April 26, 1938. N. C. ARTSAY 2,115,548

HEATING

Filed April 27, 1935 2 Sheets-Sheet 1

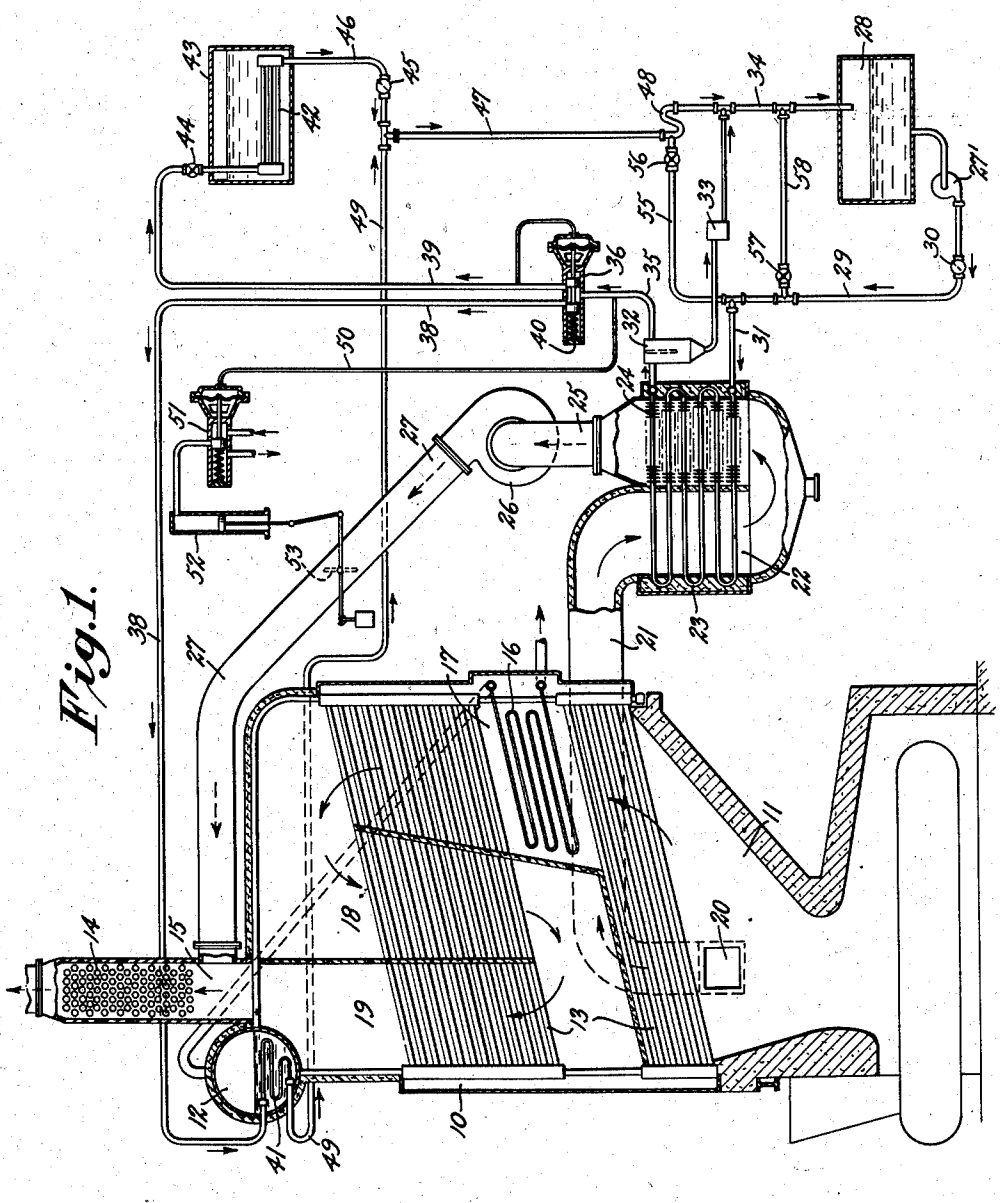


Fig. 1.

INVENTOR.
NICHOLAS C. ARTSAY

BY
William G. McKnight
ATTORNEY.

