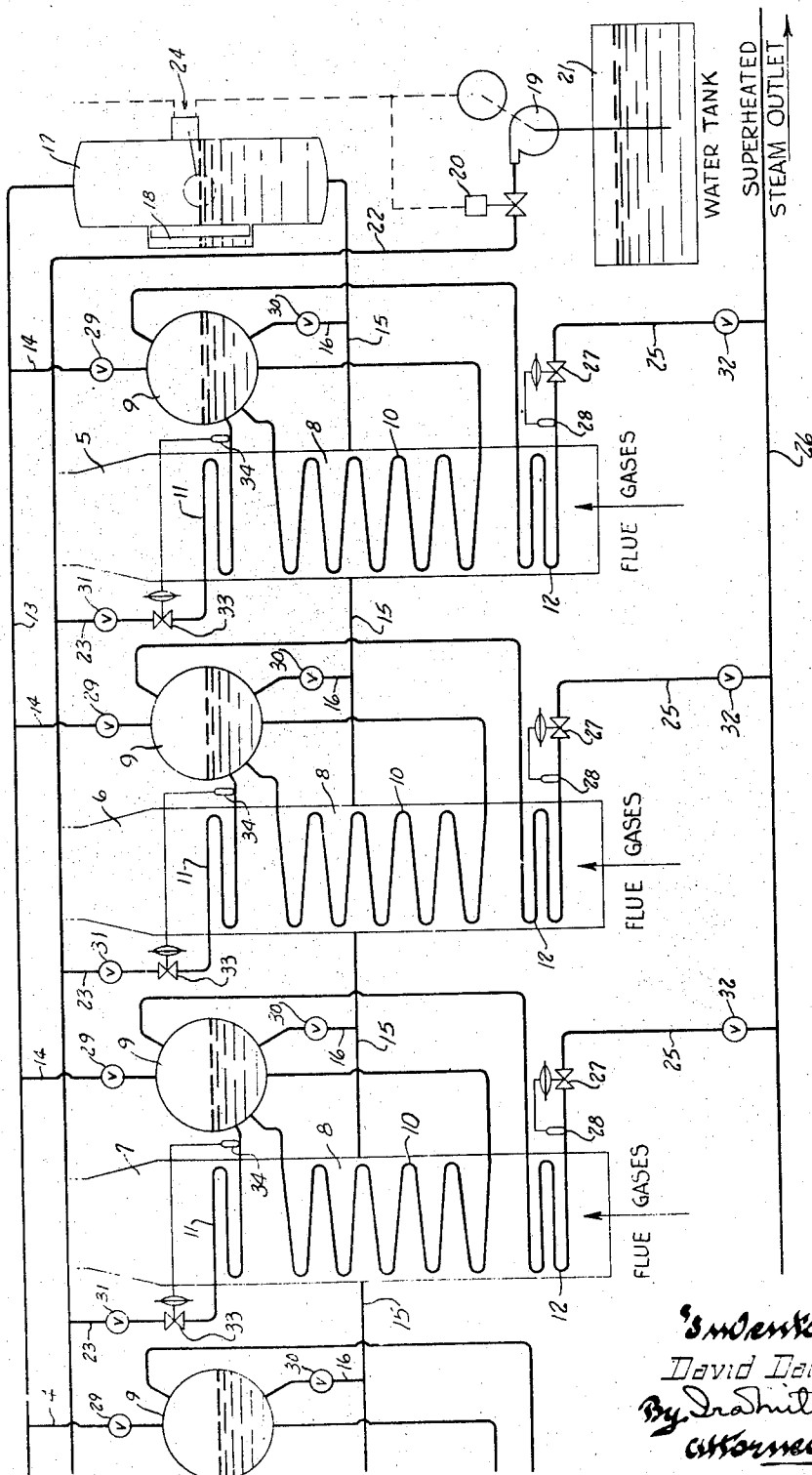


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STEAM GENERATING PLANT UTILIZING HEAT
EMANATING FROM MANY DIFFERENT SOURCES
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STEAM GENERATING PLANT UTILIZING HEAT EMANATING FROM MANY DIFFER- ENT SOURCES

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This invention relates to steam generating plants and has as its purpose to utilize the heat which is often available at many different places in an industrial plant, as for instance the otherwise wasted heat emanating from the many furnaces of a forge plant. The broad objective of this invention thus is the same as that of Patent No. 2,404,792 issued July 30, 1946, to David Dalin.

