Jan. 24, 1933. J. J. GREBE 1,895,220

METHOD OF VAPORIZING

Filed Aug. 15, 1927 2 Sheets-Sheet 1

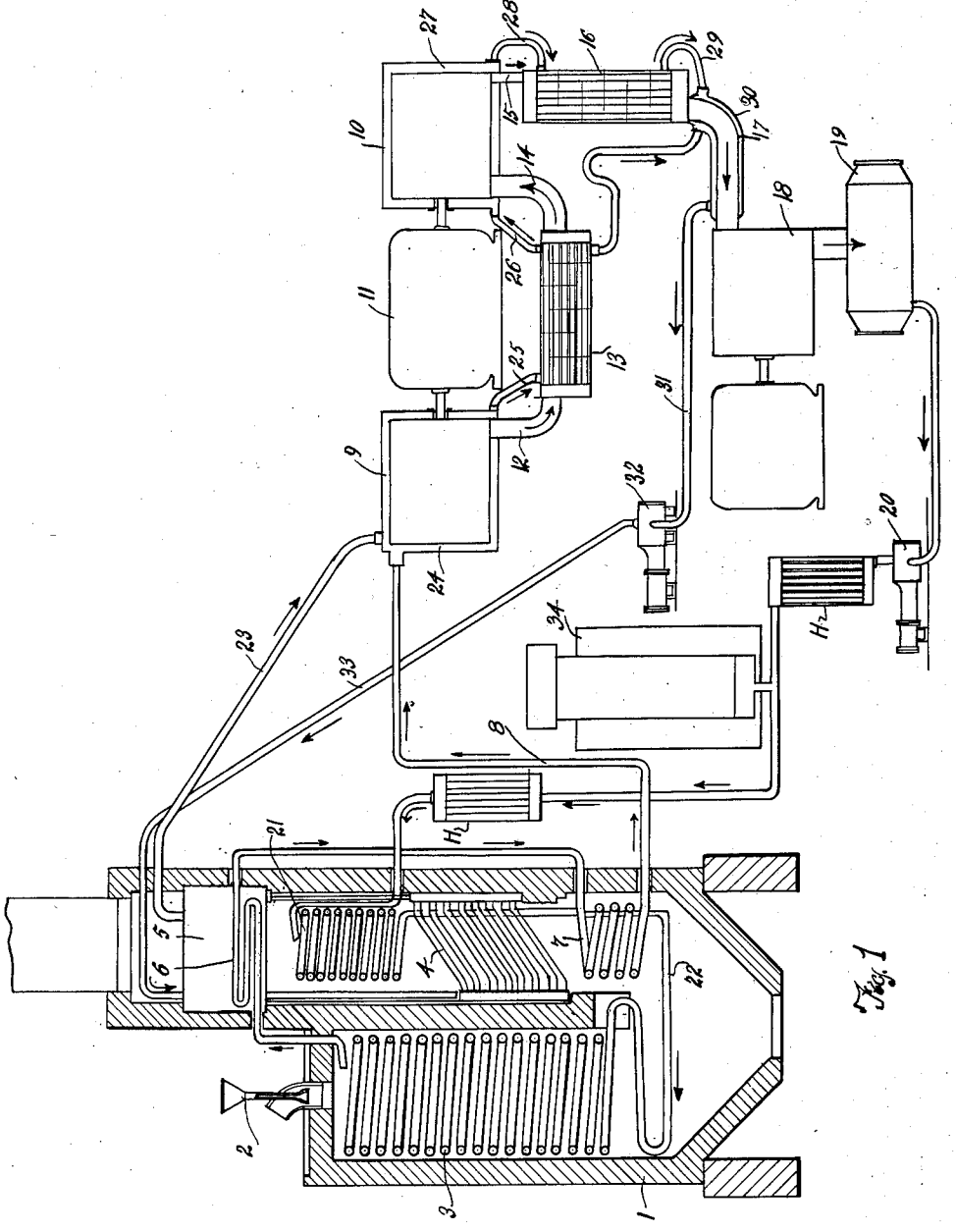


Fig. 1

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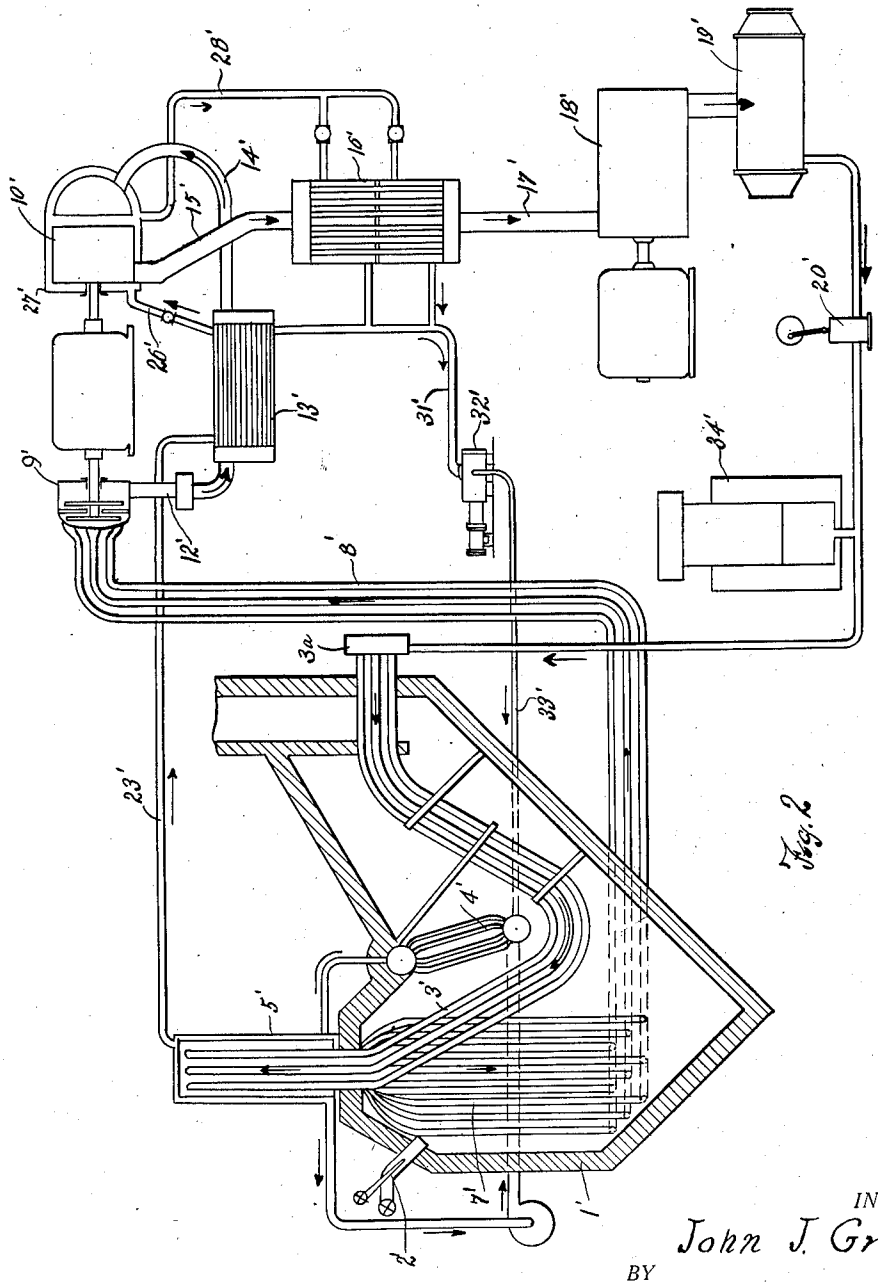


Fig. 2

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1,895,220

UNITED STATES PATENT OFFICE

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METHOD OF VAPORIZING

Application filed August 15, 1927. Serial No. 212,913.

The principle of the invention is herein explained and the best mode in which I have contemplated applying that principle so as to distinguish it from other inventions.

Where power generation is more particularly concerned with energy transfer in fluids at very high pressures, it is desirable in some circumstances to carry as high a temperature as possible. Especially in the case of steam, the advantages of very high pressures may be furthered if the temperatures be proper and adequately maintained.

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 drawings setting forth in detail certain structure embodying the invention, such being illustrative however of but a few of the various ways in which the principles of the invention may be employed.

