

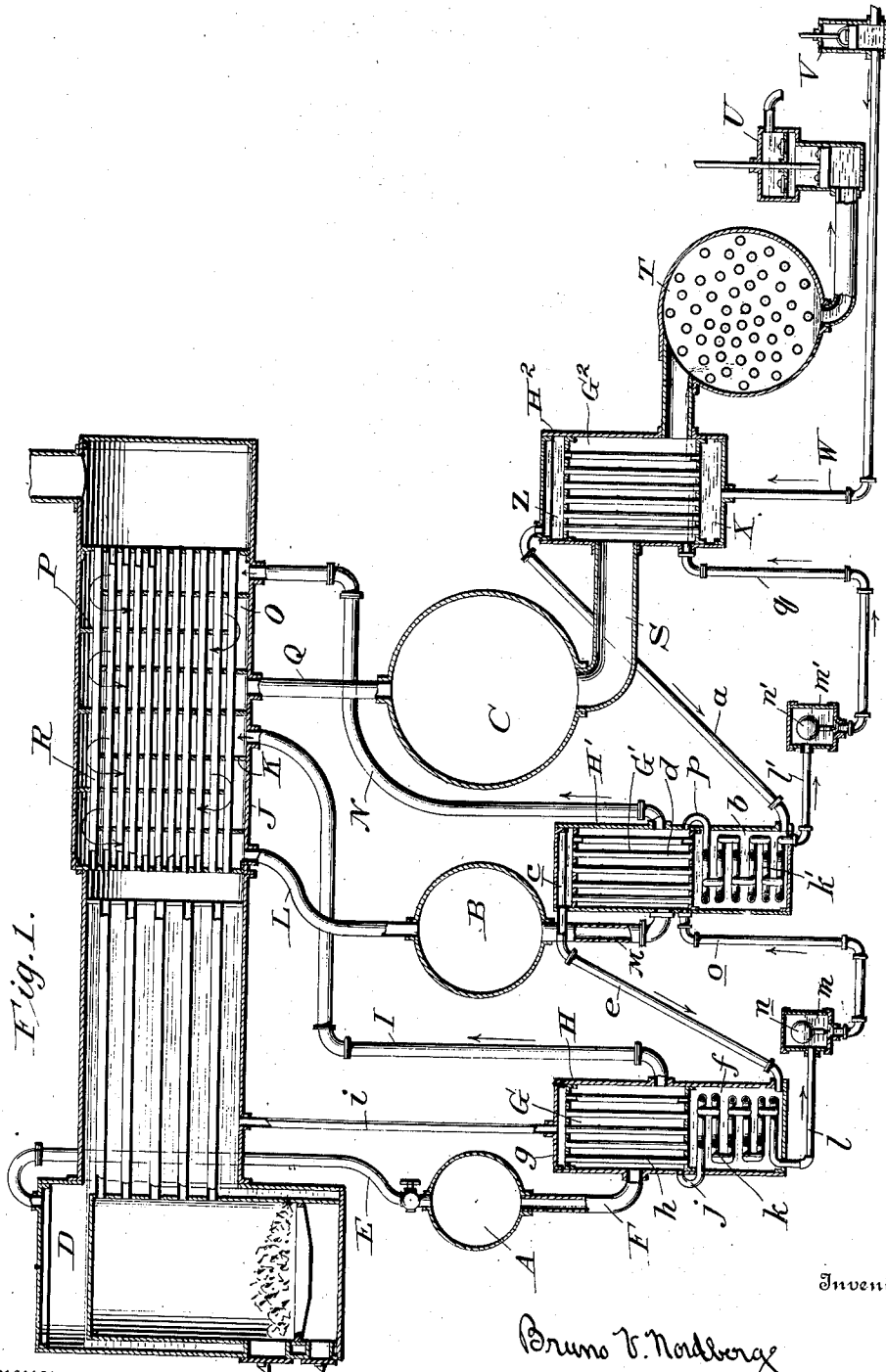


Fig. 1.

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 FEED WATER HEATING SYSTEM FOR MULTIPLE EXPANSION ENGINES.
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1,034,026.

Patented July 30, 1912.
 2 SHEETS—SHEET 2.

