Sept. 16, 1958 P. SPENCE 2,852,196

WATER HEATER

Filed Sept. 12, 1955 2 Sheets-Sheet 1

Fig. 1.

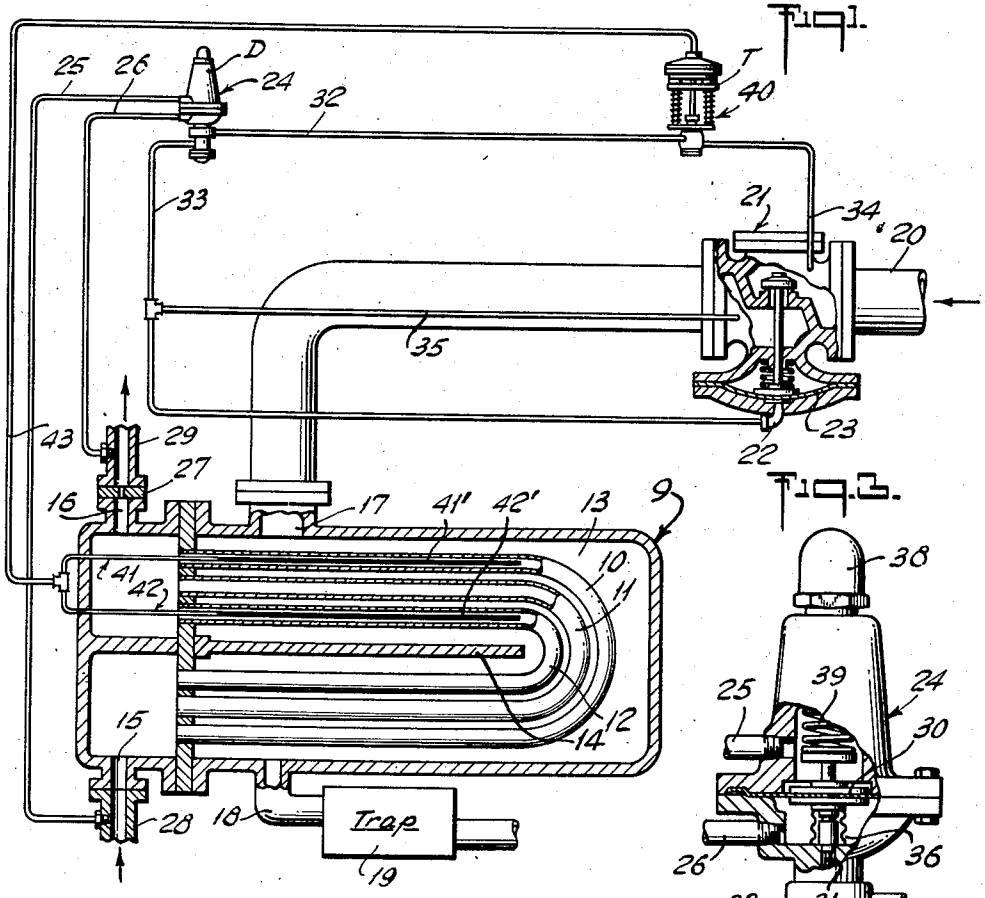


Fig. 2.

