United States Patent [19]

Guetlhuber

[11] **3,760,870**

[45] **Sept. 25, 1973**

[54] **COOLER CONSTRUCTION FOR CIRCULATING CONTROLLED AMOUNTS OF HEAT CARRIER FROM A REACTION VESSEL**

[75] Inventor: **Friedrich Guetlhuber,** Ruhmannsfelden, Germany

[73] Assignee: **Deggendorfer Werft and Eisenbau GmbH,** Germany

[22] Filed: **Dec. 4, 1970**

[21] Appl. No.: **95,207**

[30] **Foreign Application Priority Data**

Dec. 18, 1969 Germany.................. P 19 63 394.4

[52] **U.S. Cl.** **165/35,** 165/159

[51] **Int. Cl.** **G05d 23/00**

[58] **Field of Search** 165/158–161, 103, 113, 114, 108, 35, 351

[56] **References Cited**

UNITED STATES PATENTS

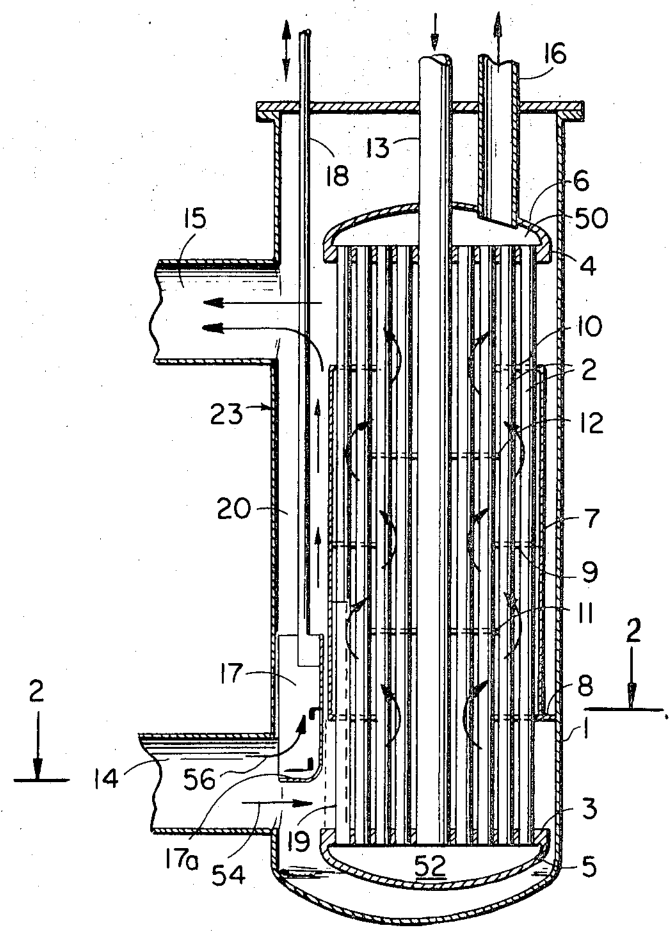
1,812,458	6/1931	Turkus	165/159 X
1,934,496	11/1933	Glisson	165/160 X
2,132,093	10/1938	Bennett	165/159 X
2,581,121	1/1952	McCurdy, Jr. et al	165/159 X

Primary Examiner—Charles J. Myhre
Assistant Examiner—Theophil W. Streule, Jr.
Attorney—McGlew and Toren