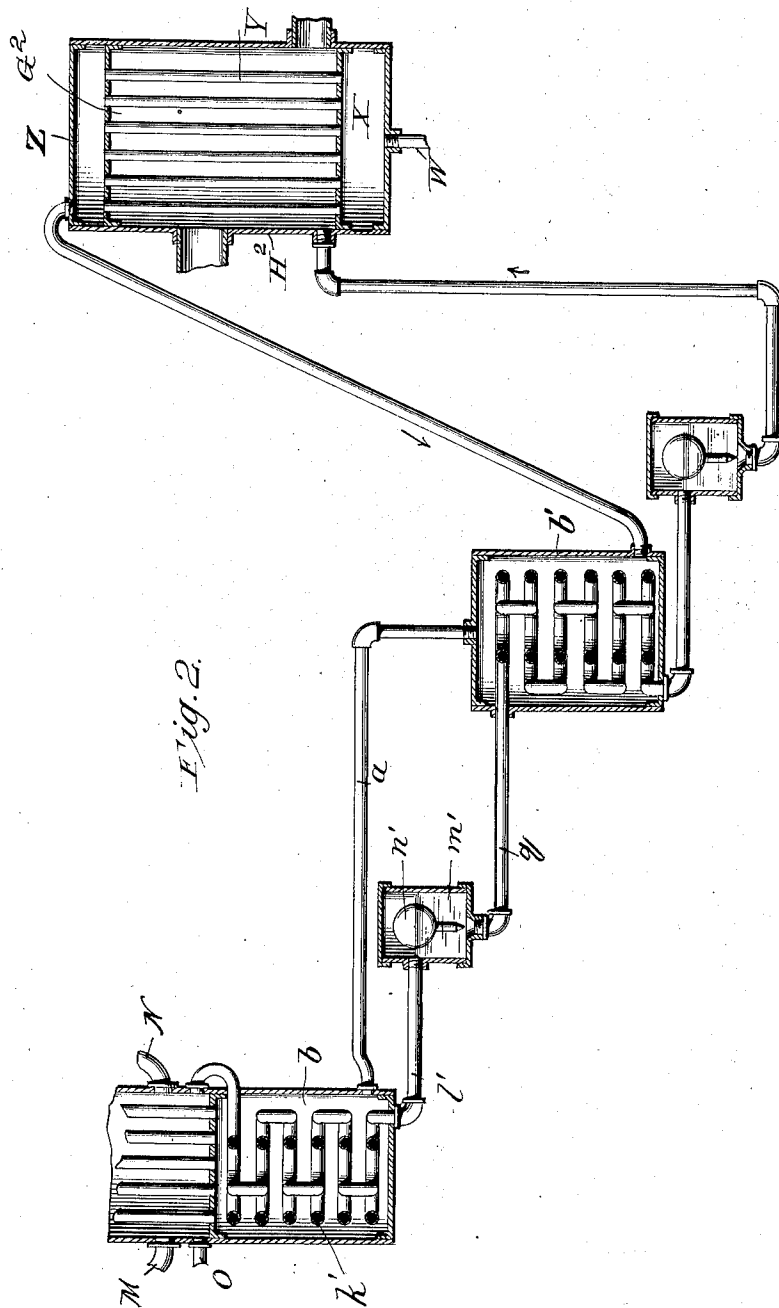


Fig. 2.

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UNITED STATES PATENT OFFICE.

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FEED-WATER-HEATING SYSTEM FOR MULTIPLE-EXPANSION ENGINES.

1,034,026.

Specification of Letters Patent.

Patented July 30, 1912.

Application filed February 4, 1907. Serial No. 355,658.

To all whom it may concern:

Be it known that I, BRUNO V. NORDBERG, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Feed-Water-Heating Systems for Multiple-Expansion Engines, of which the following is a specification.

The present invention pertains to improvements in feed water heating systems for multiple expansion engines, the construction and advantages of which will be hereinafter fully set forth, reference being had to the accompanying drawings, wherein—

In Figure 1 the system is diagrammatically illustrated and in Fig. 2 a modification of the invention is shown.

The main object of the invention is to provide a feed-water heating system wherein the exhaust steam from each cylinder of the engine or series of engines is employed to heat the feed-water, the steam by preference, after it passes through each feed-water heater being reheated before it enters the next cylinder or engine, whereby the efficiency of the engine is greatly increased.