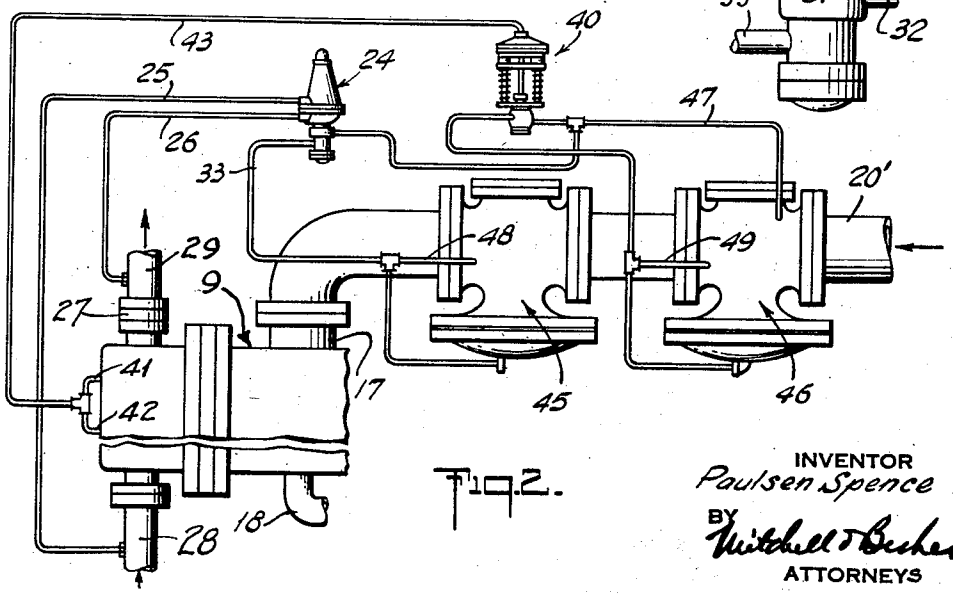


Fig. 2.

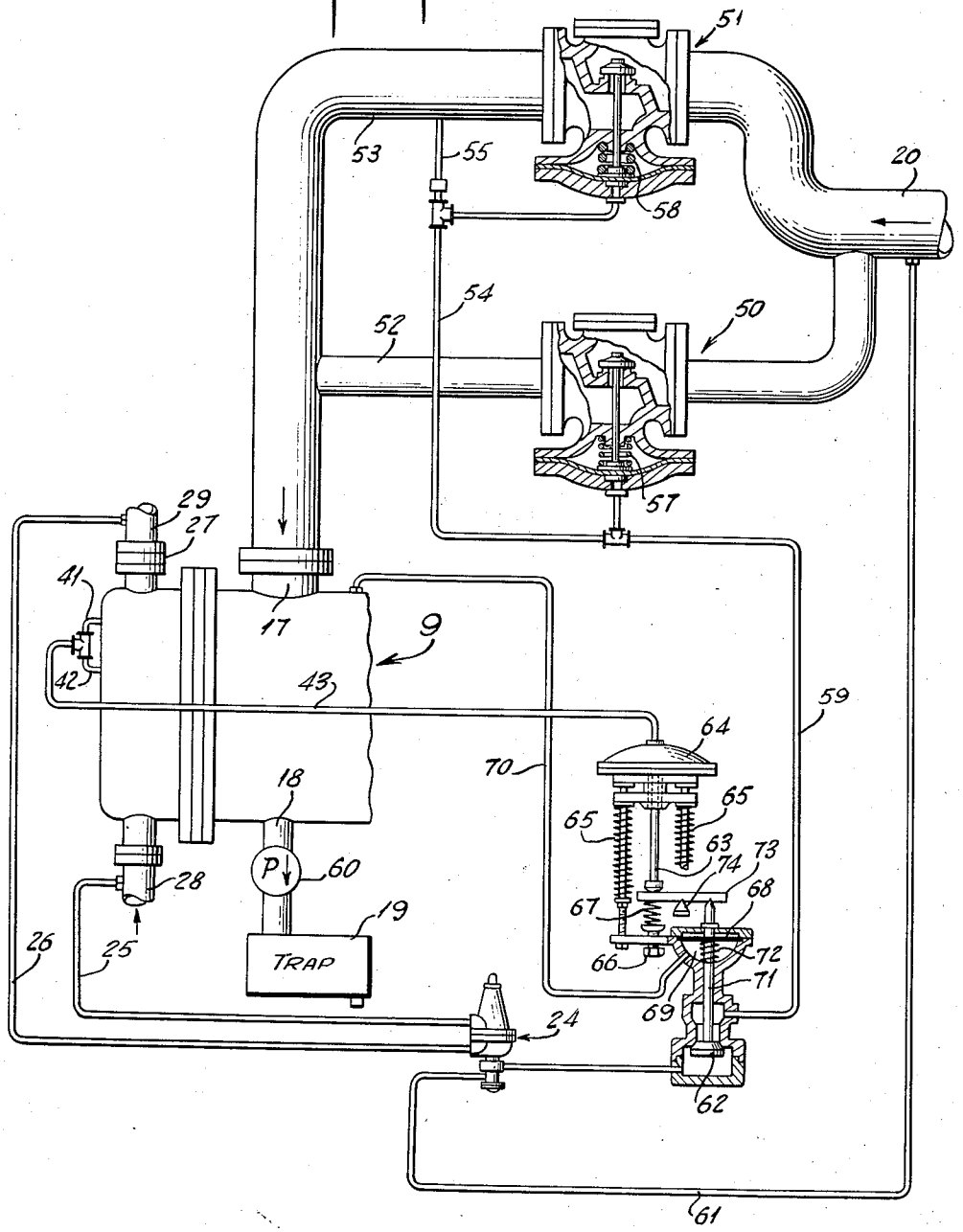
INVENTOR
Paulsen Spence
BY Mitchell & Bechert
ATTORNEYS