As brought out in that patent, in the operation of many industrial plants much heat in the form of exhaust flue gases, radiation, and so forth, goes to waste, but since these various heat sources often are scattered throughout the entire plant the utilization thereof prior to the invention of the aforesaid patent was economically unsound. The patented system utilizes this otherwise wasted heat by providing steam generating tubes at each heat source and connecting all of these steam generators with a common steam drum. This arrangement has proved to be entirely satisfactory but has one serious drawback. Its individual steam generators or boilers which make up the system are of the forced circulation type, and since all of them are connected with a common steam drum the matter of effecting circulation of the boiler fluid between the one drum and all the separate boilers presents a rather costly proposition both from the standpoint of piping required and energy expended to effect the needed circulation.

The present invention has as its purpose to eliminate these losses and to simplify the utilization of waste heat emanating from a plurality of sources though it is to be understood that the invention is not limited to the use of waste heat but is equally useful where the boilers are direct fired or have provision for auxiliary firing. To this end the present invention contemplates the use of natural circulation type boilers located at the various heat sources and the provision of a novel manner of satisfactorily operating all of the boilers from a common central control station despite the fact that they are of the natural circulation type. This objective, as will appear more fully hereinafter, is achieved by providing each of the boilers with a steam drum, disposing all of the steam drums at the same level and connecting all of them in such a way that all of the boilers will seek the same water level and providing for a centrally located means for injecting feed water into the entire system whenever necessary.

Another important consideration is that if the heat at the various sources is to be fully utilized, superheating of the steam is indicated. In the system of the aforesaid patent this meant connecting the one central drum to each of the many superheaters located at the various heat sources. The additional piping, to say nothing of the energy required in sending the steam from the drum to the various superheaters, represented a substantial cost which this invention obviates. To this end each of the several boilers which make up the total system has its own superheater connected in the usual manner with its own steam drum but all of the superheaters discharge into a common superheated steam line or main.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described, and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

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The accompanying drawing illustrates a complete example of the physical embodiment of the invention constructed in accordance with the best mode so far devised for the practical application of the principles thereof, and in which the single figure diagrammatically illustrates one adaptation of this invention.

Referring now particularly to the accompanying drawing, the numerals 5, 6 and 7 indicate three of any number of separate heat sources and which in this case are illustrated merely as flue gas passages through which hot flue gases flow. It is understood that these gases may derive their heat from any source and that it may be waste heat emanating from some operation in an industrial plant, as for instance the furnaces of a forge plant. The important consideration from the standpoint of this invention is that these heat sources are entirely independent of one another.

Associated with each flue gas duct is a steam boiler 8. While the specific design of these boilers may differ, for the purposes of this invention each must be of the natural circulation type and each must have a steam drum 9 with which the steam generating tubes 10 of the boiler are connected in a manner to effect natural circulation of the boiler fluid therethrough. Each boiler also preferably has an economizer 11 for preheating the feed water fed to the boiler and a steam superheater 12 connected with the steam drum in the customary manner to superheat the steam delivered by the boiler.

The various boilers, of which there may be as many as there are heat sources to be utilized, are mounted with all of the steam drums at substantially the same level. This fact, together with direct intercommunication between all of the steam drums above and below their water levels enables all of the boilers to seek a common water level. To this end an interconnecting line 13 is connected through branches 14 with each steam drum above the water level therein and a second interconnecting line 15 is connected through branches 16 with all of the drums below the water level, and the two interconnecting lines 13 and 15 are connected through an equalizing tank 17.

