In the conduct of chemical reactions between constituents of a mixture at high temperature under pressure, it is necessary to drive heat through the walls of the high pressure container to the reaction mixture within the same. It follows that the temperature of the container is higher than the temperature of the contents and that the temperature of the heat source is higher still. Problems of control immediately arise and become acute when temperature of the heat source approaches or exceeds safe temperatures, either for the container or the reaction materials contained therein. It is often very desirable and even necessary to control the temperature of the reaction mixture very closely to avoid overheating and it is also necessary to protect the container from overheating which might cause undue corrosion or weakening under pressure.

A simple solution in some ways is to immerse the container in a bath of high boiling point fluid and control the temperature of it, it being then assured that the temperature of the reaction mixture will not go above the temperature of the bath, and if the bath has considerable heat capacity, sudden variations are impossible and control of the temperature is made simple.

A disadvantage of the immersed type is the risk to property and attendants or operators, should an explosion occur, such as the bursting of the container which might scatter the hot fluid bath widely with disastrous results.

The present invention concerns a method of applying heat to a container, vessel, tube or conduit by means of a bath of high temperature fluid in such a way that it can be safely used for heating high pressure reaction mixtures where there is liability of corrosion or weakening of the container of the high pressure reaction mixture which might result in bursting thereof or explosion.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the steps and means herein after fully described and particularly pointed out in the claims, the annexed drawing and the following description setting forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but several of the various ways in which the principle of the invention may be used.

In said annexed drawing:—

The single figure there appearing is a vertical sectional view of one form of the apparatus contemplated in the invention.

The reaction heater is shown in the form of a series of coils of tubing 1 arranged in vertical formation within a heat conserving and insulated casing 2, provided with a cover 3, and a drain pipe 4, delivering to a kettle or other suitable vessel 5, set in a flue 6, and heated by a furnace 7. A pump 8 of the submerged centrifugal type driven by motor 9, delivers hot bath fluid by way of pipe 10 to a series of coils 11 in a superheater chamber 12, fired by furnace 13, from which the further heated fluid is delivered by a pipe 14 to a set of distributing nozzles 15 above the coils 1, and adapted to shower or flow the hot bath onto and over these coils.

The superheater 11 may not be required in all cases, but presents a convenient method of securing large heat capacity in small compass and of an efficient type, namely, tubular, and should be set as shown so that the system will all drain back into the kettle when the pump is stopped.

The liquid to be processed is caused to flow under suitable pressure through the heating tubes 1. Furnaces 7 and 13 are fired and the heated fluid bath in kettle 5 is pumped through the superheater 11, and over the coils 1, imparting thereto the required heat, after which it returns by way of drain pipe 4 from casing 2 to the kettle for reheating and recirculation. The fluid bath may be of any suitable substance, as for instance sodium nitrite for which the kettle, pump and piping may be made of iron or steel. Such a substance, which is a solid at normal temperatures, is melted in a kettle and the pump can thus handle it as a fluid at the elevated temperature. If desired, the bulk of the fuel, when once the system gets into operation, may be burnt in furnace 13, and by means of suitable flue connection 16 the kettle may be kept...
warm and its contents fluid by passing around it the flue gases from 12.

There are many uses to which such a system may be applied and the sketch herewith shows a general type of installation, the application of which to the processing of a liquid under high pressure in a tubular system will be described.

In general a container such as a kettle or pan containing the hot fluid bath is provided with a circulating pump adapted to pump the hot fluid bath over the surfaces to be heated which are disposed within a heat insulating casing at a point sufficiently elevated above the said kettle to permit the said fluid bath to flow back into the kettle. The heating is accomplished by flowing the bath over the heating surfaces in a film of convenient thickness as distinguished from submerging the heating surfaces in a large quantity of the heating liquid in the form of a bath. In this way the actual mass of hot fluid in the heating chamber is cut down to a small fraction of the amount required in a totally submerged system.

This system is distinguished from what is known as the Merrill system in that I use a heating bath substantially non-volatile at atmospheric pressure and use it at that pressure, if desired, whereas the Merrill system uses oils under high pressure to prevent volatilization. Such heating media give trouble due to cracking and are highly inflammable and dangerous at the temperatures employed and require usually the installation of fire walls between the equipment where the heat is utilized and the furnace room in which the oil is heated. My equipment can be all advantageously set close together to reduce heat losses without incurring additional hazard thereby, and constitutes a valuable advance in the art of heating by indirect method having general application, but particularly indicated in the high temperature high pressure processing art.