Sept. 16, 1958 P. SPENCE 2,852,196

WATER HEATER

Filed Sept. 12, 1955 2 Sheets-Sheet 2

Fig. 4.



INVENTOR
Paulsen Spence
BY Mitchell & Bedient
ATTORNEYS

United States Patent Office 2,852,196 Patented Sept. 16, 1958

2,852,196

WATER HEATER

Paulsen Spence, Baton Rouge, La.

Application September 12, 1955, Serial No. 533,599

7 Claims. (Cl. 236—23)

My invention relates to steam-control mechanism for fluid heaters, particularly so-called instantaneous hot-water heaters.

It is an object of the invention to provide improved mechanisms of the character indicated.

It is another object to provide an improved instantaneous hot-water heater wherein response to changes in flow, as in the case of intermittent demand, may be achieved with minimum loss in delivered temperature.

It is a general object to achieve the above objects with standardized components adaptable to existing heaters and in a manner providing utmost protection from the standpoint of a specified upper safety limit of temperature.

Other objects and various further features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification in conjunction with the accompanying drawings. In said drawings, which show, for illustrative purposes only, preferred forms of the invention:

Fig. 1 is a diagram schematically showing component parts of one embodiment of the invention;

Fig. 2 is a similar diagram to illustrate a modification;

Fig. 3 is an enlarged view in elevation and partly broken away to show one component of the arrangements of Figs. 1 and 2; and

Fig. 4 is a diagram illustrating another embodiment of the invention.

Briefly stated, my invention contemplates application to hot-water heaters of the so-called instantaneous type, wherein steam is supplied only as necessary to maintain a given delivered temperature. In the automatic controls for existing systems, prime reliance is had on delivered temperature (at the outlet of the heater) to control the admission of steam, and for the situation in which there is an intermittent demand it frequently occurs that a charge of cold water is delivered before the control system can respond to supply enough heating steam to bring the water up to temperature. With my invention, I substantially eliminate the time lag in the supply of heat to the heater for situations involving intermittent demand, and I achieve this result by making the admission of steam to the heater primarily dependent on the flow rate in the water-supply line, in which the heater is located. Thus, the prime control mechanism may include a differential pilot, responsive differentially to pressures observed at spaced locations along the water line, and the response to flow can be enhanced by the provision of a flow-metering orifice across which the differential pressure is observed.

As a further feature of the invention, I additionally provide a temperature control for the admission of steam, said temperature control being pre-set to reduce the flow of steam to the heater, in the event that the differential-pressure control causes the admission of too much steam. The temperature-responsive means preferably responds to an average water temperature within the heater and near the water outlet (or, rather, near the

location of steam admission in the heater), so that temperature-response lag in the control system may be reduced to a minimum. For heaters functioning at subatmospheric pressures, I provide means responsive to reduction in such subatmospheric pressure, to further enhance the delivery of steam to the heater.

Referring to Fig. 1 of the drawings, my invention is shown in application to a so-called instantaneous hot-water heater 9 comprising a plurality of water tubes 10—11—12 within a steam chamber 13; chamber 13 is divided by a baffle 14, and the water tubes are connected to the water-supply line 28—29, via water-inlet means 15 and water-outlet means 16. A steam supply connection 17 is made to the chamber 13 near the water-outlet connection, and steam condensate is drained by a line 18 including a trap 19. In the form shown, steam is available from a supply line 20 to the connection 17 by way of a single steam-control valve 21, which is shown as a normally closed regulator, opened by admission of control pressure at 22 over a diaphragm 23.

