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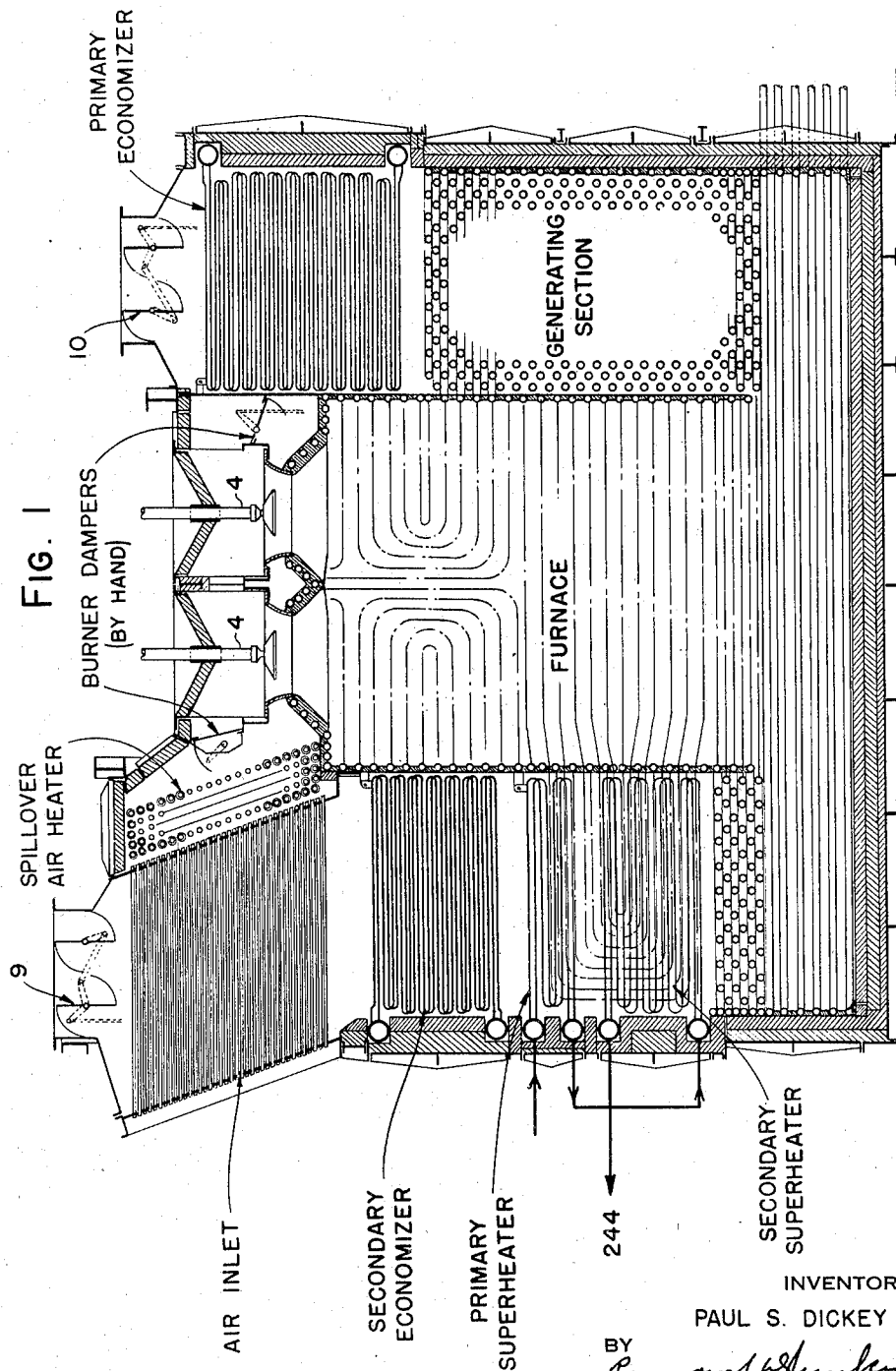
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2,471,728