My system has all the advantages of the submerged bath type, but without the dangers incident thereto. Thermostat control, either intermittent or continuous automatic, may be easily applied by anyone skilled in the art and full assurance had that overheating or heating beyond some chosen temperature will not occur either to the liquid being processed or to the high pressure container for same.

The heating surface for the processed fluid may be tubular as indicated, either connected to headers or in serpentine arrangement, or such surface may be disposed in any form or arrangement adapted to confine the processed fluid and enable a quantity of heating fluid less than enough to fully submerge such surface to transmit to the former fluid the necessary heat while flowing over said surface in film or stream form or the like.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A method of indirect heating, which comprises melting a normally solid substance, and showering the molten liquid over the surface of a container enclosing the material to be heated.

2. A method of indirect heating, which comprises melting a normally solid substance, showering the molten liquid over the surface of a container enclosing the material to be heated, collecting and reheating the liquid, and again showering it over the surface of such container.

3. A method of indirect heating, which comprises melting a normally solid substance, and showering the molten liquid in a film in heat exchange relation with a material to be heated.

4. A method of indirect heating, which comprises melting a normally solid substance, and mechanically circulating the molten substance as heating agent in film-like distribution over the surface of a container enclosing a material to be heated.

5. A method of indirect heating, which comprises melting a normally solid substance, mechanically circulating the molten substance as heating agent in film-like distribution over the surface of a container enclosing a material to be heated, returning the so-used liquid to the melting step, and reheating and recirculating the same.

6. A method of indirect heating, which comprises melting a normally solid substance, passing the molten substance through a super-heating zone and thence to discharge in film-like distribution over the surface of a container holding material to be heated.

7. The method of indirect heating of a fluid reaction mixture under high pressure, which comprises melting a normally solid substance gravitationally flowing a distributed film-like stream of the molten high-boiling point substance as heating agent at atmospheric pressure over the outer surface of a tubular pressure vessel while the fluid to be heated is passed therethrough under pressure, collecting the so-cooled heating agent, reheating such collected agent, and redistributing it to the first step.

8. The method of indirect heating of a fluid reaction mixture under high pressure, which comprises melting sodium nitrite, gravitationally flowing a distributed film-like stream of the molten sodium nitrite as heating agent at atmospheric pressure over the outer surface of a tubular pressure vessel.
while the fluid to be heated is passed therethrough under pressure, collecting the so-cooled heating agent, reheating such collected agent, and redistributing it to the first step.

9. In an apparatus for indirect heating, a circuit for a heating-substance, said circuit comprising a heating-kettle, a superheater to further heat the substance in liquid form, means to distribute the superheated liquid over a surface to be heated, means to conduct the liquid back to the kettle, and mechanical means to circulate the liquid.

10. In an apparatus for indirect heating, a closed tubular container for a substance to be heated, a circuit for heating the same, comprising a kettle to heat a heating medium, a superheater connected with said kettle, means for distributing the superheated medium over the said tubular container, means for conducting the medium back to the kettle, and mechanical means for circulating the medium through the circuit.

11. In an apparatus for indirect heating, the combination of a heat insulated casing, a tubular container for the substance to be heated in said casing, a pipe located above said tubular container adapted to discharge a hot liquid downwardly over the surface of the latter, a heated vessel arranged to receive such liquid after being thus flowed over the tubular surface, and a pump adapted to elevate such liquid through a heater and return same to said pipe for use over again.

12. In an apparatus for indirect heating, the combination of a heat insulated casing, a plurality of extended passages in said casing disposed in substantially vertical arrangement one above the other wherein the substance to be heated is placed, a device located above said passages adapted to discharge a hot liquid downwardly over the surface of the latter, a vessel arranged to receive such liquid by gravity after being thus flowed over such surface and means respectively adapted to elevate and reheat such liquid and thereupon return same to said device for use over again.

13. In an apparatus for indirect heating, the combination of a heat insulated casing, tubes arranged transversely of said casing containing the substance to be heated, a device located above said tubes adapted to discharge a hot liquid downwardly over the surface of the latter, a heated vessel arranged to receive such liquid after being thus flowed over the tubular surface, and means adapted to elevate such liquid through a heater and return same to said device for use over again.

14. In an apparatus for indirect heating, a circuit for a heating liquid, said circuit comprising a melting kettle, a superheating coil supplied thereby, mechanical means for flowing liquid from said coil over a con-