[57] **ABSTRACT**

A cooler for the passage of a regulable partial current of heat carrier in a reaction vessel includes a cooler housing having longitudinally spaced inlet and outlet connections. A plurality of cooling tubes extend longitudinally through the housing and the interior of the housing is divided into a flow path along and around the tubes from the inlet to the outlet and a control flow through a by-pass extending from the inlet to the outlet on the exterior of the tubes but within the housing. The coolant is circulated through a central coolant inlet tube which extends centrally within the tube bundle for flow from the chamber defined at the far end upwardly through the tubes to an opposite chamber for removal. The by-pass flow is regulated by means of a slide valve which may be slid along the by-pass passage to divert a portion of the inlet flow through the inlet so that it flows directly through the by-pass to the outlet and is not affected by the cooling tubes. The circulation to the cooler may be from the interior of the reactor to the inlet and from the outlet back into the reactor. Alternatively, the flow may be through an annular conduit extending around the reactor from the outlet of the cooler and thence downwardly on the exterior passage around the annular outlet back to the inlet. The first partial current conducted around the cooling tubes and the second partial current conducted through the by-pass passage, which are regulable relative to each other, form together a constant partial current of the heat carrier circulated in the reaction vessel.

5 Claims, 6 Drawing Figures



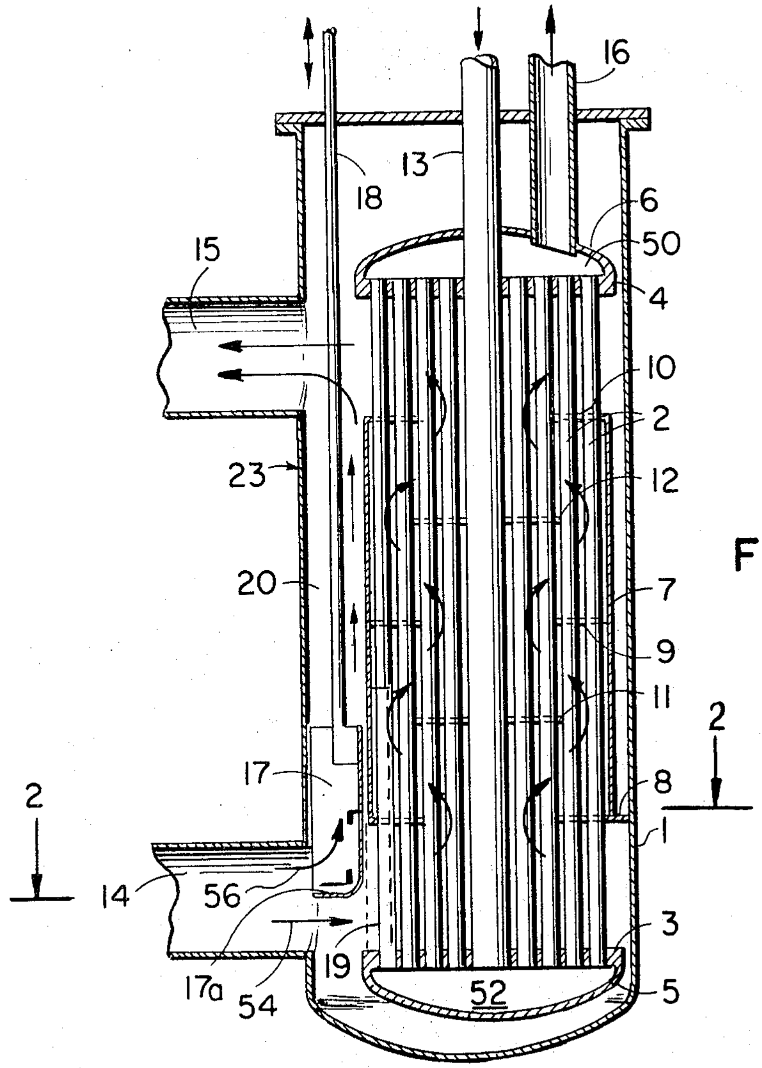


FIG. 1

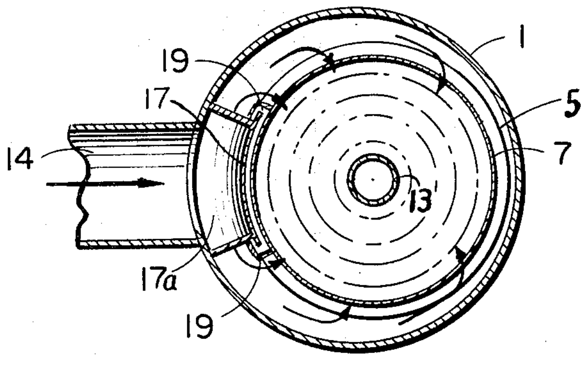


FIG. 2

INVENTOR
Friedrich Guetlhuber

by

McGlew & Toren
ATTORNEYS

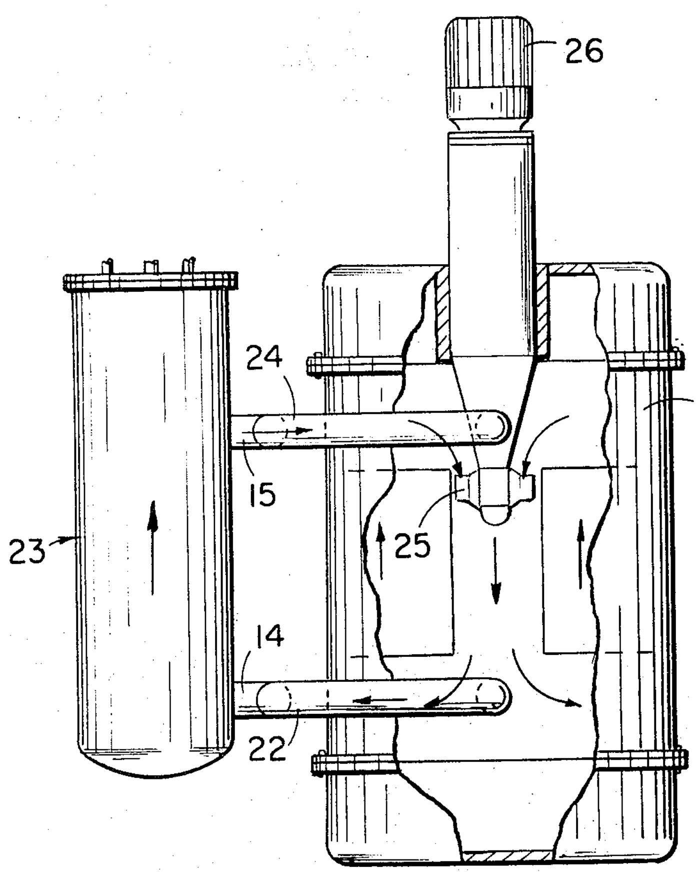


FIG. 3

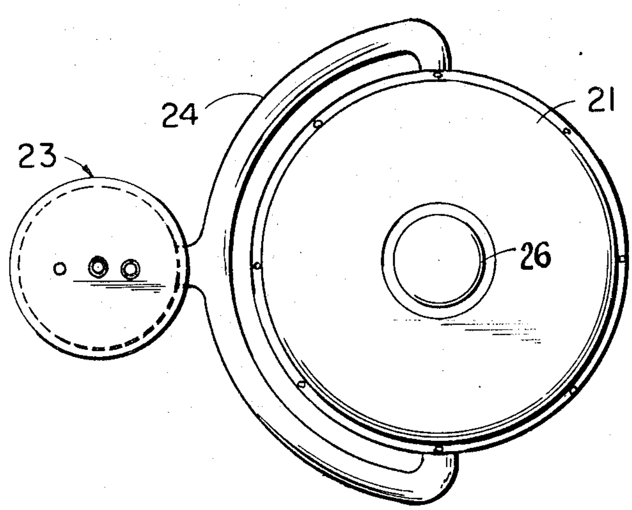


FIG. 4

INVENTOR
Friedrich Guetlhuber

by

McGlew & Toren
ATTORNEYS

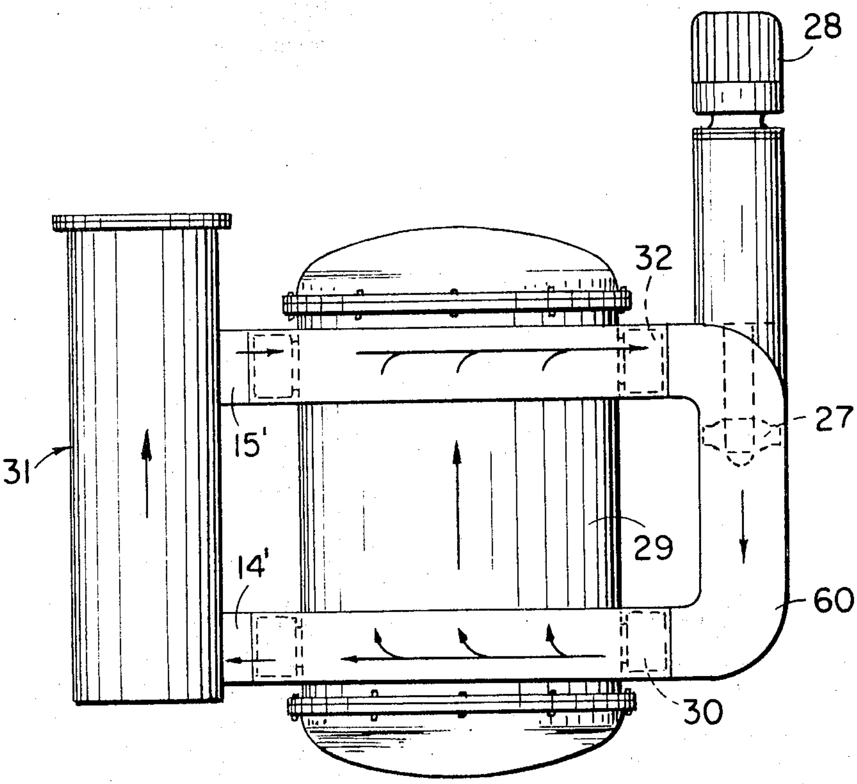


FIG. 5

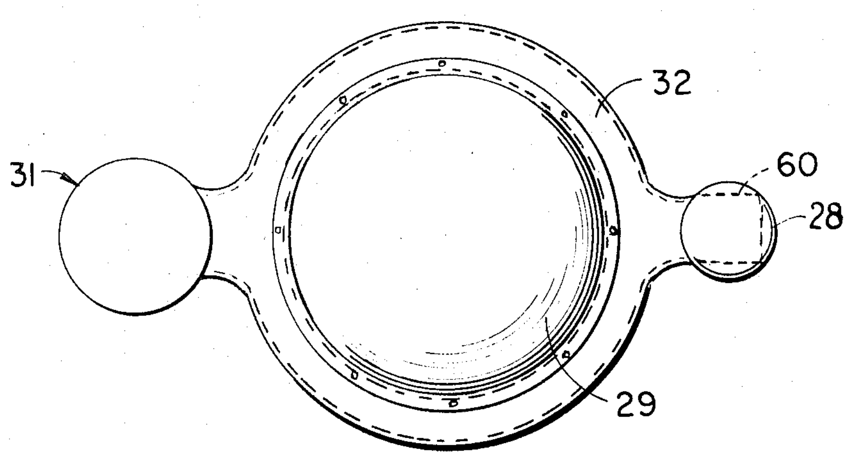


FIG. 6

INVENTOR
Friedrich Guetlhuber

by
McGlew & Toren
ATTORNEYS

COOLER CONSTRUCTION FOR CIRCULATING CONTROLLED AMOUNTS OF HEAT CARRIER FROM A REACTION VESSEL

SUMMARY OF THE INVENTION

This invention relates in general to the construction of coolers and in particular, to a new and useful cooler for the passage of a controlled partial amount of heat carrier which is circulated in a reaction vessel.

