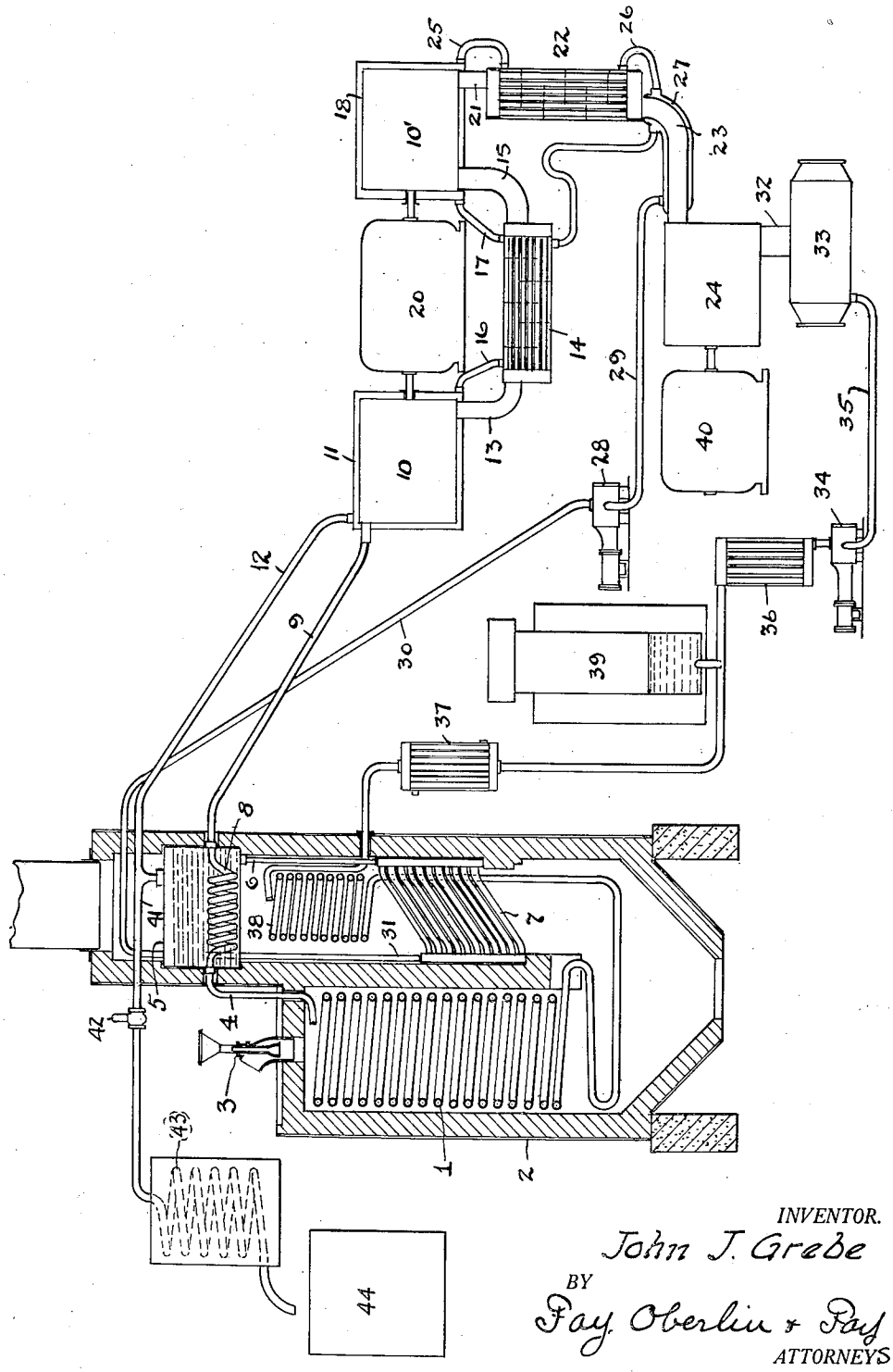
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HEAT ENERGY SYSTEM

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INVENTOR.

John J. Grebe

BY

Fay, Oberlin & Fay

ATTORNEYS.

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JOHN J. GREBE, OF MIDLAND, MICHIGAN, ASSIGNOR TO THE DOW CHEMICAL COMPANY, OF MIDLAND, MICHIGAN, A CORPORATION OF MICHIGAN

HEAT-ENERGY SYSTEM

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Steam at high temperature ranges offers advantages as a heat-energy transfer agent but practical limitations heretofore believed insuperable have stood in the way of its use or application. The present invention has among its objects the provision of a cycle employing such agent and in a manner available for heat transfer in more general applications or for power purposes as may be desired. Other objects and advantages will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the features hereinafter fully described, and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail but one of various ways in which the principle of the invention may be employed.

In said annexed drawing, the sole figure is a diagrammatic showing of one form of apparatus which may be used in carrying out the invention.