In said annexed drawings:—

Fig. 1 is a semi-schematic showing of a plant layout embodying the invention; and Fig. 2 is a similar view of a modification.

In its general aspects the invention contemplates means for generating vapor under pressure, more usually steam, and a heater for a higher boiling point fluid, and means for temperature balancing heat transfer between the two fluids, and a further means for applying heat to the first-named fluid by means of furnace temperatures permitting production of vapor temperatures approaching furnace temperature without requiring a correspondingly high temperature in the equalizer. As illustrated in Fig. 1, an advantageous equipment may comprise a furnace 1 heated by any suitable means, for example by powdered fuel supplied by a feeder 2. Within this furnace chamber is a generator for steam or the like, comprising a tubular system 3. Located also in exposure to the furnace conditions is a heater for a fluid higher boiling point agent, for example diphenyl oxide, this heater comprising preferably a tubular system 4. The tubular system 4 is in communication with a drum or the like 5, and passing through the drum is a conduit 6, preferably in multi-coil form, this conduit being connected with the generator system 3 on the one hand and on the other hand connecting with a tubular system 7 exposed in the furnace chamber, preferably in the path of the gases on their way to the stack. From the furnace-heated tubular system 7, a pipe 8 leads to the point of usage of the steam or the like, in the illustration this comprising a turbine 9 for high pressure and a second stage turbine 10, these being connected to a dynamo or other load 11. The exhaust from turbine stage 9 passes by connection 12 to a heat exchanger 13, and thence by connection 14 to the second stage turbine 10. From the latter, a connection 15 leads to a heat exchanger 16 and from thence a connection 17 in turn leads to a further prime mover, preferably a turbine 18. A condenser 19 may be arranged to receive exhaust from such final turbine and in turn the condensate may then be forwarded by a pump 20 to a first stage heater coil system 21 in the outlet section of the furnace, and from this, a connection 22 leads to the main generator tubular system 3.

A higher boiling point agent in fluid form may be conducted from the drum 5 by a connection 23 to a jacket 24 about the turbine 9, and thence by connection 25 to the heat exchanger 13, and by a connection 26 further to a jacket 27 about the second stage turbine 10. From the latter, a connection 28 leads to the exchanger 16, and a connection 29 in turn leads therefrom to a jacket 30 about the steam pipe 17. Return of the higher boiling point agent may be provided by a connection 31 leading through a pump 32 to a return pipe 33 to the boiler system 4.

In operation, as will be readily understood from the foregoing, steam is generated in the boiler 3, and such equipment may particularly favor the generation of steam under very high pressures, for instance of usable magnitude even over 1200 pounds per square inch. From the generator 3, it will be noticed that the steam passes through the interchanger or balancer drum 5, and thence through the furnace heated tubular system 7 where a final booster heating is received. From this, the

steam passes by pipe 8 to the point of usage, this in the illustration comprising the first and second stage turbines 9, 10, and the final turbine 18. The temperature of the turbines 9 and 10 as will be noted is further maintained by the jackets 24, 27 supplied by the high boiling point agent from the boiler system 4 therefor; and heat exchangers 13 and 16 in the inter-stages provide reheating in an advantageous manner. From the final point of usage in the last turbine, the exhaust goes through the condenser 19 and is thence forwarded by the pump 20 to the first stage heater 21 of the boiler system in the furnace. An accumulator 34 may be included in the boiler feed line if desired, for regulating the feed to the boiler. Also heat exchangers H may be included in the line, as may be dictated by convenience. All these being immaterial to the present invention, further detail is unnecessary.

In the form shown in Fig. 2, a furnace chamber 1′ is heated by any suitable means, for example as shown, a powdered coal system having feeder 2′, and arranged in the furnace chamber is a boiler or generator for steam or the like, such generator comprising a bank of tubes 3′ connected with an inlet header 3*a* and extending through an interchanger drum 5′ whence by return bends, the tubes continue as at 7′ back through the furnace, particularly along the walls thereof in the primary combustion zone, and thence leading as connections 8′ to the point of usage, for instance, the first-stage prime mover or turbine 9′, and the second stage prime mover or turbine 10′. A final stage prime mover or turbine 18′ may also be arranged.