In a reaction vessel for carrying out chemical reactions such as contact furnaces, heat is transferred to a heat carrier preferably a fused salt bath. The heat carrier is circulated by means of a pump in the reaction vessel and a cooler is provided to maintain constant temperature conditions. The heat generated in through reaction vessel is delivered to the water circulated through a nest of tubes in the cooler.

At the present time, there are two principal possibilities for maintaining a certain operating temperature.

The entire heat carrier flows in a cycle from the reaction vessel into the cooler and back again. The control of the temperature by eliminating heat is effected by the amount of feed water supplied to the cooler.

In the second system, the heat carrier, such as a salt bath which is circulated in the reaction vessel, is only branched off in a partial current which is conducted through a cooler and back again into the reaction vessel. There this partial current or flow mixes with the rest of the salt bath. The connections for the exit and reentry of the partial current are arranged in the reaction vessel at points where a pressure difference exists. With this latter arrangement, an additional circulation pump is not required for the partial current flow.

The first system described above has the disadvantage that the evaporation and superheating of the water takes place by necessity in a tube field. At the points where the water is transferred in the steam phase, high alternating thermal stresses are produced which frequently lead to tension cracks.

In the second system described above coolers are used which include a slide valve control for regulating the partial current flow of the cooling medium. Such a design has disadvantages. With a low load of the reaction vessel there is little heat to eliminate. The amount of salt is then greatly throttled by the slide valve. This produces a correspondingly smaller amount of heat carrier flow and it causes the heat carrier to flow relatively slowly through the cooler. Due to the longer stay, the salt bath is greatly cooled. The salt bath, which has been reduced significantly in temperature, thus returns to the reaction vessel and is likely to cause trouble in the operation of the vessel. In addition, the materials are highly stressed by the great temperature differences due to thermal stresses.

In those instances, where a great amount of heat has to be eliminated from the reaction vessel the slide valve of the cooler must be opened wide. The partial amount of the heat carrier flowing through the cooler is great so that the stay period in the cooler is short. The salt bath thus has a relatively high temperature at the outlet of the cooler. A larger amount of salt bath with a small reduction of temperature is therefore returned into the reaction vessel. Since the amount of heat to be eliminated is inversely proportional to the temperature difference between the cooler inlet and the cooler outlet it is not possible to achieve the desired plant performance. In addition, the cooling area of the cooler can-

not be calculated exactly because of the above-described conditions. If the cooling surface is too large, the partial amount of the salt bath returning to the reaction vessel has substantially the very low temperature of the water in the cooler in all load ranges. The flow distribution in the reaction vessel is also distorted by the fact that the partial current temporarily branched off from the circulation in the reaction vessel and flowing through the cooler is changed during the regulation by the slide valve.

In accordance with the present invention the disadvantages of the prior art are substantially eliminated by providing a cooler having a by-pass which serves for the tempoerary subdivision of the constant partial current of the heat carrier which may be branched off from the reaction vessel into two parallel flowing and then combined currents, or streams, of which only one is directed along side the cooling tubes. In accordance with a feature of the invention, the control of the amount of partial current flow through each path is controlled by a control element designed as a slide valve which is arranged so that movement thereof will divert a larger or smaller partial cross section of the inlet flow stream into the by-pass with the remainder being directed for flow into assocation with the cooling tubes.

The construction of the cooler includes a nest of cooling tubes which are arranged eccentrically to the longitudinal axis of an associated outer shell or housing wall. The tubes are offset from the axis to provide a wider part of an annular or ring shaped by-pass at one side adjacent the inlet and the outlet openings for accommodating a control member such as a slide valve. The construction preferably includes an annular passage around the tube nest which is divided in an axial direction by a plurality of disc elements which permit the flow of a partial current stream from the inlet in a transverse direction through the tube nest and then axially around the spaced disc members which provide baffle elements along and around the tubes. The partial stream is discharged at the other end through the outlet. The discs define on their inner and outer circumferences a flow cross section similar to a coil shaped guide for the partial flow of the heat carrier to be cooled and the internal wall portion or inner shell of the cooler permits an annular flow of a partial stream outside of the tubes directly to the outlet so that this part of the stream is not cooled.