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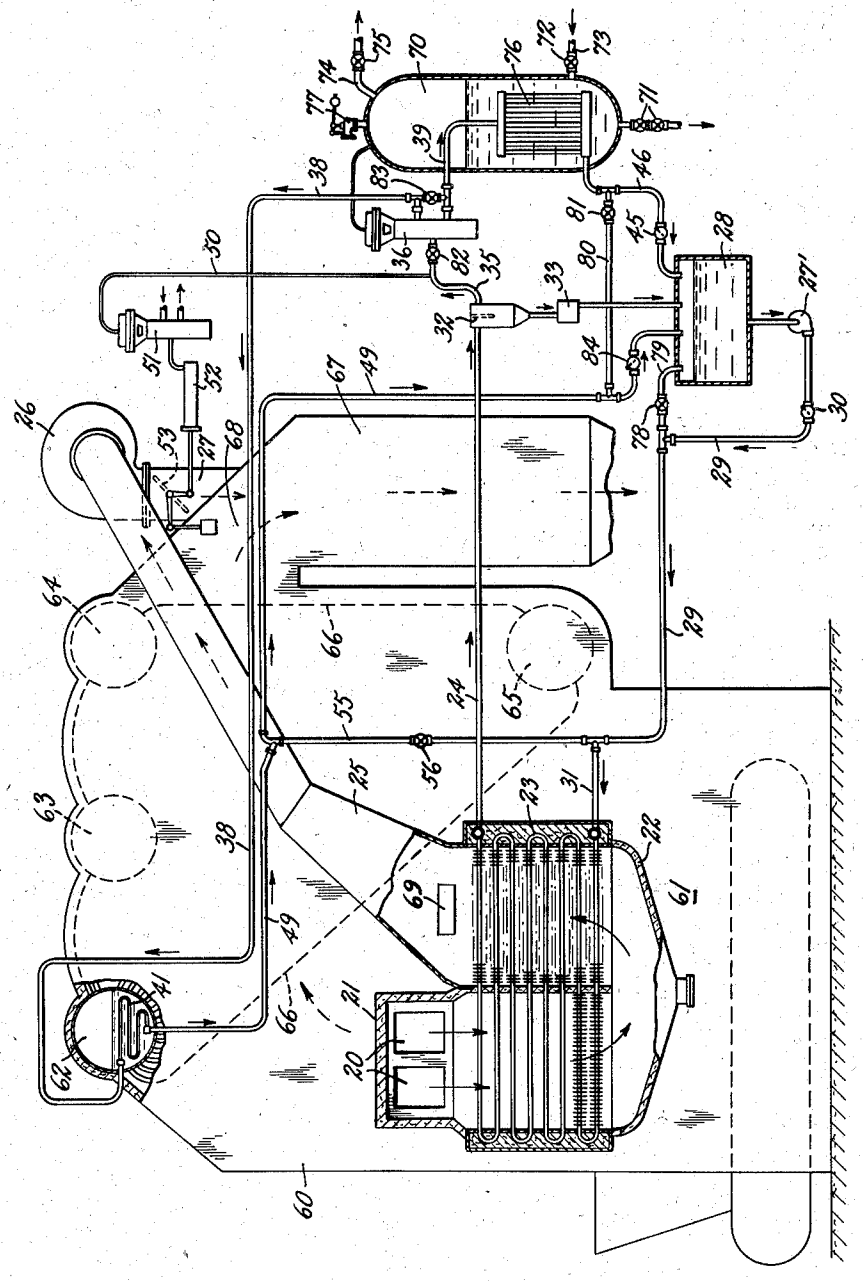


Fig. 2.

INVENTOR.
NICHOLAS C. ARTSAY

BY

William G. McKnight

ATTORNEY.

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HEATING

Nicholas C. Artsay, Valhalla, N. Y., assignor to Foster Wheeler Corporation, New York, N. Y., a corporation of New York

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4 Claims. (Cl. 122—33)

This invention relates to heating processes and apparatus.