The heat interchanger or balancer 5′ is arranged to receive the highly heated fluid higher boiling point agent from the boiler or tubular system 4′ mounted in the furnace, and from the interchanger drum 5′ a connection 23′ leads to an exchanger 13′ for reheating the exhaust from the turbine stage 9′, a connection 12′ forwarding such exhaust to the exchanger, and a connection 14′ leading the steam in turn to the second stage turbine 10′. A further exchanger 16′ may be applied between the turbine stages 10′ and 18′, such exchanger receiving the exhaust steam by connection 15′ from the turbine 10′, and having a connection 17′ in turn to the turbine 18′. From the exchanger 13′, the diphenyl oxide or other agent of high boiling point may pass by connection 26′ to a jacket 27′ about the turbine 10′, a connection 28′ thence leading to the heat exchanger 16′, and from thence a return pipe 31′ to the pump 32′. From the latter, a return line 33′ leads to the boiler system 4′.

With such installation analogously, steam or the like is generated in the boiler system 3′, and passes through the interchanger or balancer 5′ where it is in heat transfer relationship with the highly heated agent of high boiling point from the boiler system 4′. Thence the steam proceeds through the heater tubes 7′ exposed in the furnace preferably in a location to receive the radiant heat of the furnace, and thence thus highly heated, steam under high pressure, which may be for instance on the order of 1200 to 1500 pounds, and with any degree of superheat feasible and desirable, as for instance a temperature of 950° F. may proceed to the point of usage, in the illustrative form shown, this comprising the first and second turbines 9′, 10′, and the final turbine 18′. Between the turbine stages, reheating is provided by the exchangers 13′, 16′ which are supplied by the highly heated diphenyl oxide or like high boiling point agent. From the final turbine 18′, the exhaust may lead to a condenser 19′ and thence by pump 20′ to the boiler 3′. An accumulator 34′ may be arranged in the line if desired.

While the arrangements as shown, include various refinements of multi-stage prime mover use, and interstage reheating by exchangers, jackets, etc., it will be understood that such refinements may be omitted, and the utility of the invention may be realized in its simplest terms, and while particularly advantageous where applied to steam plants operating at very high pressures and temperatures, the advantages of the invention may be realized in degree also with lower pressures.

Instead of steam, in some instances the primary fluid to be used may be alcohol, acetone, chlor-organic compounds, organic hydrocarbon compounds, inorganic compounds, etc. And as high boiling point fluid, I may employ available high boiling point substances of stable character such as diphenyl oxide, most usually, and in some instances also pyrene or stable hydrocarbons, inorganic substances as mercury, aluminum bromide, tin bromide, etc.

Other modes of applying the principle of the invention may be employed, change being made as regards the details disclosed, provided the step 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 a method of evaporating a low boiling liquid in one pass under presure, the steps which consist in evaporating a substantial portion of said liquid with hot products of combustion, passing the fluid products of said evaporating step in temperature balancing heat transfer relation with a heated fluid of higher boiling point, and then subjecting the so generated vapor of the low boiling point liquid to heat from a furnace.

2. In a method of one-pass evaporation of water under pressure, the steps which con-

sist in evaporating a substantial portion of said water by means of heat from a hot fluid, subjecting the so heated fluid products of said evaporation step to a temperature balancing heat transfer with another heated fluid of higher boiling point than water, and then further heating the so generated steam.

3. In a method of evaporating water under pressure in one pass, the steps which consist in evaporating a substantial portion of said water by means of hot products of combustion, subjecting the so produced steam to temperature balancing heat transfer with hot diphenyl oxide, and then further heating the steam by furnace heat.

4. In a method of one-pass rapid evaporation of water under pressure, the steps which consist in evaporating a substantial portion of said water by means of hot products of combustion, subjecting the so produced steam to a temperature balancing heat transfer with a heated fluid of higher boiling point than water, and then further heating the so generated steam with hot products of combustion.

5. In a method of one-pass evaporation of water under high pressure, the steps which consist in initially supplying heat from hot products of combustion to evaporate at least a major portion of said water, subjecting the so produced fluid products of said evaporation step to a reversible heat flow temperature balancing heat transfer with a heated fluid of higher boiling point to insure completion of evaporation of the water and its delivery at relatively uniform temperature, and subsequently supplying a further amount of heat to said steam to superheat same.

Signed by me this 2nd day of Aug., 1927.

JOHN J. GREBE.