In accordance with the invention, the valve 21 is caused to respond primarily to detected flow in the water-supply line, and for this purpose I employ a differential pilot 24 in controlling relation with the valve 21. Sensing-pressure connections to the pilot 24 are made by an upstream pressure-sampling line 26. The points of connection of lines 25—26 to the water-supply line should be such that a sufficient pressure drop can be observed in response to changes in flow, for the flow range of interest in a particular application. For the form shown, I have provided a pressure-metering orifice member 27 in the water-supply line to assure development of sufficient pressure drop. The lines 25—26 may be connected immediately adjacent the orifice 27 and on opposite sides thereof; however, in the form shown, it is more convenient to make connections at the inlet and outlet ends of the lines 28—29 connected to the heater.

The differential pilot 24 is shown in Fig. 3 to comprise a diaphragm 30 across which pressure lines 25—26 are connected. A valve member (not shown) is connected to the diaphragm 30 by a stem 31 and controls the supply of control pressure from a supply-pressure line 32 to a control-pressure line 33, connected at 22 to the space over the diaphragm 23 of the main valve 21. The supply-pressure line 32 is shown connected at 34 to the upstream side of the main valve, so that high-pressure steam may be used for control purposes. A bleed connection 35 is made from the line 33 to the downstream side of the valve 21. Inasmuch as the differential-control fluid is water and the main-valve control fluid is steam, I show provision of a seal bellows 36 between the diaphragm 30 and the body of the differential pilot 24, thereby isolating the steam from the water.

The operation of the parts thus far described will be one of assuring increased delivery of steam to the heater immediately on detection of a differential pressure at pilot 24; the resulting actuation of steam valve 21 will be of a magnitude reflecting the need for additional heat and will be based on the water-flow demand. Adjustment to achieve this purpose may be made by means (not shown) within the cap 38 of pilot 24 so as to determine the loading on the spring 39 of said pilot. There need be no time lag in such admission of steam, because as soon as there is a demand for water there is a pressure drop on the downstream side of the orifice 27, and the differential pilot 24 may operate almost instantaneously to open the steam valve 21.

For situations in which an enormous sudden demand can develop excessive admission of steam to the heater, I provide a temperature safety feature for the additional control of steam admitted at 17 to the heater. In the form shown, this additional control is achieved by means

of a temperature pilot 40 in series with the pilot 24 and responsive to average water temperature, within the heater and near the location of steam admission to the water heater. For this purpose, I show thermostat means comprising a plurality of tubes 41—42 extending well into the heater tubes and preferably into upper and lower tubes 10—12, so that an average temperature response may be achieved. I prefer that the thermostat elements 41—42 be of the variety in which response is localized along a limited length, and this variety is schematically indicated in the drawing by means of solid inking 41'—42' over the temperature-responsive lengths of the thermostat elements 41—42. Such lengths will be seen to be preferably localized to the vicinity of steam admission to the heater and for substantially that half of the heater which lies near the point of steam admission. To derive an average temperature response, both thermostats are interconnected to a single thermostat pressure line 43, connected in turn over the diaphragm (not shown) of the temperature pilot 40.

Because the temperature pilot 40 is relied upon to perform an upper temperature safety-monitoring function, the loading springs of the temperature pilot are preferably set so that the valve member thereof is normally open. This will mean that high-pressure steam will normally be admitted to the supply-pressure line 32 to the differential pilot 24, so that normal response within the heater may be to changes in demand, as detected by the flow-responsive means. Only when the change in demand is so sudden as to supply excessive steam to the heater will the temperature pilot be called upon to throttle steam admission and thus protect the heater. By this means, one can also be assured that excessively hot water will not be delivered, whatever the change in demand.

The arrangement of Fig. 2 generally resembles that of Fig. 1 and therefor corresponding parts have been given the same reference numerals. The essential difference between the two arrangements is the employment of two separate steam-pressure regulating systems in series on the supply line 20' to the steam inlet 17 for the heater. Thus, the differential pilot 24 independently controls operation of its own main valve 45, and the temperature pilot 40 independently controls operation of its own main valve 46. Both pilots derive high-pressure steam in line 47 from the upstream side of the upstream main valve 46, and control pressures in each case are vented by separate bleed means 48—49 to the downstream sides of the respective valves 45—46. Differential-pressure connections to the pilot 24, and thermostat connections to the pilot 40, may be as described for Fig. 1.