In many industrial plants, especially chemical plants, there is a need for heating processes in the range of 500° to 700° F. in which the temperature of heating elements must be constant and uniform throughout. This result, in the lower range of temperature, is usually attained by condensing steam. However, the higher temperature range involves steam pressures from 650 to 3000 lbs. per sq. in. which necessitates special boiler installations and large expense. To reduce the operating vapor pressures necessary, other fluids or materials such as the diphenyloxides, have been employed. In most cases, the high temperature range processes are of intermittent character and considerable inconvenience is experienced in starting up the special boiler after each shut down. Instead of employing special boilers for this purpose, it has been found more desirable to draw the needed amounts of heat from steam or other vapor produced by a boiler already on the line. There are several known methods of incorporating high pressure steaming elements in ordinary low pressure boilers and these arrangements throttle down the high pressure steam to the pressure in the mains when the higher pressures are not needed. This involves the installation of a high pressure feed pump and the contamination of the high pressure heating surfaces with the boiler feed water which may be satisfactory for the low pressure boiler but is undesirable for the high pressure elements. The high pressure feed pump can be eliminated, if desired, to make the circuit a closed circuit and return the condensate by gravity, however, the throttling of unneeded steam is then impossible so that another place of condensation must be provided. If this place of condensation is a coil in the boiler drum, the high pressure heating elements should be placed considerably above the boiler drum to provide for the gravity return of condensate. This involves great difficulties in a great majority of boiler designs and cannot be done at all with boilers already built. This consideration applies both to water steam and also to any other heat carrying fluid used in the system. A condensate pump can be installed which is located in a sufficiently low position to draw the liquid and return it to the heating elements, but if water is used as a fluid, the pump must be constructed to stand the high pressure and necessarily will be expensive. Moreover, the circulating means must always be operating so to insure the reliability of boiler operation and to comply with the boiler statutes, at least two circulating pumps will be required.

The present invention provides a novel heating method and apparatus which overcomes all these difficulties. In general, the arrangement includes a fluid heater placed outside an ordinary heater, such as a steam boiler, the fluid to be heated and vaporized being circulated by a pump through the tubes in one or more circuits. The fluid or other material to be heated may be any substance having a sufficiently high boiling point for the purpose desired. Such materials will include diphenyloxides, or a mixture of diphenyl and diphenyloxide, mercury, high boiling point oils, and concentrated solutions of certain salts. Part of the hot gases passing through the boiler or other heater is diverted into the fluid heater and after being cooled by giving up heat to the fluid, it is returned into a lower temperature zone of the boiler or its economizer or air heater. When the fluid is only partly vaporized in the heater, the arrangement preferably includes a separator which returns the liquid phase to the pump, and the vapor is conducted to the place of heat consumption. A distributing valve is employed to divert part of the vapor into cooling coils in the boiler drums whenever the vapor pressure in the heating system rises above the required value. The diverted vapor generates steam in the boiler so that the trouble of excess pressure when the vapor demand is reduced and losses through the safety valve are avoided.

In many cases there is a need for high pressure steam to be used in direct contact heating processes after which the steam is contaminated and the condensate made worthless for further use. The safe operation of a high pressure steaming element subject to hot gases requires the use of distilled water for feeding, which is often unavailable. For these cases, the arrangement embodying the invention may include a drum in which high pressure steam is generated by means of heating elements in which the heating vapor is condensed. This arrangement eliminates the danger of overheating or burning the high pressure tubes.

The heating process and apparatus of the invention and its novel features will be understood from the following description when considered in connection with the accompanying drawings, in which:

Fig. 1 is a more or less diagrammatic view in vertical section, of apparatus embodying the invention; and

Fig. 2 is a similar view showing another form of the invention.

Like reference characters refer to the same or similar parts in both views.

The invention will be described and illustrated in connection with steam boilers and with part of the products of combustion produced in the furnaces of the boilers being utilized to heat the fluid by means of which heat is supplied to the process or other desired points or zones. It will be understood however that the invention is not limited in its application to steam boilers but that it also may be utilized in connection with heaters in general or other sources of heat.