In its general aspects, the invention contemplates employing steam at high temperatures and providing a heat compensating or balancing system in transfer relation with the steam system. Such steam may be used as an agent for high temperature heating, in chemical work, or for other purposes, or it may be used for power generation. As an additional feature, the steam may be reheated or boosted after being used, and thus allow of further use.

Where operating at pressures over 1000 pounds per square inch, it is advisable that the steam generator be of tube type or best of a substantially continuous coil, without any vapor or liquid drums. The steam pipe coming from the furnace is passed in heat exchange relation with the fluid products of a high-boiling point liquid operating at low pressures. This may take the form of an exchanger with separate passages for the steam and for the high-boiling point agent, or for instance a coil for the steam passing through a drum containing the high-boiling point agent. The latter fluid may also be additionally heated by providing heating tubes or a coil in the furnace in cases where desired. With the steam thus brought into relation with the higher-boiling point agent heated from the furnace, if the temperature of the steam should exceed that of the high-boiling point agent, heat will be given up to the latter by the steam, but on the other hand when the steam temperature is below that of the high-boiling point agent, as in the case of a sudden load drain on the steam system, the high-boiling point agent supplies heat to the steam. In this manner not only is a tendency to an equalization had at all times but the low pressure high-boiling point heating fluid acts to supply reserve capacity immediately available for the steam system itself, but without the hazards of a large body of steam under very high pressure.

As high-boiling point substance or agent, I may employ diphenyl oxide, or in some instances aluminum bromide, silicon bromide, tin bromide, mercury, phenanthrene, mineral oils, etc.

After using the steam to give up heat in any apparatus desired, it may be brought in heat transfer relation with the high-boiling point agent again whereby the steam temperature is again raised to allow of a further use, and such procedure may be still further repeated.

In the accompanying drawing, the reference character 1 designates a steam generator with tube or coil in a furnace 2 which may be heated by suitable means, for example by powdered fuel supplied by feeder 3. From the furnace the steam pipe 4 passes to a drum 5 exposed in the path of the hot products of combustion and containing a high-boiling point agent, for instance diphenyl oxide. The drum is connected by pipe 6 with a tubular heater 7 located in a hotter portion of the chamber or setting. The passageway 8 for the steam through the high-boiling point agent drum connects by a pipe 9 to a point of use for the steam; here a turbine 10. A jacket 11 about the turbine is heated by the vapor of the high-boiling point agent coming from drum 5 by way of pipe 12. From the turbine 10 the steam exhausts through a pipe 13 to a reheater 14 which contains passages for the steam to a pipe 15 leading to another tur-

bine 10'. Other passages in the reheater 14 receive the fluid high-boiling point heating agent from the jacket 11 by a pipe 16 and thence forward it by a pipe 17 to the jacket 18 about the turbine 10'. A dynamo 20 is illustrated as driven by the turbines. From the turbine 10', a pipe 21 exhausts the steam to a reheater 22 and its passageways connect to outlet pipe 23 leading to a further turbine 24. A pipe 25 leads the high-boiling point agent from the jacket 18 to the compartments about the steam passageways in the reheater 22, and a pipe 26 hence leads to a jacket 27 about the steam pipe 23. A pump 28 returns the high-boiling point substance through pipes 29, 30 and 31 to the heater 7 in the furnace.

From the turbine 24, illustrated as driving a dynamo 40, the steam exhausts by a pipe 32 to a condenser 33, whence a pump 34 returns the condensate through pipe 35, feed heaters 36 and 37 to a preheater coil 38 and steam generator 1. An accumulator 39 is desirably connected in the condensate line.

In an equipment on this order, steam may be generated and brought to a pressure of 1000 pounds per square inch and upward, even to 3500 pounds per square inch, the hazards of such pressures being greatly minimized by my arrangement, in which there is a relatively small body of steam in existence at any given time. An ample reserve capacity is provided however, as has been seen in the body of high-boiling point agent, operating at low pressures, but which is in such heat relation with the steam system as to constitute a heat energy cycle therewith. Thus, ample reserve is provided for taking care of fluctuations in steam demand, and as effectively as with large steam body accumulation. The heat transfer with the high-boiling point agent affords an effective equalizer for the temperature of the steam delivered for use, the steam heating the high-boiling point agent and vice versa, the temperature averaging between the two fluids as the one or the other is hotter with the varying load-drain on the steam line. Where this function only is desired, the additional heating means or furnace-coil for the high-boiling point agent is omitted. The number of re-heat stages can be varied to suit conditions. The more such stages used, the greater the efficiency total in the system, the isothermal expansion then involving a series of steps in which the temperature may range between for illustration say 725 and 650° F. For power plant purposes in some cases it will be sufficient to apply the heat of the vapor of the high-boiling point agent to the jackets of the turbines only and omit the intermediate reheaters. Or where preferred, the reheaters may be provided and the heating jackets may be omitted. All such details will of course necessarily vary with the particular kind of plant, the size of the plant, conditions, etc., and any or all of the features of the invention may be applied, as desired.

