Aug. 12, 1958 R. H. CARTER 2,847,193

HEAT EXCHANGER

Filed Aug. 30, 1954 2 Sheets-Sheet 1

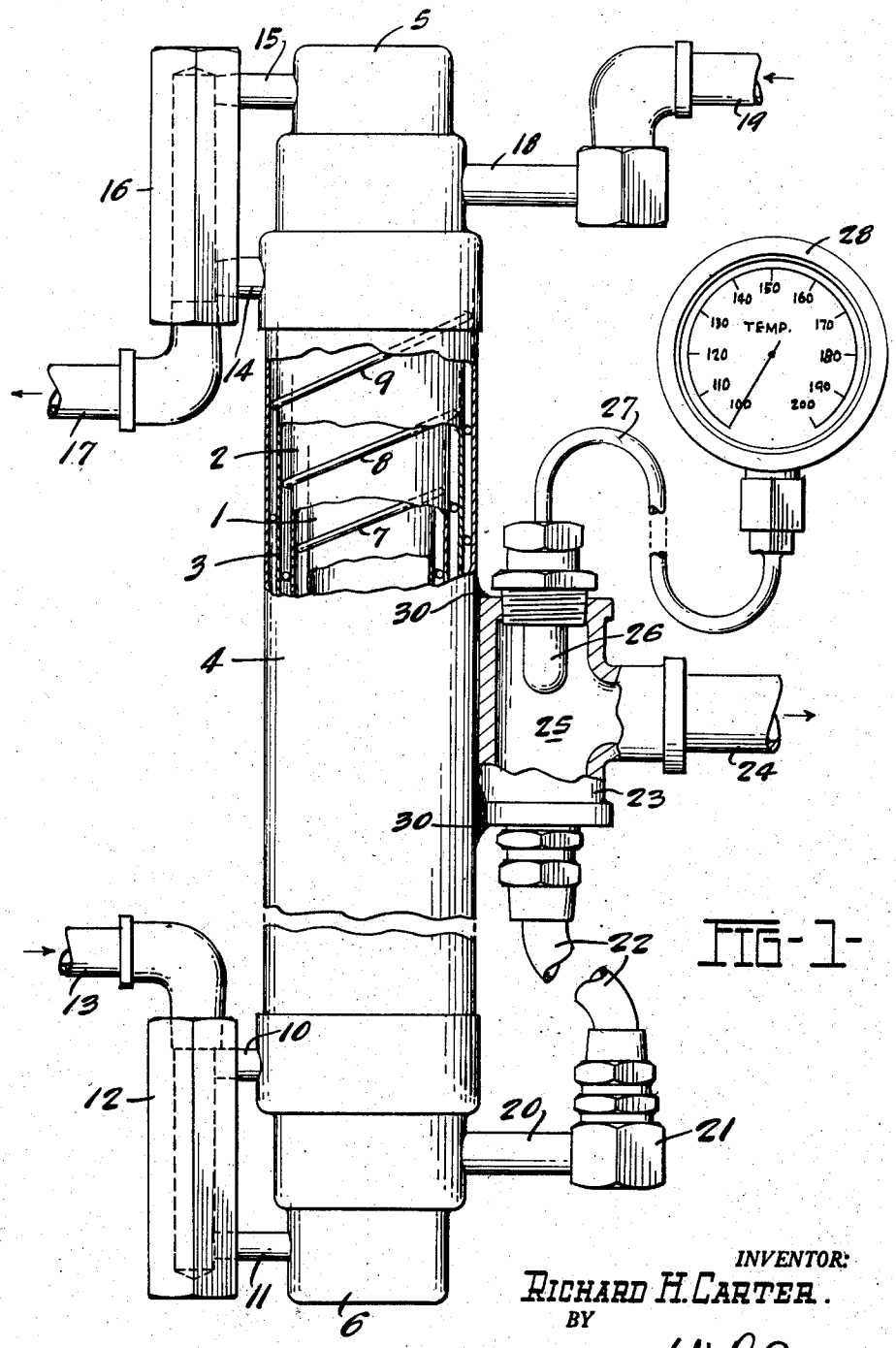



FIG-1-

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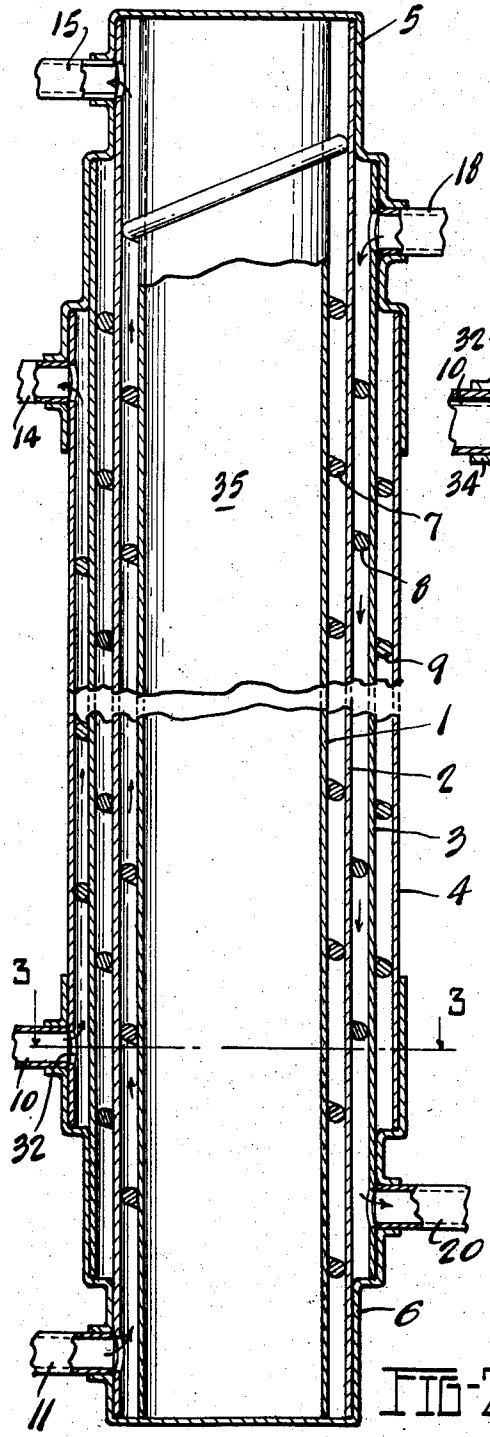



FIG-2-

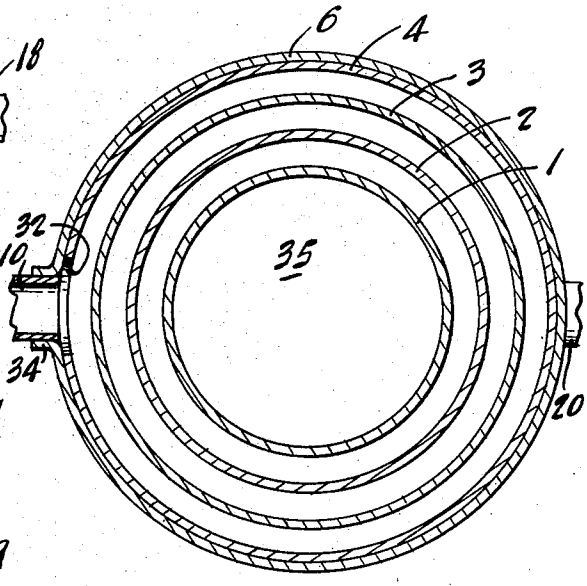



FIG-3-

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2,847,193

# HEAT EXCHANGER

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Application August 30, 1954, Serial No. 452,908

3 Claims. (Cl. 257—246)

This invention relates generally to a heat exchanger and particularly to one adapted to transfer heat from a fluid heat carrying medium to a liquid coating material. Such a heat exchanger is associated in operation with a thermostatically controlled heater and delivery system for circulating the fluid heating medium, preferably water, to and from the heat exchanger at a comparatively high rate of flow whereby the heat transfer may be rapid without greatly reducing the temperature of the heating medium. An essential part of such a system is the means for delivering and circulating liquid coating material through the heating exchanger.