Referring to the form of invention shown in Fig. 1, reference character 10 designates a straight tube stoker fired boiler of conventional design. Any other boiler design may be employed, if desired. The boiler shown has a furnace 11, a steam and water drum 12, banks of boiler tubes 13 and an economizer 14 in a flue 15. A superheater 16 is located in the first of the three passes 17, 18 and 19. During operation of the boiler, part of the combustion gases are withdrawn from the furnace at 20 and are led through a refractory lined duct 21 into a two-pass fluid heater 22. It is understood that the gases may also be withdrawn from any other convenient high temperature zone of the boiler. The heater 22 has a heating coil 23 extending through both passes, and the tubes in the cooler second pass are fitted with extended surfaces 24. Obviously, the heater may have a single pass or more than two passes and the tubes of the heating coil may all be bare or may all be fitted with extended surfaces. After being drawn through the heater, the gases enter an outlet duct 25 and are delivered by a fan 26 into an outlet duct 27 which discharges into the flue 15 below the economizer. A circulating pump 27' takes the fluid to be heated in the liquid phase from a surge tank 28 and delivers it through pipe 29 having a check valve 30, and pipe 31 to heating coil 23. After being vaporized to the extent desired in coil 23, the fluid enters a vapor separator 32. The liquid phase thrown down in the separator 32, returns through a trap 33 and pipe 34 to the surge tank 28, while the separated vapor flows through pipe 35 into a distributing valve 36 having a piston 37 which controls the inlets to pipes 38 and 39, so that when the inlet to one of these pipes is closed the other is open. Valve 36 is controlled in response to the pressure of the fluid in pipe 39 and is normally urged in a position to close the inlet to pipe 38 by a spring 40. From the valve 36 the vapor may be led through pipe 38 to the condensing coil 41 placed in the boiler drum and/or to the process heating coils 42 shown as a bank of tubes heating a fluid in a tank 43 through pipe 39 and control valve 44. The process heating is controlled by the valve 44 and a check valve 45 in the fluid's condensate return pipe 46 which connects through pipe 47, loop seal 48 and pipe 34 with the surge tank. The fluid's condensate in the boiler drum coil 41 is returned also to the surge tank through pipe 49 which connects with pipe 47. The heater 22 produces an amount of fluid's vapor in proportion to the amount and temperature of the gases drawn through it. The boiler may be running at variable load and hence the amount of gases for a given amount of heat extraction will be variable also. The amount of heat extraction as manifested by the vapor pressure may be regulated in any known manner. In this instance, the vapor pressure impulse is transferred by the pipe 50 to a pressure responsive device 51 which controls the pneumatically actuated cylinder 52 which in turn operates and controls the damper 53 in duct 27. If desired, the pressure responsive device 51 or the like may be arranged to control the speed of the fan 26. For any given amount of heat extraction, the vapor pressure in the fluid circuit will depend on the proportion of vapor flowing into the coil 42 and the coil 41, the latter being surrounded by boiler water at a substantially lower temperature than that of the process fluid in the tank 43. For proper heating effect in the tank 43, the pressure of vapor in the pipe 39 before the process valve 45, is maintained constant by the distributing valve 36. Whenever vapor pressure in the pipe 39 decreases, the valve 36 reduces the flow into the coil 41 and increases the flow to the coil 42 and vice versa. Thus during the operation the vapor pressure in the coils 41 and 42 will be tending to be different, but substantially lower in the former. To make the control of distribution more effective, a slight over-pressure will be maintained before the distributing valve 36 by proper setting of the device. When the process valve 44 is open, the vapor pressure in the fluid condensate lines 46, 49, and 47 and the surge tank 28 will be equal to the pressure in the process coil 42 which means that the return of condensate from the coil 41 through the pipe 49 will be impeded and consequently the coil 41 will be flooded with condensate up to a certain level when the remaining vapor condensing surface of high heat transfer rate will be sufficiently small to give an undercooling to the condensate in the coil 41, and a reduced flow of vapor to maintain the vapor pressure and effect the return of condensate. When the process valve 44 is closed at the end of the process operation, the vapor pressure in pipe 39 will rise and the valve 36 will close the inlet to the pipe 39 and open more the inlet to the pipe 38 leading to the coil 41. This will result in the purging of the coil 41 and the restoration of the full heat transfer capacity by means of which all of the heat extracted from the boiler gases by the heater 22 will be utilized in generating steam in the drum 12. If the process is intermittent, with each action being followed by a relatively long pause, the fan 26 can be stopped. Due to the imperfect tightness of the damper 53, some of the gases will nevertheless pass the heater 22 and the vapor generated at such times will be condensed in the coil 41. Should it be desired to shut down the circulating pump 27', a by-pass 55 controlled by a valve 56 and which connects pipe 47 at loop seal 48 with pipe 31 provides a circuit of natural circulation for the fluid. Check valve 30 will prevent flow into the surge tank through the pump 27' when the pump is not operating.