A further object of the invention is to secure such reheating of the steam by the gases or products of combustion passing from the steam generator and to cause the steam to pass through the reheater in a direction reverse or counter to that of the passage of the gases therethrough, whereby the steam consumption will be reduced and as a consequence a smaller amount of fuel will be required.

A still further object of the invention is to provide means for arresting and withdrawing, to a greater or less extent, the oil or other lubricant which passes from the engine cylinders with the exhaust steam, thus preventing such lubricant from passing along with the steam as it goes to the reheater and the other cylinders of the series.

Another object of the invention is to utilize the water of condensation which comes from the exhaust steam of the engine or cylinder in the feed-water heaters in such manner as to cause said water of condensation to impart its heat to the feed-water before said feed-water passes into the upper part of the heater where the steam serves as a heating medium.

With the apparatus hereinafter set forth

in detail the feed-water is heated to the temperature of the exhaust steam of the first cylinder as the water is being forced into the boiler.

The invention, to a certain extent, may be said to be an improvement on the system shown in Letters Patent 728,282, granted to me under date of May 19, 1903. The present invention differs from the system therein shown in that in the present case the steam after passing from the high and intermediate cylinders and through the feed-water heaters, is itself reheated before passing to the next cylinder or engine in the series. Provision is also made for causing that portion of the exhaust steam which condenses to pass through heating coils or ducts located in the path of travel of the feed-water, whereby the heat units of such condensed steam will be fully utilized. At the same time, the lubricating oil which passes from the engine cylinders will be withdrawn and thus kept from passing through the reheater and into the next engine or cylinder in the series.

The feed-water heaters in the form herein illustrated are of the tubular type, and there is no commingling of the steam which passes from the cylinders through the heaters with the feed-water.

Referring to the drawing, A, B, C denote the cylinders of a multiple expansion engine, A being the high-pressure cylinder, C the low-pressure cylinder, and B the intermediate cylinder. In so far as the generic invention is concerned, it will be evident that two or more cylinders may be used or compounded as desired.

Steam passes to the high-pressure cylinder from the generator D through a pipe E and is exhausted from the high-pressure cylinder through a pipe F, into the receiver or steam chamber G formed in the upper portion of the heater H. From said chamber G it passes through a pipe I into a reheater J, said pipe entering the reheater at the end remote from the boiler or generator, so that the steam will pass in the direction indicated by the arrows, such circuitous passage being affected by the diaphragms or partitions K mounted in the reheater. The reheated steam passes through a pipe L to the intermediate cylinder B, being discharged therefrom through a pipe M into a chamber G' formed in the upper portion of the feed-water heater H'. From said chamber it

passes through a pipe N to a reheater O, provided with partitions P, so as to cause the steam to take a circuitous or tortuous path through said reheater to the pipe Q which is located at the end of the reheater nearest to the furnace or generator. As will be noted upon reference to the drawing, the reheaters J and O have a series of pipes or tubes R, through which the smoke and products of combustion from the furnace pass on their way to the stack. The steam reheated in the second reheater passes through pipe Q to the low-pressure cylinder C, through pipe S to the chamber or receiver G² formed in the reheater H². The steam from said chamber G² passes to a condenser T, the water of condensation being exhausted from said condenser by an air-pump U.

The feed-water for the boiler is forced through the system by a pump V, passing from the pump through a pipe W into a chamber X formed in the lower portion of the heater H². It then passes through tubes Y which communicate with the chamber X and a chamber Z formed in the upper portion of the heater H². From said chamber Z it passes through a pipe q into a chamber b formed in the lower portion of the heater H'. Said chamber b is in communication with a chamber c located at the upper end of the heater H', through pipes d which pass through the chamber G'. The chamber c discharges into a pipe e which communicates with a chamber f formed in the lower portion of the heater H. Said chamber f communicates with a chamber g through tubes or pipes h which pass through the chamber G. The water entering chamber g is fed into the boiler through a pipe i.