In the arrangement of Fig. 4, steam is admitted to the steam-inlet connection 17 by way of two main valves 50—51 in parallel. Thus, valves 50—51 are in separate branch lines 52—53, derived from the steam main 20 and connected to each other at inlet 17. Both valves 50—51 are responsive to control pressures supplied by a common connection 54 and may be of like proportions, the essential difference being that for one valve the relation between control-pressure response and steam flow is substantially different from that for the other valve; a single bleed connection 55 may also serve both valves. In the form shown, the desired difference in response is achieved by spring means 57—58 of desired preloading and relative stiffness; springs 57—58 resiliently oppose control-pressure actuation of the valves 50—51. Spring 58 is shown as having a substantially greater stiffness coefficient than spring 57, and the preloaded or stiffness relationship is preferably such that with increasing control pressures delivered in line 59, valve 50 will become substantially fully actuated (open) for a control pressure at which valve 51 is just beginning to open. This means that for normal control pressures, relatively even steam flow at low flow rates may be accommodated by valve 50 and the smaller line 52, but that for sudden large demands valve 51 in the larger line 53 will be available to supply immediate large steam flows.

The control pressure in line 59 may be established in the manner described for line 33 in Fig. 1. However, in Fig. 4 I illustrate a situation in which the heater is operated at subatmospheric pressures and in which steam-supply control is enhanced by response to detected drops in the subatmospheric pressures. The valves 50—51 and pumping means 60 in the line to trap 19 may be viewed as means for subjecting the heater 9 to subatmospheric pressures.

Pilot-valve means is again relied upon to determine control-fluid pressures, as supplied from the high-pressure connection 61 to the main 20. The fluid-flow response may be achieved by the differential pilot 24, connected as previously described, and the temperature and subatmospheric-pressure responses may be combined to operate a single pilot-valve member 62. The particular temperature-pressure pilot assembly shown is described in greater detail in my copending patent application, Serial No. 399,222, filed December 21, 1953. Specifically, temperature response is derived by actuating a stem 63 by a diaphragm (not shown) within a hood 64, connected to thermostat line 43. The diaphragm is loaded by springs 65, and adjustable means 66 provides means whereby an upper or safety temperature threshold may be selected, by loading stem 63 via a spring 67.

Subatmospheric-pressure response is derived by motion of a diaphragm 68, overstanding a chamber 69 which is connected by line 70 to the heater 9. A stem 71 connects diaphragm 68 to pilot-valve member 62, and a spring 72 resiliently opposes motion of diaphragm 68; the stiffness and preloading of spring 72 should be sufficient to withstand any possible vacuum condition sensed by line 70, i. e. not to collapse fully under such conditions. Finally, the combined temperature-and-pressure response is achieved by rocker arm 73, fulcrumed at 74, and interconnecting the two stems 63—71.

In operation, at normal fluid-flow demand rates in line 29, subatmospheric pressure will not be very low, neither will the thermostat-detected temperature be excessive; pilot 62 will thus be normally open, and the flow-sensitive pilot 24 will do all the necessary regulation of steam flow. Probably all this steam flow will be served by valve 50. Now, if the demand should suddenly increase, not only will pilot valve 24 call for an immediate increase in steam (which may be shared by valves 50—51) but the sudden lowering in subatmospheric pressure in the heater will serve to oppose any tendency of the temperature-responsive means 63 to shut off steam supply prematurely. In effect, then, the upper temperature safety limit is momentarily raised in order to assure a steam supply adequate to the sudden demand. When the steam supply meets this demand, the subatmospheric pressure will rise to normal, and the normal upper temperature safety function of means 63 can resume.

It will be seen that I have described a relatively simple means whereby the performance of an instantaneous hot-water heater may be substantially improved, so that in intermittent-demand situations the delivered temperature may be more uniform, and so that there may be minimum time lag in the response of delivered temperature. The temperature-safety feature serves to protect not only the heater itself but also assures against delivery of excessively hot water.

While I have described the invention in detail for the preferred forms shown, it will be understood that modifications may be made within the scope of the invention as defined in the claims which follow.