Accordingly, it is an object of the invention to provide an improved cooler construction for use with a reaction vessel which includes a housing defining a partial flow path from an inlet through and around cooling tube elements and another partial flow path for by-passing the flow through the tubular elements which is regulated by the movement of a control member and which advantageously includes a housing formed by a tube bundle which is eccentrically positioned within a cylindrical housing shell in order to define a passage for a movement of the slide valve for controlling the partial flows.

A further object of the invention is to provide a reactor cooling system having an improved means for flow control and regulation of a circulating medium for cooling the reactor.

A further object of the invention is to provide a cooler and a reactor system which are simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a longitudinal sectional view of a cooler constructed in accordance with the invention;

FIG. 2 is a section taken along the line 2—2 of FIG. 1;

FIG. 3 is a partial side elevational and partial sectional view of a reactor with the cooler shown in FIG. 1;

FIG. 4 is a top plan view of the reactor and cooler shown in FIG. 3;

FIG. 5 is a view similar to FIG. 3 of another arrangement of the reactor and cooler; and

FIG. 6 is a top plan view of the reactor shown in FIG. 5.

GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in particular, the invention embodied therein in FIGS. 1 and 2 comprises a cooler or heat exchanger generally designated **23** which includes an outer substantially cylindrical housing or shell **1** having a nest of longitudinally extending cooling tubes **2** arranged eccentrically therewithin and connected at respective ends through tube sheets **3** and **4** which are surrounded by hoods **5** and **6** respectively. The tube sheet **4** and the hood **6** define a cooling liquid outlet chamber **50** and the tube sheet **3** and hood **5** define a reversing chamber **52.** The tube sheet **2** is surrounded, in an intermediate area between an inlet **14** and an outlet **15** of shell **1,** by an inner shell **7.** A disc member or partition baffle **8** extends transversely between the nest of tubes **2** and to the exterior wall of the outer shell **1** at a location at the top of the inlet **14** but not in a slide valve slot area of a by-pass **20** which extends from the inlet **14** directly to the outlet **15** between the inner shell **7** and the outer shell **1.** A plurality of similar discs **9** and **10** which do not extend to the interior wall of the outer shell **1** but only to the inner shell **7** as well as the disc **8** have central openings for the passage of a partial flow stream therethrough. The discs **8,** **9** and **10** are alternately arranged with discs **11** and **12** which engage around the periphery of a coolant medium supply tube **13** which extends centrally through the nest of tubes **2** and communicates at its inner end with the reversing chamber **52.** The discs **11** and **12** do not extend outwardly to the inner shell **7** but leave a flow passage between the shell and the discs. The first partial flow is from the inlet in the direction of the curved arrows and through and around the nest of tubes **2** and along the tubes to the outlet and then transversely out through the outlet. The cooling medium which flows through the tube **13** and into the reversing chamber **52** flows through the tubes of the nest **2** and to the discharge chamber **50** and out through an outlet tube **16.**

The cooler **23** is advantageously arranged vertically and the outlet **15** is aligned vertically with the inlet **14** and connected into the outer shell **1** in the area of the widest interior space between the inner tube shell and the interior of the wall of the outer shell **1.** This is the area of the by-pass **20** and in this by-pass a box-shaped slide valve **17** is movable either upwardly or downwardly by actuating means (not shown) connected to a rod **18.** The slide valve **17** is guided by means of guide elements **19** and it may be shifted upwardly and downwardly in order to regulate the amount of incoming heat carrier which is circulated either through a first flow path indicated by the arrow **54**; which is through and around the tubes **2,** or a second flow path indicated by the arrow **56**; which is through the by-pass **20** to the outlet **15** and without passing in heat exchange relationship with the tubes **2.** The valve **17** has a curved wall **17***a* which may be oriented in the flow stream of the heat carrier to provide an even diversion of this stream to the by-pass **20** in accordance with operational requirements. The partial current, which flows in the direction of the arrow **56** through the by-pass, is practically not influenced by the cooling medium circulated through the nest of tubes **2.** This flow is combined with the partial current flowing in the direction of the arrow **54** through and over the tubes **2** at the location of the outlet **15.**