The steam passing from exhaust pipe F will to a greater or less extent condense in the chamber G, and to withdraw said water of condensation and utilize it in heating the feed-water a pipe j opens out from the lower end of the chamber G and is connected with a series of coils k located in the chamber f. Said coils are connected to a pipe l which discharges into a valve-casing or chamber m, in which is placed a float valve or trap n. The valve-chamber is connected with a pipe o which opens into the lower portion of the chamber G'. A pipe p opens into the lower end of the chamber G' and is connected with a series of coils k', located in the chamber b, such coils at the lower end being connected by a pipe l', with a valve-box or chamber m', in which is located a float valve or trap n'. The lower portion of said valve-box or chamber is in communication with the lower part of the chamber G² through a pipe q.

The operation of the apparatus thus described is as follows: The exhaust steam passing from the cylinder A acts upon the feed-water flowing through tubes or pipes h

and thence passes through the pipe I to the reheater J, which is located nearest or adjacent to the boiler. It then passes through the pipe L to the cylinder B where it acts expansively, is exhausted through pipe M into the second heater H', and circulates around the pipes d, serving to impart a portion of its heat to the feed-water flowing through said pipes. From heater H' the steam passes through pipe N to the reheater O and from said reheater through the pipe Q to the low-pressure cylinder C. The exhaust steam from said cylinder passes through the pipe S into the chamber G² and around the pipes Y therein, imparting the greater portion of its heat to the feed-water flowing through said pipes. It then passes to the condenser T, from which the water of condensation is withdrawn by the air-pump U. As before noted, a portion of the steam which passes from the cylinder A into the chamber G will be condensed and a certain amount of lubricant or oil will likewise enter said chamber G with the steam. The pipe j will tend to drain this water of condensation and the oil from said chamber, the pipe discharging into the coils k, and the oil and water flowing therethrough in a direction reverse to the flow of the feed-water through the chamber f. The water and oil passing through the pipe l will flow through the valve-box or chamber m, and through the pipe o so long as there is sufficient water in the valve-box to hold the valve n off its seat. The water entering chamber G' will mingle with the water of condensation formed in said chamber by the steam passing through pipe M, and will flow with such additional water of condensation through pipe p and coils k', the direction of travel, as in the former case, being the reverse of that of the feed-water through the chamber b. From the coils k' the water will pass through the pipe l', valve-box or chamber m', pipe q, and into the lower portion of the chamber G². From said chamber it passes to the condenser T.

Inasmuch as the pressure of the steam in the chamber G will be higher than that in the chamber G' and the pressure of the steam in the latter higher than that in the chamber G², it is necessary to employ the valves n and n' to prevent the steam from blowing through the pipes when no water is present therein. The water passing from the air-pump may be allowed to go to waste, or purified and again used as feed-water. The steam which passes from the feed-water heaters G and G' will be quite wet, but by the employment of the reheaters J and O the steam passing to the cylinders B and C will be comparatively dry and, therefore, highly efficient. By connecting the coils k and k' in the manner set forth the feed-water while in its coldest condition enters

either of the chambers *b* or *f* and comes in contact with the coils which are the coolest, and as the water flows upwardly it is gradually warmed and comes in contact with the coils which are the hottest. It is evident that under these conditions the greatest possible exchange of heat between the water of condensation and the feed-water takes place. The water leaving the coils *k* is cooled to approximately the same temperature as the feed-water passing into the chamber *f* through the pipe *e*, or to approximately the temperature of the steam in the exhaust pipe *M*. The same relation exists between the temperatures in the coils *k'* and the feed-water which passes into the chamber *b* through pipe *a*. In practice the water of condensation passing from the pipe *o* into the chamber *G'* will be a little hotter than the water of condensation from the pipe *M*, and as a consequence a part of the water will be evaporated. As the pressure in the chamber *G'* is considerably less than that in the chamber *G* whatever steam may be formed in this manner will, of course, pass through the superheater and thus be utilized.

It may, under certain conditions, be profitable to pass the water of condensation from the pipe *g* through a separate heater for the feed-water, constructed in a manner similar to the heating chambers *b* and *f*. Such construction is shown in Fig. 2. In this case the supplemental heater *b'* would have to be placed between the heater *H*² and the chamber *b*, as the temperature to which the water would be heated in said supplemental heater would probably be higher than that at which the feed-water would leave the heater *H*².