This application is a continuation in part of applicant's prior application Serial No. 321,681, filed November 20, 1952, and which issued as U. S. Patent No. 2,762,652, granted September 11, 1956. This earlier application relates to a complete heating system including the subject heat exchanger.

In many product finishing operations it has been found advantageous to spray apply lacquers, synthetic enamels, varnishes, etc. at elevated temperatures. This added heat reduces viscosity and permits the use of heavier bodied formulations. As a consequence a lesser amount of costly thinners are required to bring the finishing material to a proper spraying consistency and a fewer number of coatings needed with an attendant saving in time and labor. Other benefits experienced include a better final finish and a shorter baking or drying period.

For fully satisfactory results the temperature to which a particular coating material is raised must be carefully controlled and maintained. With insufficient heating even if momentary the material is likely to become too viscous for proper atomization and a pebbly coating is deposited. Also with a temporary rise above the preferred temperature, the material may be discolored through charring or lose some other valuable property through a heat initiated chemical reaction.

A prime object of this invention is the provision of a heat exchanger with which the coating material may be heated to a desired temperature and maintained within a close range of such selected temperature.

Also it is an object of this invention to provide a heat exchanger that is efficient and rapid in function.

A further important object is the provision of a heat exchanger of a simple, sturdy design with a minimum of parts and with ease of assembly.

A correlated object is to provide a heat exchanger in which the outside connections to the internal passages are direct without traversing any intermediate space whereby possibilities of leaks are minimized.

These and other objects and advantages will become apparent in the following description and accompanying drawings.

In the drawings:

Figure 1 is an elevation, partly broken away, of a heat exchanger embodying my invention;

Figure 2 is a vertical section of the main body of the heat exchanger of Figure 1; and



Figure 3 is a horizontal section taken on the line 3—3 of Figure 2.

Referring to the drawing, it will be noted that the device embodied therein is formed with a set of four concentric tubes. The innermost tube 1 in this particular embodiment is about eighteen inches long and one inch in outside diameter. The next innermost, tube 2, is of the same length as tube 1 and one and one quarter inches in diameter. Tube 3 encircles tube 2 and is one and one half inches in diameter and about sixteen and one quarter inches long. Both tubes 1 and 2 therefore extend about an inch out each end of tube 3. The outer tube 4 of the set of the four concentric tubes is one and three quarters inches in diameter and only about fourteen and three quarters inches long allowing tube 3 to extend about one inch out each end of tube 4.

The tubes are preferably made of steel with a wall thickness of thirty-five thousandths inch. With the selected dimensions the annular chamber between adjacent tubes is restricted to a width of only ninety thousandths. In preferred position of the heat exchanger the tubes are on a vertical axis as illustrated. A cap 5 with stepped cylindrical sections is placed over the upper ends of the tubes. The ends of tubes 1 and 2 fit against the top of the cap while the uppermost cylindrical section of the cap snugly surrounds the outside of tube 2. Tube 3 fits within the second cylindrical section and abuts the shoulder between the two mentioned cylindrical sections. Likewise tube 4 is received into the lowermost cylindrical section with its end against the shoulder separating two lower sections.

The lower ends of the tubes are covered in a similar manner by cap 6 which is identical to cap 5. The contacting areas between the tubes and the caps are sealed by an oven braze operation. However, it is of incidental importance whether or not tube 1 is tightly sealed at the ends as neither water nor air in space 35 affects the operation of the exchanger.