The design of the cooler **23** has several operating advantages in addition to its simple construction. The amount of circulating heat carrier flowing through the salt bath cooler and thus also the circulating amount of the flow distribution in the reaction vessel are constant in all load ranges. The control characteristics is linear, that is, the temperature difference between the salt bath inlet and the salt bath outlet of the cooler rises linearly between zero in the unloaded reaction vessel and the maximum temperature deviation at full load. At a temperature deviation of substantially zero the slide valve is at the bottom and the entire amount flows through the system without coming into the range of the cooling tube nest **2.** Under load the slide valve **17** is moved to the top position in which substantially the entire stream is diverted into heat exchange relationship with the tubes and there is very little or no flow through the by-pass **20.** The temperature difference is established between the salt bath inlet **14** and the salt bath outlet **15** after the two temporarily separated partial flow streams are mixed at the outlet **15.**

With the known system the necessary cooling surface cannot be calculated exactly and in addition the heat transfer value decreases in the course of time due to fouling. This causes the heat carrier to be cooled too much and there is a possibility, after prolonged operation, that the heat can no longer be transferred sufficiently. This disadvantage is eliminated in the present invention since the cooling surface can be selected in accordance with operational requirements and without supercooling the heat carrier.

The nest of tubes **2** can be designed as an evaporator or as a gas heater or as an evaporator with a series connected superheater. In some instances, the by-pass **20** may be arranged outside of the housing to provide the same function.

In the arrangement of FIGS. 3 and 4, the cooler **23** is arranged in association with a reaction vessel **21** which includes an inlet ring conduit **22** and an outlet ring conduit **24** which provide a connection to the reactor **21** from the cooler **23.** The salt bath heat carrier is circulated in the reaction vessel **21** by a pump **25** which is driven by an external driving motor **26**. The circulation through the reactor is through the outlet **15** of the cooler through the ring conduit **24** and downwardly in the reactor vessel **21** and is returned to the cooler through the ring conduit **22** and the inlet **14**.

In the arrangement of FIGS. **5** and **6**, a cooler **31** similar to the cooler **23**, includes an outlet **15'** which is connected to a ring conduit **32** extending around a reactor vessel **29** and an inlet conduit **14'** is connected to a ring conduit **30** extending the reactor vessel **29**. The heat carrier is circulated from the ring conduit **32** downwardly by a pump propeller **27** driven by a motor **28** and located in an external passage **60**. The salt bath heat carrier is fed from the ring conduit **30** partly to the reaction vessel **29** and partly to the cooler **31** and this heat carrier medium is returned to the pump **27** from the ring conduit **32**. Some of the flow into the ring conduit **32** is from the reactor vessel **29** and some is from the outlet **15'** of the cooler **31**.

What is claimed is:

1. A cooler for a heat carrier comprising an elongated housing having an inlet connection secured thereto fo introducing the heat carrier into said housing and an outlet connection secured thereto and spaced in the elongated direction of said housing from said inlet for withdrawing the heat carrier from said housing after its flow therethrough, a nest of tubes positioned within and spaced inwardly from said housing and said nest of tubes extending between said inlet and said outlet, means within said housing for defining a first passage for the flow of the heat carrier over said tubes and for defining a second passage for bypassing the flow of the heat carrier about said tubes within said housing, said first and second passages each being in communication at one end with said inlet and at the other end with said outlet, and movably positionable flow control means located within said housing at said inlet for selectively dividing the flow of the heat carrier introduced through said inlet into said first and second passages for regulating the flow of the heat carrier over said tubes.