No claim is made herein to a feed-water heating system comprising the combination of the feed-water heater into which the exhaust from the engine cylinder passes, and means for causing the water of condensation to primarily heat the feed water, such matter being reserved for a separate application filed as a division hereof.

Having thus described my invention, what I claim is:

1. In a feed-water heating system for multiple expansion engines, the combination of a plurality of engine cylinders; a feed-water heater through which the exhaust steam from the high-pressure cylinder passes; and a reheater for such exhaust steam located between the feed-water heater and the low-pressure cylinder.

2. In a feed-water heating system for multiple expansion engines, the combination of a plurality of engine cylinders; a feed-water heater through which the exhaust steam from the high-pressure cylinder passes; a reheater for such exhaust steam located between the feed-water heater and the low-pressure cylinder; and a steam generator,

the products of combustion from which pass through the reheater in a direction the reverse of that of the steam.

3. In a feed-water heating system for multiple expansion engines, the combination of a plurality of engine cylinders; a feed-water heater communicating with the exhaust port of each of said cylinders; and a pair of reheaters communicating respectively with the steam spaces of the first and second feed-water heaters and with the steam inlets of the second and third engine cylinders.

4. In a feed-water heating system for multiple expansion engines, the combination of a water-heater having a steam space into which the high-pressure cylinder exhausts; a pipe or duct extending from the lower portion of the steam space and passing through the water in the lower part of the heater; means for introducing water into the lower end of the heater and drawing it from the upper portion thereof; and means for reheating the steam as it passes from the water-heater to the next cylinder in series.

5. In a feed-water heating system for multiple expansion engines, the combination of a plurality of engine cylinders; a feed-water heater for each engine into which it exhausts; means for utilizing the water of condensation of such exhaust steam to primarily heat the water in the water heater; and means for reheating the steam as it passes from the water heater to the next cylinder in the series.

6. In a feed-water heating system for multiple expansion engines, the combination of a plurality of engine cylinders; a feed-water heater for each engine into which it exhausts; a pipe communicating with the lower portion of the steam space in the first heater of the series, said pipe passing through the water space in the heater and communicating with the steam space of the next heater; a similar pipe connecting the steam space of said second heater with the steam space of the third heater; and means for reheating the steam as it passes from the water-heater to the next cylinder in series.

7. In a feed-water heating system for multiple expansion engines, the combination of a plurality of engine cylinders; a feed-water heater connected with the exhaust of each of said cylinders; a pipe extending from the steam space of the heater through the water space in the heater, and to the steam space of the next adjacent heater; a similar pipe connecting the second and third heaters; a check-valve located in each of said pipes; and means for reheating the steam as it passes from the water-heater to the next cylinder in series.

8. In a feed-water heating system for multiple expansion engines, the combination of

a plurality of engine cylinders; a water-heater connected to the exhaust of each of said cylinders; a pipe extending from the steam space of the first heater through the water space in the heater and to the steam space of the next adjacent heater; a similarly arranged pipe connecting the second heater with the third heater; and means for reheating the steam passing to the low-pressure cylinders.

9. In a feed-water heating system for multiple expansion engines, the combination with a series of engine-cylinders and their steam supply and exhaust connection; of a feed-water heater supplied with steam from the low-pressure cylinder and adapted to raise the temperature of the feed-water to approximately that of the steam from the exhaust of said cylinder; a heater through which said feed water passes on its way to the boiler, having connection with the steam-space of the engine and adapted to further raise the temperature of the feed-water to approximately that of the steam at the point from which it is diverted to said last-mentioned heater; and means for reheating the steam after it passes through said last-

named heater and before it passes into the low-pressure cylinder.

10. In a feed-water heating system for multiple expansion engines, the combination with a series of engine cylinders, their steam and exhaust connections, and a condenser connected with the exhaust of the low-pressure cylinder; of a heater located in the exhaust connection between said condenser and cylinder; a pump arranged to force water through said heater; one or more heaters through which the feed-water passes on its way to the boiler from the first-named heater, each of said last-mentioned heaters being located between the exhaust of one cylinder and the supply of the next cylinder; and means for reheating the steam as it passes from said last-mentioned heaters and before it passes into the low-pressure and intermediate cylinders.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

BRUNO V. NORDBERG.

Witnesses:

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