In the narrow annular space between tubes 1 and 2 is a steel wire 7 wound helically about and secured by spot welding to tube 1. This wire is of a gauge which substantially spans the width of the annular space and accordingly forms with the adjoining tubular surfaces a thin helical passage. In a similar arrangement wire 8 forms a thin helical passage between tubes 2 and 3 and wire 9 a like passage between tubes 3 and 4.

The inner and outer helical passages are designed for the heat bearing fluid, for which, water has many advantages including its heat carrying capacity, high fluidity, and low cost. It also has low chemical activity when used in the small volume required in a closed system such as is involved here.

The water is delivered from its heating source through nipple 11 into the inner helical passage between tubes 1 and 2 and through nipple 10 into the outer passage between tubes 3 and 4. These nipples are preferably connected to a common manifold 12 receiving the heated water from supply line 13 as illustrated in Figure 1. The water is delivered in a substantial volume compared to the capacity of the helical passages and the flow rate is accordingly high.

Discharge nipples 14 and 15 from the upper cap 5 connect to the common outlet manifold 16 from which the water flows into return pipe 17 and back to the circulating water heater.

The intermediate helical passage between tubes 2 and 3 is sandwiched between the two hot water passages. For the benefit of counter current flow the coating material is introduced into the top of the intermediate passage through nipple 18 from a supply line 19 receiving the material from a conventional pressure tank, pump or circulating system.

The coating material spirals downwardly in a ribbon form quickly and easily heated by the hot water through the encompassing tubular surfaces. The coating material is discharged from the bottom cap **6** through nipple **20**. The material proceeds through elbow **21**, tubing **22** and into the fitting **23** from which it is delivered through conduit **24** to the spray applying equipment. Fitting **23** has as part of the passage through it the chamber **25**, which acts as a small reservoir. Into this chamber extends an ether bulb **26** which is joined through capillary tube **27** with a temperature recording gauge **28** functioning in the well known manner under the influence of the gas pressure generated by the temperature being reported. Fitting **23** is intimately secured to outer tubing **4** by extra heavy weld joints **30** which readily conduct heat from the tubing to the fitting.

Referring back to the water and coating material inlet and outlet connections special notice should be given the benefit of the stepped cylindrical design. This enables each connection to be made to its associated chamber through a single tube wall. Such an arrangement avoids the very objectionable possibility of a leak between chambers that is present when a connection traverses another chamber to reach its destination. Because of the thinness of the chambers it would be more expensive and awkward to make vertically disposed connections into the extreme ends of the chambers. Contributing to the simplification of the fabrication procedure is the exact manner of securing the nipple connectors in place. This is illustrated in Figures 2 and 3 with regard to nipple **10**. Slot **32** in tube **4** with which nipple **10** communicates is substantially longer circumferentially of the tube, than the diameter of nipple **10**, as may be seen in Figure 3. As other ports in the tubes are similarly elongated quite a broad tolerance in the placing of the caps on the tubes is afforded. Lengthwise of the tube **4**, slot **32** is narrower than the outside diameter of the nipple **10** as seen in Figure 2. This provides a positive stop on the insertion of the nipple through the extruded opening **34** in cap **6**. The nipples are oven brazed in place at the same time the contacting areas of the tubes and caps are so sealed.

Because of the restricted size and the enclosed nature of the coating material helical passage it is not feasible to introduce therein a temperature reporting element. A very effective arrangement for securing a reading is provided by fitting **23**. Heat from the hot water between tubes **3** and **4** is transferred to this fitting from tube **4** through the heavy welds **30**. The coating material resting in chamber **25** between periods of flow is thereby kept at the temperature to which it is raised by the exchanger. This temperature is recorded through bulb **26** on gauge **28**. If fitting **23** were loosely mounted on tube **4** the paint in chamber **25** would fall below the temperature of the paint in the exchanger during an idle period and the temperature reading would not give a true report of the temperature of the heated material. With a continuous flow of paint the transfer of heat to fitting **23** is of little consequence.