2. A cooler, as set forth in claim **1**, wherein said flow control means comprises a slide valve movably mounted within said housing and located at said inlet into said housing, said slide valve being movably positionable in the path of flow of the heat carrier into said housing for selectively dividing the flow of the heat carrier between said first and second flow passages.

3. A cooler, as set forth in claim **1**, wherein said housing comprises a vertically extending cylindrically-shaped vessel with said inlet vertically aligned below said outlet, said nest of tubes arranged eccentrically within said cylindrical vessel and spaced inwardly from the inner surface thereof, said means defining said first and second passages comprises a tubular shell concentrically disposed about said nest of tubes within and spaced inwardly from said housing, said shell in combination with the inner surface of said housing forming an annular space wider on the side of said housing containing said inlet and outlet, and said second passage extending vertically from said inlet to said outlet through said annular space.

4. A cooler, as set forth in claim **3**, wherein a plurality of alternating first and second discs are located within said tubular shell extending transversely of the axial direction of said tubes, said first and second discs being arranged in spaced relationship, said first discs being centrally positioned within said tubular shell with the circumferential peripheries thereof spaced inwardly from the inner surface of said shell and said second discs being ring-shaped and concentrically positioned within said tubular shell with the raidally outer circumferential peripheries thereof arranged in contact with the inner surface of said tubular shell and the radially inner circumferential peripheries of said second discs arranged in spaced relationship from the axis of said tubular sleeve, so that said first and second discs are arranged to provide a tortuous flow path for the heat carrier as it flows over said tubes within said tubular shell passing around the outer circumferential periphery of said first discs and through the opening defined by the inner circumferential periphery of said second discs.

5. A cooler, as set forth in claim **1**, wherein said housing comprises a vertically extending cylindrically shaped shell closed at its lower and upper ends, said inlet and said outlet to said housing extending through said shell with said outlet aligned vertically above said inlet, said nest of tubes extending vertically and positioned eccentrically within said housing, a first tube sheet and a second tube sheet disposed in vertically spaced parallel relationship, said first and second tube sheets positioned within and extending transversely of said shell, said tubes secured at their ends within and extending through said first and second tube sheets, said first tube sheet located vertically above said second tube sheet, a first hood secured to and cooperating with said first tube sheet and defining therewith an outlet chamber for the coolant flowing through said tubes, a second hood connected to and cooperating with said second tube sheet and defining therewith an inlet chamber for the coolant flowing into said tubes, a coolant supply tube extending downwardly through the upper end of said housing and passing through said outlet chamber into said inlet chamber for supplying coolant thereto for flow through said tubes, an outlet tube connected to said outlet chamber for the discharge of the coolant from said housing after its flow through said tubes, an inner shell laterally surrounding said tubes for a portion of the length thereof between said inlet and said outlet, a plurality of alternating first and second discs located within said inner shell and extending transversely of the axial direction of said tubes, said first and second discs arranged in spaced relationship, said first discs centrally positioned within said inner shell with the circumferential peripheries thereof spaced inwardly from the inner surface of said inner shell and said second discs being ring-shaped and concentrically positioned within said inner shell with the radially outer circumferential peripheries thereof arranged in contact with the inner surface of said inner shell and the radially inner circumferential peripheries of said second discs arranged in spaced relationship from the axis of said inner shell, an annular-shaped partition baffle extending across the lower end of said inner shell with its outer circumferential periphery in contact with the inner surface of said housing and with its inner circumferential periphery aligned below the inner circumferential peripheries of said second discs, said partition baffle having an opening at its outer circumferential periphery in vertical alignment with said inlet and outlet of said housing, said control member comprising a valve member vertically movable within said housing at said inlet thereof, said valve member extending through the opening in said partition baffle and the opening in said partition baffle forming an inlet to said second passage extending between said shell forming said housing and said inner shell, and said partition baffle and first and second discs combining to form a tortuous flow path for the heat carrier as it flows over the tubes within said inner shell.

* * * * *