The equalizing tank 17 is mounted at substantially the same elevation as the steam drums so that the water level therein is the same as in the various drums. Consequently, the level of the water in the equalizing tank is an accurate measure of the water level in all of the boilers and to facilitate an indication thereof the equalizing tank is equipped with the customary water gage 18. Since the equalizing tank 17 and its water gage 18 form no part of any one of the boilers it follows that these control elements may be located at any convenient central observation station.

Whenever the water level in the equalizing tank, and hence in all of the boilers, drops to the point where feed water must be admitted into the system, a motor driven feed water pump 19 is started and a solenoid valve 20 is opened to allow feed water to be pumped from a suitable supply tank 21 into a feed water main 22 which connects through branches 23 with the economizers 11 of all of the boilers. The motor for the feed water pump 19 and the solenoid 20 are under the control of a float controlled switch mechanism indicated generally by the numeral 24.

The superheaters 12 all deliver through branch ducts 25 into a superheated steam line or main 26 which leads to any desired point of use of the steam delivered by the plant and, as will be readily apparent to those skilled in the art, it is of no consequence whether the plant delivers low or high pressure steam. A degree of balance between the heat available at any particular boiler unit and the heat abstracted by its superheater is maintained by automatically regulating the flow through the superheater in accordance with the temperature of the steam leaving it. Thus, an automatic valve 27 is connected in the outlet of the superheater and controlled by a temperature responsive regulator having its sensitive element 28 located at the outlet from the superheater.

To enable any one boiler unit to be disconnected from the system, shutoff valves 29 and 30 are connected respectively in the branches 14 and 16; shutoff valves 31

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are connected in the branch lines 23 leading to the economizers, and shutoff valves 32 are connected in the branch lines 25 leading from the superheaters.

While it is preferable to provide the equalizing tank 17, it can be omitted and instead observation can be made of one of the boilers itself. In this case the customary water gage on the steam drum of the selected boiler would suffice to afford visual indication of the water level in all of the boilers.

Since it is quite probable that the heating capacities, that is, the amount of flue gas flowing through the various boilers or its temperature, may vary from time to time and be different at the several boilers, it is important to provide some means for coordinating the amount of feed water supplied to the boilers with their respective heat transfers. This can be done by means of any of the well known water level responsive controls, one being provided for each steam drum. In addition, throttle valves 33 may be provided in the feed lines 23 leading to the individual economizers and controlled from the temperature of the feed water leaving the economizer as by thermostats having their sensitive elements 34 positioned in juxtaposition to the outlets of the economizers.

It is, of course, also to be understood that all of the economizers need not be fed at the same time, in fact, it is quite likely that in the operation of a plant of this type having many boilers, the feed water demands of the various boilers may seldom be simultaneous, but regardless of how this demand may vary between the various boilers, all will always have the required water level.

From the foregoing description taken in connection with the accompanying drawing, it will be readily apparent to those skilled in the art that this invention provides a steam generating plant especially well adapted to the utilization of waste heat emanating from a large number of widely scattered heat sources and that the system has the advantage of being exceptionally economical to install and operate.

What I claim as my invention is:

1. A steam generating plant wherein steam is generated from heat available at a plurality of widely separated heat sources, comprising: a plurality of independently operating individual boilers of the natural circulation type, each located at a different one of the heat sources and arranged to utilize the heat thereat, each of said individual boilers having a steam drum and tubes positioned to abstract heat from the heat source and connected with the drum for natural circulation of boiler fluid therethrough; means mounting the boilers with the steam drums of all of them at substantially the same level; means for delivering feed water to each boiler at a rate governed by the heat abstracted at the respective boiler and independent of the feed water requirements of the other boilers; means for withdrawing steam from each boiler at a rate governed by the heat abstracted at the boiler and independent of the rate at which steam is withdrawn from the other boilers; duct means interconnecting all of the steam drums above their water levels; and duct means interconnecting all of the steam drums below their water levels, both of said duct means being entirely independent of the circulating systems of the boilers and of the means for delivering feed water to the boilers, so that all of the boilers seek the same water level.

