through is not altered by changes in the pressure or any other accidents in working, but depends only on the effective cross-section at the throttling point.
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The invention is not limited to the constructions shown. In particular, any other kind of pump may of course be used as the auxiliary pump for the centrifugal pump 1, and the nature of the steam generator is immaterial for the invention. Likewise the steam generator need not be used for driving engines, but may be used for any other purpose.

Again, in place of the governor, a thermostat, a steam meter or the like may be used for regulating the effective cross-sectional area at the throttling point. The transmission of the regulating movement from the regulator to the throttling point may also be effected by power means and servomotors instead of mechanically.

I claim:

1. In a feed-system for steam generators, a throttling-member for receiving feed-water under substantially constant pressure, a conduit passing therethrough, means for regulating the cross-section of the flow through the throttling-member, and a centrifugal feed-pump connected to the conduit passing through said throttling-member, said pump having means therein for producing therein a peak-pressure greater than the difference between the pressure to the steam generator and the pressure anterior to the throttling-point, whereby to cause a break-down in the size of the column of liquid and a reduction in the cross-section of the liquid flow immediately posterior to the throttling-point.

2. In a feed-system for steam generators, a feed-water reservoir with a gravity-potential, a conduit leading from same, a throttling-member located in said conduit above the balance of the apparatus, means for regulating the cross-section of the flow through the throttling-member, a centrifugal feed-pump connected to the conduit passing through said throttling member, the conduit having a length and cross-section, and the capacity pressure of the pump being predetermined, to cause a break-down zone in the continuity of the flow and reduce the cross-section of the liquid column to substantially zero, said zone extending between the pump and the throttling-member, on the pump-side of the throttling device.

3. In a feed-system for steam generators, a source of feed-water, a conduit leading from same, a throttling-member located in said con-

duit, means for regulating the cross-section of the flow through the throttling-member, a centrifugal feed-pump connected to the conduit passing through said throttling-member, an auxiliary pump for supplying water to said conduit at a constant superatmospheric pressure, said throttling-member being located in said conduit between said auxiliary pump and said centrifugal pump, the conduit having a length and cross-section, and the capacity pressure of the pump being predetermined, to cause a break-down zone in the continuity of the flow and reduce the cross-section of the liquid column to substantially zero, said zone extending between the pump and the throttling-member, on the centrifugal pump-side of the throttling device.

4. In a feed-system for steam generators, a source of feed-water, a conduit leading from same, a throttling-member located in said conduit, means for automatically varying the effective cross-section of the conduit at the throttling-member, and a centrifugal feed-pump connected to the conduit passing through said throttling-member, the conduit having a length and cross-section, and the capacity pressure of the pump being predetermined, to cause a break-down zone in the continuity of the flow and reduce the cross-section of the liquid column to substantially zero, said zone extending between the pump and the throttling-member, on the centrifugal pump-side of the throttling device.

5. In a feed-system for steam generators, a source of feed-water, a conduit leading from same, a throttling-member located in said conduit, means for automatically varying the effective cross-section of the conduit at the throttling-member, said means being directly responsive to variations in steam consumption, and a centrifugal feed-pump connected to the conduit passing through said throttling-member, the conduit having a length and cross-section, and the capacity pressure of the pump being predetermined to cause a break-down zone in the continuity of the flow and reduce the cross-section of the liquid column to substantially zero, said zone extending between the pump and the throttling-member, on the centrifugal pump-side of the throttling device.

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