Since most of the high boiling point substances which are suitable are solids at moderate room temperatures, when the boiler is shut down, the fluid is drained to the surge tank 28 from the heater, by opening the valve 57 in line 58 which connects pipes 29 and 34. In the surge tank, the substances can remain solid without inconvenience and can be melted when needed either by the higher boiler room temperature or by using a small steam coil around the tank 28.

In the form of the invention shown in Fig. 2, a boiler of the Stirling type is employed. This boiler is designated generally 60 and has a furnace 61, drums 62, 63, 64 and 65, which are connected by boiler tubes 66 in the usual manner.

The combustion gases after flowing over the boiler tubes, are delivered to an air heater 67 through a duct 68 and thence out to a flue or stack. High pressure steam, for instance at 1500 lbs. per sq. in., is generated in the drum 70 placed in a vertical position preferably. The drum is fitted with blow down valves 71 at the bottom to purge it from mud and concentrated solids in the feed water which enters through the valve 72 in pipe 73. The steam generated in the drum is taken out through pipe 74 controlled by a stop valve 75. Heat is supplied for vaporizing the water in the drum 70 by condensing the vapor of diphenyloxide or other suitable substance in a heating coil 76 disposed in the drum and connected with the vapor and condensate pipes. Due to the relatively low temperature inside the tubes of the coil 76, there is no danger in scale accumulation on their outer surface and consequently ordinary feed water can be supplied for high pressure steam generation. The degree of scale accumulation will be observable through the vapor pressure of the substance employed (or temperature difference) for a given high pressure steam output. The method of descaling these tubes will be hereinafter described.

The pump 27' circulates diphenyloxide or other substance through the heater 22 which is supplied by a controlled amount of furnace gas drawn through the heater by the fan 26, as hereinbefore described. The vapor and liquid mixture is passed through the separator 32 and the separated liquid is returned to the surge tank 28, while the vapor is led to the distributing valve 36. In this case, the distributing valve is responsive to and is regulated to maintain the desired pressure of steam in the drum 70. Whenever steam pressure in the drum changes, the valve 36 reduces or increases the flow of vapor in the tubes 76 and at the same time increases or decreases the flow into the coil 41 placed in the water of the boiler drum 62. The fan speed or damper regulator 51, 52 will maintain the pressure of vapor by changing the flow of gases through the heater 22.

The return of condensate from the coil 41 and heating element 76 is effected in substantially the same manner as described for the form shown in Fig. 1. To comply with the law, a safety valve 77 may be put on the high pressure drum 70 and also on the circuit of the heating substance (not shown). The natural circulation for such times as the high pressure steam is not needed, and both the fan 26 and the circulating pump 27' are shut down, is effected by opening the valve 56 in the by-pass pipe 55 which returns condensed vapor from the coil 41 and by loading the valve 36 with a deadweight to open the vapor circuit into the coil 41 and to close the circuit into heating element 76. If the latter were open, all the heating substance from the heater 22 would gradually be drained into the surge tank 28. The shortage of heating substance in the circuit in the condition of natural circulation will be manifested by too high a level in the surge tank 28 and a few seconds operation of pump 27' will serve to restore the shortage. The draining of the heating substance into the surge tank 28 during the long shut downs of the boiler is effected by the by-pass valve 78 in pipe 79. The check valve 30 on the pump discharge prevents the emptying of the heater 22 into the tank 28 when operating under natural circulation.

The descaling of the heating elements 76 may be effected in the following manner: When the high pressure steam is not needed, the pressure of steam in the drum is still maintained normal by the operation of valve 36. Fan 26 is shut down and damper 53 is closed while the auxiliary damper indicated 69 is opened. Next the valve 81 in line 80 is opened, valve 82 in line 35 is shut, and valve 83 in line 38 is opened. In these conditions the heating substance circuit will be divided into two parts: the first part including heater 22, tank 28 and separator 32 will be under higher vapor pressure than the other part which contains both heating elements 76 and 41. To preclude any untoward rise of vapor pressure in the isolated first part, cold air is admitted into the furnace through the damper 69 and the heater 22. The check valves 45 and 84, the closed valve 82 and the opened valve 83 define a natural circulation circuit comprising both the heating elements 76 and 41. Due to the high temperature difference between the drum 70 and the boiler drum where the coil 41 is immersed, there will be a quick transfer of heat from the water in drum 70 to the boiler water. Vapor in the tubes 76 will be boiling at a temperature very near to that at which it is condensing in the coil 41. By opening the valve 83 last and quickly, a substantial quick cooling of the tubes 76 from the inside will be effected which will be sufficient to break the scale sheath, which may be afterward removed by opening the blowdown valves 71. If there is a shortage of heating substance in the circuit, it may be restored by cracking valve 56 for a few seconds. In this manner the cleaning of the heating coils can be effected without opening the high pressure drum.