2. A steam generating plant wherein steam is generated from heat which is ordinarily wasted at a plurality of widely separated heat sources, comprising: a plurality of independently operating individual boilers of the natural circulation type, each located at a different one of the heat sources and arranged to utilize the waste heat thereat, each of said individual boilers having a steam drum and tubes positioned to abstract the otherwise wasted heat and connected with the drum for natural circulation of boiler fluid therethrough; means mounting the boilers with the steam drums of all of them at substantially the same level; an economizer for each boiler connected with its respective steam drum to supply preheated water thereto; a water feed line connected with all of the economizers and through which water may be supplied to all of the boilers; a throttling valve in the connection between each of the economizers and the water feed line; a thermostatically responsive control operatively connected with each throttling valve and hav-

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ing its temperature sensing element at the outlet of the economizer for controlling the throttling valve to thereby coordinate the amount of feed water supplied to each boiler through its economizer with its heating capacity as manifested by the heat which has been transferred to the fluid circulated through its economizer; means, including thermostatically controlled throttling valve means, for withdrawing steam from each boiler at a rate governed by the heat abstracted at the boiler and independent of the rate at which steam is withdrawn from the other boilers; duct means interconnecting all of the steam drums above their water levels; and duct means interconnecting all of the steam drums below their water levels; both of said duct means being entirely independent of the circulating systems of the individual boilers and the feed water line so that all of the boilers seek the same water level.

3. The steam generating plant of claim 2 further characterized by a feed water pump having its outlet connected to the inlet of said water feed line; and further characterized by means responsive to the level of water in the steam drums for starting and stopping the pump.

4. A steam generating plant adapted to utilize waste heat emanating from a plurality of widely separated heat sources, comprising: a flue gas duct at each of said heat sources in which the waste heat is manifested in the form of hot flue gases flowing therethrough; a plurality of independently operating individual boilers of the natural circulation type, one for each of said flue gas ducts, each boiler having a steam drum outside the flue gas duct and heat abstracting tubes located within the duct and connected with their respective steam drum in a manner providing for natural circulation of boiler fluid therethrough; a steam superheater for each boiler mounted in its flue gas duct and connected with its steam drum to receive steam therefrom; a common steam line connected with the outlets of all of the steam superheaters; a valve for independently controlling the connection of each steam superheater with said common steam line; a temperature responsive regulator for each valve having a sensitive element positioned to be responsive to the temperature of the superheated steam leaving the superheater and connected with its respective valve to move the same toward closed position as the temperature of the steam leaving the superheater drops; means for supplying feed water from a common source thereof to each of said boilers individually at a rate substantially proportional to the rate at which heat is abstracted at the respective boiler; and duct means directly interconnecting all of the steam drums above and below their water levels, said duct means being independent of the circulatory systems of the boilers and of the means for supplying feed water to the boilers, so that all of the boilers seek the same water level.

5. The steam generating plant of claim 1 wherein the duct means interconnecting all of the steam drums includes an equalizing tank mounted at substantially the same level as the steam drums so that the water level therein is the same as that in the steam drums, whereby observation of the water level in the equalizing tank affords an indication of the level in all of the steam drums.

6. A steam generating plant, comprising: a plurality of separate gas passages through which hot gaseous fluid flows; a plurality of independently operating natural circulation type boilers, one for each of said gas passages, each of said boilers having a steam drum located outside its gas passage and steam producing tubes connected with the drum and disposed within the gas passage; means mounting the boilers with all of their steam drums at substantially the same level; duct means directly interconnecting all of the steam drums above their water levels; other duct means directly interconnecting all of the steam drums below their water levels so that all of the boilers seek a common water level; means for withdrawing steam from each of the boilers at a rate substantially proportional to the rate at which heat is abstracted from the gases at the boiler; a feed water source common to all of the boilers; and means connecting said feed water source with the interconnected boilers and through which feed water may be fed to the boilers individually at rates governed by the heat abstracted at the respective boiler.

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