Not only will the usual safety-valve precautions be applied on the steam line out of the boiler, but ordinarily it is also advisable to apply a large capacity safety valve to the vapor portion of the high-boiling point agent system, for instance a safety valve 42 with connection 41 to the drum and on the other side to a cooling coil 43 and receiving tank 44. In this manner, in the event of a break in the steam line within the drum 5 the contents, which in some instances will be of combustible character, will merely be driven out and cooled and caught in storage.

Other modes of applying the principle of the invention may be employed, change being made in the details disclosed, provided the steps or means stated in any of the following claims, or the equivalent of such, be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. In apparatus of the character described, the combination of a vapor generator, a drum for a higher-boiling point agent, a duct for conducting vapor from said generator immediately after generation through said drum, means for heating the higher-boiling point agent, means for abstracting energy from the vapor delivered from said vapor generator, and a heating jacket about said means, said jacket being supplied with the heated higher-boiling point agent.

2. In apparatus of the character described, the combination of a one pass vaporizer for a low boiling point liquid, a container for a high boiling point agent, a duct connected to the outlet of said vaporizer for a low boiling point liquid and passing through said container for the high boiling point agent, means for at least partially vaporizing the high boiling point agent and delivering same direct to said container, means for abstracting energy from the vapor of the low boiling point liquid, and means to supply heat from the vapor of said hot high boiling point agent to the vapor of the low boiling point liquid at the energy abstracting means.

3. In apparatus of the character described, the combination of a vapor generator, a drum for a higher-boiling point agent, a duct for conducting vapor from said generator immediately after generation through said drum, means for heating the higher-boiling point agent, means for abstracting energy from the vapor delivered from said vapor generator, a heating jacket about said means, said jacket being supplied with the heated higher-boiling point agent, a reheater for the vapor exhausted from the energy abstracting means, and further means for abstracting energy from the reheated vapor including a heating jacket about the same, said reheater and said

jacket being likewise supplied with said heated higher-boiling point agent.

4. In apparatus of the character described, the combination of a steam generator, a drum for a higher-boiling point agent, a duct for conducting steam from said generator immediately after generation through said drum, means for heating the higher-boiling point agent, a turbine for receiving the steam, a jacket about said turbine heated by the higher-boiling point agent, a reheater having ducts for the steam and ducts for the higher-boiling point agent, another turbine for receiving the steam from the reheater, and a jacket about said turbine heated by the higher-boiling point agent.

5. In apparatus of the character described, the combination of a steam generator, a drum for a higher-boiling point agent, a duct for conducting steam from said generator immediately after generation through said drum, means for heating the higher-boiling point agent, a turbine for receiving the steam, a jacket about said turbine heated by the higher-boiling point agent, a reheater having ducts for the steam and ducts for the higher-boiling point agent, another turbine for receiving the steam from the reheater, a jacket about said turbine heated by the higher-boiling point agent, a reheater having ducts for the steam and ducts for the higher-boiling point agent, and another turbine for receiving the reheated steam.

6. In apparatus of the character described, the combination of a steam generator, a drum for a higher-boiling point agent, a duct for conducting steam from said generator immediately after generation through said drum, means for heating the higher-boiling point agent, a turbine for receiving the steam, a jacket about said turbine heated by the higher-boiling point agent, a reheater having ducts for the steam and ducts for the higher-boiling point agent, another turbine for receiving the steam from the reheater, a jacket about said turbine heated by the higher-boiling point agent, a reheater having ducts for the steam and ducts for the higher-boiling point agent, another turbine for receiving the reheated steam, a steam condenser, and means for returning the steam condensate to the steam generator.

7. In apparatus of the character described, the combination of a steam generator, a drum for a fluid higher-boiling point agent, a duct for conducting steam from said generator immediately after generation through said drum, means for heating the higher-boiling point agent and delivering same to said drum, a turbine for receiving the steam, a jacket about said turbine heated by the hot vapor of the higher-boiling point agent, a reheater having ducts for the steam and ducts for the vaporized higher-boiling point agent, another turbine for receiving the steam from the reheater, a jacket about said turbine heated by the higher-boiling point agent, a reheater having ducts for the steam and ducts for the higher-boiling point agent, another turbine for receiving the reheated steam, and means for returning the higher-boiling point agent to its heater.

8. In apparatus of the character described, the combination of a one pass steam generator, a drum for a fluid higher-boiling point agent such as diphenyl oxide, a duct for conducting steam from said generator immediately after generation through said drum, means for heating the higher-boiling point agent and delivering same to said drum, a turbine for receiving the steam, a jacket about said turbine heated by the vaporized higher-boiling point agent, a reheater having ducts for the steam and ducts for the higher-boiling point agent, another turbine for receiving the steam from the reheater, a jacket about said turbine heated by the higher-boiling point agent, a reheater having ducts for the steam and ducts for the higher-boiling point agent, another turbine for receiving the reheated steam, a steam condenser, means for returning the condensate to the steam generator, and means for returning the higher-boiling point agent to its heater.

Signed by me this 13th day of January, 1927.

JOHN J. GREBE.