I claim:

1. In combination, a water heater including a plurality of tubes for the conduct of water through said heater, steam-supply means including pressure-responsive valve means connected to said heater, a water-supply line including water-inlet and water-outlet connections to said

heater, first means controlling the admission of steam to said heater and including a differential-pressure pilot valve in controlling relation with said valve means and responsive to pressure at spaced locations along said water-supply line, whereby response to water flow may be achieved, and second steam-control means comprising multiple thermostats immersed in the water in said tubes and responding to the average water temperature in said tubes.

2. In combination, a fluid heater, a fluid-supply line including fluid-inlet and fluid-outlet connections to said heater, steam-supply means connected to said heater and including a plurality of steam-flow control valves in parallel, said valves each including fluid-pressure responsive operating means and means resiliently opposing the response of said operating means to fluid pressure, the stiffness coefficient of the resilient means for one of said valves substantially exceeding the stiffness coefficient of the resilient means for the other of said valves, and operating means for said valves including a common supply of control-pressure fluid to both said fluid-pressure responsive operating means.

3. The combination of claim 2, in which the stiffness relation of the respective resilient means associated with said valves is such that substantially full resiliently opposed control-pressure actuation of one of said valves is achieved for a control pressure at which the control-pressure actuation of the other of said valves is substantially just commencing.

4. In combination, a fluid heater, a fluid-supply line including fluid-inlet and fluid-outlet connections to said heater, steam-supply means connected to said heater and including a plurality of steam-flow control valves in parallel, said valves each including fluid-pressure responsive operating means, the relation between fluid-pressure response and steam flow being different for one valve as compared with the other, whereby one of said valves may have a first range of steam-flow control for a given range of control pressures and the other of said valves may have a second and different range of steam-flow control for said given range of control pressures, and operating means for said valves including a common supply of control-pressure fluid to both said fluid-pressure responsive operating means, said common supply including two pilot valves in series, one of said pilots being responsive to fluid flow through said heater, the other of said pilots being responsive to average fluid temperature in said heater.

5. In combination, a fluid heater including means for conducting a flow of fluid through said heater, means to reduce to subatmospheric the pressure of steam in said heater, said last-defined means including two steam-flow control valves connected in parallel to said heater and means connected to said heater to remove condensate

from said heater, each of said valves including fluid-pressure responsive operating means, the relation of fluid-pressure response to steam flow being different for one valve as compared with the other, whereby one of said valves may have a first range of steam-flow control for a given range of control pressures and the other of said valves may have a second and different range of steam-flow control for said given range of control pressures, and operating means for said valves including a common supply of control-pressure fluid to both said fluid-pressure responsive operating means, said common supply including a pilot-valve means having a pressure-sensing connection to said heater and responsive to subatmospheric pressures in said heater.

6. In combination, a fluid heater including means for conducting a flow of fluid through said heater, means to reduce to subatmospheric the pressure of steam in said heater, said last-defined means including two steam-flow control valves connected in parallel to said heater and means connected to said heater to remove condensate from said heater, each of said valves including fluid-pressure responsive operating means, the relation of fluid-pressure response to steam flow being different for one valve as compared with the other, whereby one of said valves may have a first range of steam-flow control for a given range of control pressures and the other of said valves may have a second and different range of steam-flow control for said given range of control pressures, and operating means for said valves including a common supply of control-pressure fluid to both said fluid-pressure responsive operating means, said common supply including pilot-valve means responsive to fluid flow through said heater and to subatmospheric pressures in said heater, the sense of response of said pilot-valve means being to admit greater steam flow on detection of greater fluid flow and to admit greater steam flow on detection of more reduced subatmospheric pressures.

7. The combination of claim 6, in which said pilot-valve means is further responsive to fluid temperature in said heater, the sense of temperature response being to reduce the supply of steam to said heater on detection of fluid temperatures in excess of a normal operating delivered temperature.

References Cited in the file of this patent

UNITED STATES PATENTS

922,783	Korting	May 25, 1909
1,404,249	Walker	Jan. 24, 1922
1,987,032	Spence	Jan. 8, 1935
1,995,826	Soderberg	Mar. 26, 1935
2,006,035	Stewart	June 25, 1935
2,296,325	Bak	Sept. 22, 1942
2,329,682	Alfery	Sept. 14, 1943