CONTROL SYSTEM

Original Filed July 24, 1940

2 Sheets-Sheet 1



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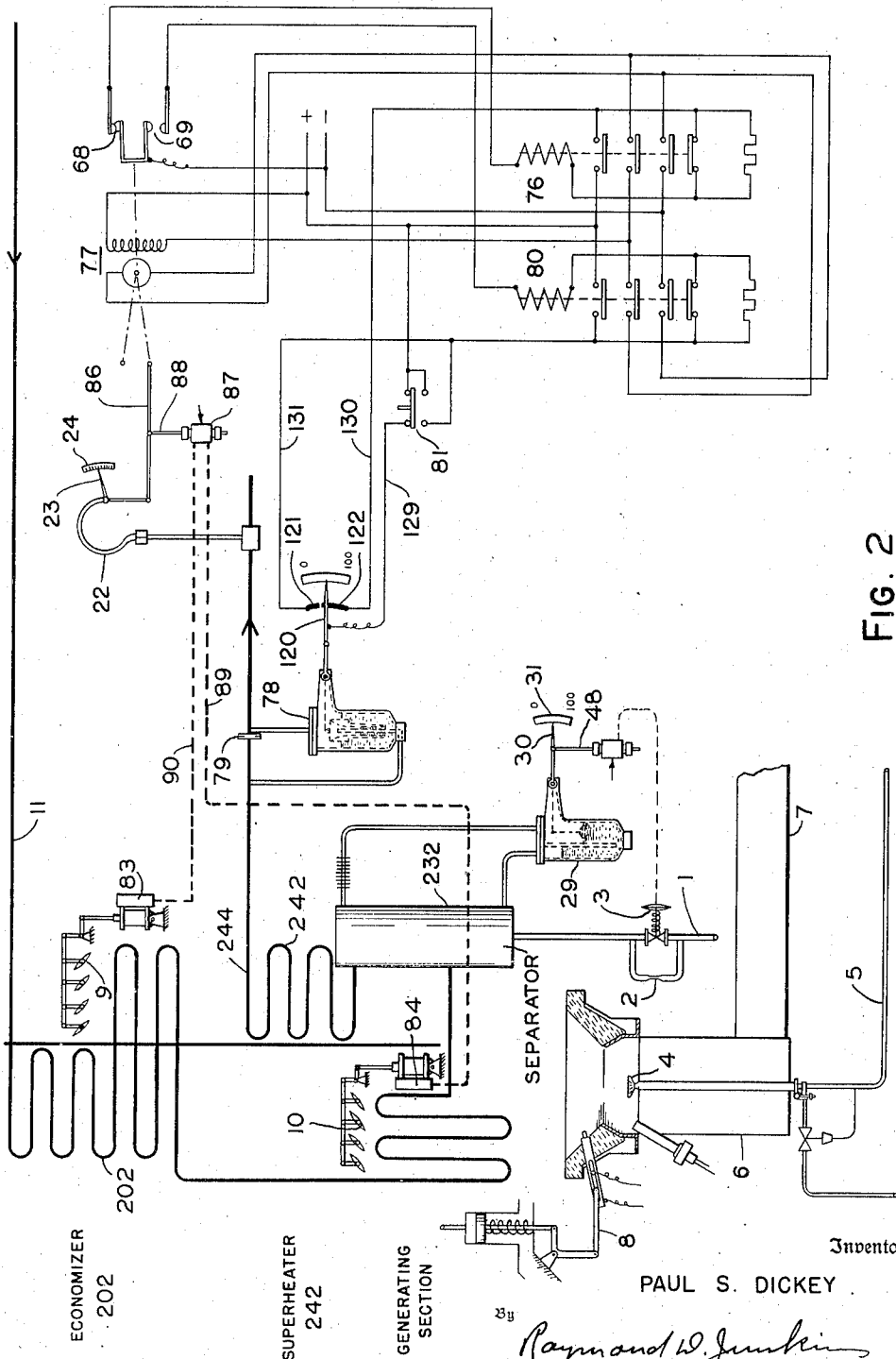


FIG. 2

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2,471,728

CONTROL SYSTEM

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347,191. Divided and this application June 27,
1942, Serial No. 448,829

3 Claims. (Cl. 122-480)

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This invention relates to method and means for operating and controlling the operation of vapor generators; particularly vapor generators of the drumless, forced flow type, having a fluid flow path including one or more long small-bore tubes, in which the flow in the path is initiated by the entrance of liquid under pressure at one end, and the exit of vapor only at the other end; characterized by an inflow of liquid normally greater than the outflow of vapor, the difference being diverted from the path intermediate the ends thereof.