It will thus be perceived that I have provided a process and apparatus for carrying out the process, which effectively supplies desired quantities of heat to a heating zone at the desired temperature level. The process may be practiced in conjunction with ordinary forms or types of heaters, such as steam boilers or the like, without essentially altering their construction or operation. The process is efficient, since only such quantities of heat are withdrawn from the said heaters as are necessary for the requirements in the said heating zone and because any heat after being withdrawn and not utilized is recovered in the heater furnishing the heat initially.

Since changes may be made in the process and the several steps thereof and in the forms of apparatus and the several parts thereof which are disclosed herein, without transcending the principles of the invention, it will be understood that no intention is entertained to limit the invention except by the scope of the appended claims.

What I claim is:

1. Apparatus for supplying heat to a heater comprising a closed circuit for the circulation of a high boiling point heating fluid, said circuit having a portion thereof in said heater, a second heater in said circuit, a steam generator, means for withdrawing and conducting part of the products of combustion from a high temperature portion of the furnace of said generator to the second heater to heat the fluid flowing therethrough prior to its flow through the first heater, means for returning the withdrawn products of combustion to a low temperature portion of said generator after passage through the second heater, means for controlling the quantity of products of combustion withdrawn in response to the heating requirements of the first heater, means for by-passing heated fluid around the

first heater, means for controlling the by-pass in response to the heating requirements of the first heater, and means for recovering the heat from said by-passed fluid in the steam generator.

2. Apparatus for supplying heat to a heater from a steam generator at irregular intervals in variable amounts at a temperature level above that of the saturated steam produced in the generator, comprising means for passing a high boiling point heating fluid through a second heater, means for withdrawing a portion of the products of combustion from a high temperature portion of the generator and passing said portion through the second heater to heat the heating fluid to vaporization temperature, means for controlling the quantity of products of combustion so withdrawn from the generator in response to the heat requirements in the heater, means for separating the vaporized and unvaporized portions of the heating fluid, means for distributing the vaporized portion between the heater and a heat absorbing portion of the generator in such manner as to provide the required quantity of heat in the heater with excess heat being conducted to said heat absorbing portion of the generator, and means for circulating the unvaporized portion of the heating fluid through the second heater to absorb heat from the products of combustion passing therethrough at such times as heat is not required to be supplied to said heater.

3. Apparatus for supplying heat to a heater from a steam generator at irregular intervals in variable amounts at a temperature level above that of the saturated steam produced in the generator, comprising means for passing a high boiling point heating fluid through a second heater, means for withdrawing a portion of the products of combustion from a high temperature portion of the generator and passing said portion through the second heater to heat the heating fluid to vaporization temperature, means for controlling the quantity of products of combustion so withdrawn from the generator in response to the heat requirements in the heater, means for returning the products of combustion so withdrawn to a low temperature point in the generator in the path of flow of the products of combustion, means for separating the vaporized and unvaporized portions of the heating fluid, means for distributing the vaporized portion between the heater and a heat absorbing portion of the generator in such manner as to provide the required quantity of heat in the heater with excess heat being conducted to said heat absorbing portion of the generator, and means for circulating the unvaporized portion of the heating fluid through the second heater to absorb heat from the products of combustion passing therethrough at such times as heat is not required to be supplied to said heater.

4. Method of descaling tubular elements disposed in contact both interiorly and exteriorly with heated fluids under pressure and at least partially in the liquid phase, one of said fluids having scale forming constituents, which comprises quickly lowering the pressure upon the other of said fluids to cause partial evaporation of said fluid, thereby cooling said liquid and the tube surface in contact therewith, while maintaining the pressure and temperature of the other fluid substantially constant, to thereby break the bond between the scale and tubes to remove the scale from the tubes.

NICHOLAS C. ARTSAY.