Such a vapor generator having small liquid storage and operated with wide range combustion devices forms a combination rendering practical extremely high heat release rates with the consequent ability to economically handle practically instantaneous load changes from minimum to maximum, and vice versa, without heavy standby expense, and is particularly suitable for operating conditions such as marine service, where load variations are of a wide range and are required to be met substantially instantaneously.

The generator has a minimum liquid storage capacity with a maximum heat absorbing surface so disposed and arranged as to be substantially instantaneously responsive to rapid changes and wide diversities in heat release rate in the furnace. The heat absorbing surface is arranged in relation to the path of the products of combustion and radiant heating so that the entering liquid is received at the cooler end of the path. Further, the vapor generator insofar as the passage of combustion gases is concerned has a continuously increasing resistance to gas flow throughout the length of the passageway.

The heat absorbing surface, or flow path for the working medium, is comprised of one or more long small-bore tubes with an enlargement, preferably at the end of the generating section, which acts as a separator to divide liquid and vapor. The vapor is then passed through a superheater, while the excess liquid carried through the tubes for the purpose of wetness and preventing scale deposit, is diverted out of the separator under regulated conditions, as will be hereinafter set forth. From the separator there is a normal continuous and an additional regulated spillover or diversion of a part of the liquid entering the economizer under pressure, so that there is always being fed to and through the economizer and vapor generating sections more liquid than can be converted into vapor in a single passage there-through, although the proportion of such excess liquid may represent but a small part of the total

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volume of fluid passing through the vapor generator and is at most times only sufficient to insure tube wetness and to carry off scale forming material. The generating and superheating sections are desirably arranged in separate flow paths for the combustion gases, and dampers arranged in these paths are actuated by means responsive to the discharge steam temperature for maintaining predetermined temperature standards.

An object of the invention is to provide an automatic control of the superheated steam temperature going to the steam utilizing apparatus and in particular to provide a system wherein the temperature control standard for the superheated steam is automatically changed when conditions warrant or demand a different standard of temperature for safe and efficient operation.

Another object is to provide for a vapor generator a control system operating to control the flow of combustion gases in parallel paths over generating and superheating sections so as to maintain predetermined temperature standards.

Further objects will become evident from a study of the specification and of the drawings, in which:

Fig. 1 is a sectional elevation of a vapor generator having my invention incorporated therein.

Fig. 2 is a schematic diagram of the vapor generator of Fig. 1 with a control system operating to maintain temperatures of the discharged vapor at values corresponding to predetermined load demands.

In the various drawings, identical parts bear the same reference numerals.

The drumless forced flow vapor generator of the type to which the present invention may preferably be applied is diagrammatically illustrated in Fig. 1 to indicate the arrangement of heat absorbing surfaces in separate flow paths for combustion gases, and the control of gas flow through the paths by dampers, as will be described shortly.

The flow circuits comprising the vapor generating surface tangentially enter a bulge in the fluid flow path, which is in the form of a separating chamber 232 for dividing the fluid into liquid and vapor; the vapor passing to a superheater 242, and the excess liquid being diverted from the fluid flow path through a pipe 1 to the hot well or to waste. This excess liquid may pass through heat exchangers, if desired. A normal continuous spillover occurs through the restriction 2, while a variable spillover occurs through the regulating valve 3.

The "heat source" (Fig. 2) includes an oil

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burner 4 supplied by a pipe 5, and an air chamber 6 supplied by a conduit 7. Initial ignition of the oil firing means is accomplished through the agency of an igniter means 8, which is disclosed and claimed in the Patent 2,261,458 issued to Ervin G. Bailey and Paul S. Dickey. The electrical control system and mechanism for actuating and controlling such ignition means is also disclosed and claimed in said patent.

Fig. 1 is a longitudinal sectional elevation of the vapor generator having my improved controls associated therewith, and on this figure are indicated the relative locations of the burners, furnace, and heat absorbing surfaces. It is not believed necessary, in this application, to go into detail as to the construction and arrangement of the vapor generator further than is shown in Figs. 1 and 2, since the structure as shown is sufficient for a clear understanding of my invention. I have indicated on Fig. 1 by name the various portions of the unit in sufficient detail to allow an understanding of the general arrangement. In particular, attention is directed to what I term the superheat dampers 9 and the generator dampers 10. Further and more detailed reference will be made to these dampers and to their control throughout the specification and claims. Suffice it to say here that a positioning of the damper 9 controls the passage of hot products of combustion through the superheaters, while a positioning of the dampers 10 controls the passage of hot gaseous products of combustion through a major portion of the generating surface and economizer surface. Thus, by a regulation of the two sets of dampers, the products of combustion or the heating may be shifted more or less from or to the superheating surface for a control of the final superheated steam temperature leaving the generator to the point of usage.

Referring now in particular to Fig. 2, I illustrate the fluid flow path as a single sinuous tube, to the economizer section 202 of which, liquid is supplied under pressure through a conduit 11 from a pump, not shown, which may be of any suitable type. From the economizer section the fluid passes to and through the generating section discharging into the separator 232. From the separator, vapor passes to and through the superheater 242, leaving by the conduit 244. Products of combustion pass successively through the generating section comprising the furnace wall, superheater, and economizer and may contact a part or all of the separator. In the embodiment illustrated in Fig. 1 of course a portion of the products of combustion may not contact the superheater but may pass over a second portion of the generating surface and over the economizer surface.

29 represents means responsive to liquid level within the separator 232 and constitutes a pressure casing enclosing a mercury U-tube connected across the vertical elevation of the separator. A float is adapted to rise and fall with the surface of the mercury in one leg and to thus cause a positioning of a pointer 30 relative to an index 31 to advise the instantaneous value of liquid level within the separator.

The liquid level responsive device 29 further controls, through a pilot stem 48, the positioning of the variable spillover valve 3 in such manner that upon a rise in liquid level within the separator 232 above a predetermined elevation there will be a regulated opening of the valve 3 to supplement the normal continuous spillover 2 to the pipe 1.

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Referring now to Fig. 2, I illustrate a temperature control system for the boiler of Fig. 1. Herein I show the superheat dampers 9 and the generator dampers 10 separately positioned by pneumatic actuators 83, 84 respectively. A Bourdon tube 22, forming part of the temperature system, is sensitive to the total steam temperature leaving the superheater 242 and passing through the conduit 244, and indicates by means of a pointer 23 relative to the index 24 the value of a total steam temperature. Freely suspended from the movable end of the Bourdon tube 22 is a link 85 carrying at its free end one end of a floating link 86, the other end of which is positioned by a motor 77 to one or the other of two extremes of travel representing different temperature standards. Suspended intermediate the ends of the floating beam 86 is a pilot stem 88 positioned relative to a pilot casing 87, adapted to establish air loading pressures effective upon the pneumatic actuators 83, 84.

The arrangement is such that as the pilot stem 88 moves downwardly the loading pressure in the pipe 89 gradually decreases, while the loading pressure within the pipe 90 gradually increases. Conversely should the pilot stem 88 move upwardly, then the loading pressure in the pipe 89 gradually increases, while that within the pipe 90 will gradually decrease.

The arrangement of the control mechanism and of the dampers 9, 10 is such that as one set of dampers tends to close the other tends to open, and vice versa. This arrangement provides that if the superheat temperature is above the desired value the superheat dampers 9 will tend to close, while the generator dampers 10 will tend to open, thus sending a greater proportion of the hot gaseous products of combustion through the generator and economizer portions of the flow path and away from the superheater portion.

Inasmuch as the Bourdon tube 22 vertically positions the pilot stem 88 relative to a substantially fixed right-hand end of the beam 86, it will be apparent that if said fixed pivot for the beam 86 is moved to a new location by the motor 77, then a given position of the stem 88 will be accomplished only at a new Bourdon tube position. Thus the motor 77 positions the right-hand end of the floating link 86 to one of two possible positions corresponding respectively to a desired total steam temperature standard.

A rate of flow meter 78, measuring the total steam outflow from the vapor generator positions a contact member 120 relative to two contact segments 121, 122. The contact segments 121, 122 are so arranged that they are separated from each other by insulating material and may not be contacted simultaneously by the arm 120.

Throughout any predetermined portion of the total load range of the vapor generator the contact arm 120 will be in engagement with the contact segment 121 and throughout another portion of the load range the contact arm 120 will be in engagement with the contact segment 122. Such closure of contact acts to change the temperature standard of the pilot valve assembly 88, 87 through the agency of the motor 77. In other words, the steam temperature control dampers 9, 10 are jointly positioned through the agency of the pilot stem 88 to maintain one or the other of two predetermined temperature standards corresponding to definite ranges of load on the vapor generator. In this particular embodiment the load on the vapor generator is,

of course, represented by the total steam out-flow rate passing the orifice 79.

The location and extent of the contact segments 121, 122, as well as the adjustments provided in connection with the motor 77, provide that a predetermined superheat or other temperature of the vapor outflow will be maintained throughout a desired portion of the load range and another standard will be maintained throughout a second portion of the load range.

The segment 121 is adapted to be connected through the winding of a relay 80 and a limiting switch 69 to one side of a power line, while the segment 122 is adapted to be connected through the winding of a relay 76 and a limiting switch 68 to the same side of the power line. The segments 121 and 122 are both adapted to be connected by the contactor 120 and a push button 81 to the other side of the power line. When the contactor 120 is first moved into engagement with the segment 122, a circuit is completed from the power line through the push button 81, the contactor 120, the segment 122, the winding of the relay 76, and the limiting switch 68 to the power line again. The relay 76 then operates to energize the motor 77 so that it rotates in one direction and eventually effects an opening of the limiting switch 68 and a closing of the switch 69. The circuit through the relay winding 76 is then broken, and the relay operates to open the motor circuit. If the contactor 120 then moves into engagement with the segment 121, a circuit is completed from the power line through the push button 81, the contactor 120, the segment 121, the winding of the relay 80, and the limiting switch 69 to the power line again. The relay 80 then operates to energize the motor for rotation in the opposite direction until it opens the limiting switch 69 and closes the switch 68. The push button 81 is arranged to close a circuit by-passing the contactor 120 and the segment 121 so that the motor may be caused to operate and establish the same temperature standard that would be obtained when the contactor 120 engaged the segment 121.

Since the contactor 120 is positioned by the meter 78 in response to the rate of steam flow in the conduit 244, it will be appreciated that the dampers 9 and 10 will be positioned to maintain steam temperature standards varying with the rate of steam flow.

It will be appreciated that there may be many modifications and arrangements possible of the illustrative example given herein, without departing from the spirit of my invention, and that I have illustrated and described only a preferred embodiment without intending it to be limiting.

This application constitutes a division of my application, Serial No. 347,191, filed July 24, 1940, entitled Control systems, now Patent 2,292,023, dated August 4, 1942.

What I claim as new, and desire to secure by Letters Patent of the United States, is:

1. In a vapor generator having generating and superheating portions lying in parallel paths conducting heated gases, in combination, dampers arranged in said paths so as to proportion the flow of heated gases therethrough, fluid actuated

means for positioning said dampers, valve means for controlling the supply of pressure fluid to said fluid actuated means, means including an elongated member connected between its ends to said valve means for controlling the latter, means sensitive to the temperature of the vapor leaving the superheater and operatively connected to one end of said elongated member, a reversible motor connected to the other end of said elongated member for moving the latter to different positions, and means for energizing said motor to run for a predetermined period of time in one direction or the other on a predetermined change in the load conditions on the generator.

2. In a vapor generator having generating and superheating portions lying in parallel paths conducting heated gases, in combination, dampers arranged in said paths so as to proportion the flow of heated gases therethrough, fluid actuated means for positioning said dampers, valve means for controlling the supply of pressure fluid to said fluid actuated means, means including an elongated member connected between its ends to said valve means for controlling the latter, a reversible motor connected to one end of said member, means for energizing said motor to run for a predetermined period of time in one direction or the other to move the end of said member to a predetermined position and establish a temperature standard, and means responsive to the temperature of the vapor leaving the generator and connected to the other end of said member for maintaining the temperature standard established by said motor.

3. The structure of claim 2 in which said motor energizing means comprises relays for controlling motor circuits effecting operation of said motor in one direction or the other when energized, limiting switches operatively connected to said motor, means for connecting said limiting switches and said relays in separate circuits from one side of a power source to separate contact members, and means for connecting the other side of the power source to said contact members in response to the rate of output of the vapor generator.

PAUL S. DICKEY.

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