Due to the design of the thin passages, the stepped tubes and end caps, and the arrangement of the connections this heat exchanger is easily produced, compact and convenient to use. With the film of coating material passed between enveloping curtains of the heated water heat exchange is rapid and uniform.

It has been found that with a per minute flow of only one gallon of water heated to 185° F. at its source, coating material passing through the exchanger at the exceptionally high rate of one quart per minute will be heated and maintained at at least 150° F. and more likely at 155° F. The latter temperature is approximately that generally recommended for most materials. A much higher heat endangers the desirable qualities of such coating materials. Obviously with the temperature of the heating medium restricted to 185° F. objectionable overheating is not possible.



The swirling action of the coating material through the helical passage not only facilitates its absorption of heat but also inhibits settling of pigment and adhesion of resinous components. Because of the limited capacity only a small amount of thinner is required to flush the passage after a period of use.

While heating is the principal function of the subject invention it may of course be used for cooling as well, and the claims should be read to cover such a reverse transfer of heat.

Also, while water and coating material or paint are specifically referred to such terms should be interpreted sufficiently broadly to compass other fluent materials capable of carrying and transferring heat through the disclosed exchanger.

Although a specific embodiment has been shown and described it should be understood to constitute an example only and variations may be made therein without departing from the spirit of the invention as set forth in the following claims.

What is claimed is:

1. In a heat exchanger, four concentric tubes including a first innermost tube, a second tube encircling the first, a third tube encircling the second and an outside tube encircling the third, the first and second tubes being of equal length and longer than the third tube and exteriorly extending a short distance beyond both ends of the third tube, the third tube being longer than the outside tube and exteriorly extending a short distance beyond both ends of the outside tube, the diameters of the tubes being gauged to provide a narrow annular chamber between each adjacent pair; a thin-walled cap fixed in sealing relation over each set of ends of the tubes, each of said caps having a central flat circular area overlying and completely closing the ends of the first and second tubes, a contiguous primary cylindrical skirt embracing the outside of the exteriorly extending end portion of the second tube, a flat annular shoulder from the edge of the skirt overlying and completely closing the end of the third tube and the space between it and the second tube, a contiguous secondary skirt embracing the outside of the exteriorly extending end of the third tube, said skirt terminating in another flat annular shoulder overlying and completely closing the end of the outside tube and the space between it and the third tube, and a final contiguous cylindrical skirt embracing the outside of the end of the outside tube; means providing a liquid flow opening through the primary cylindrical skirt of each cap and the second tube into the space between the first and second tubes, means providing a liquid flow opening through the secondary cylindrical skirt of each cap and the third tube into the space between the second and third tubes, means providing a liquid flow opening through the final skirt of each cap and the outside tube into the space between the third and outside tubes, and means in the annular chamber between each adjacent pair of tubes directing the flow of liquid therethrough in a longitudinally-advancing circumferential path.

2. A heat exchanger according to claim 1 in which there is a heated liquid outlet pipe, a heat conductive means forming a chamber to which the pipe leads, additional heat conductive means between the outside tube and the first mentioned heat conductive means, and a temperature gauge in temperature sensitive association with said chamber.

3. In a heat exchanger, four concentric tubes including a first innermost tube, a second tube encircling the first, a third tube encircling the second and an outside tube encircling the third, the first and second tubes being of equal length and longer than the third tube and exteriorly extending a short distance beyond both ends of the third tube, the third tube being longer than the outside tube and exteriorly extending a short distance beyond both ends of the outside tube, the diameters of the tubes being gauged to provide a narrow annular chamber between

each adjacent pair; a thin walled cap fixed in sealing relation over each set of ends of the tubes, each of said caps having flat, annular area overlying and completely closing the ends of the first and second tubes, a contiguous primary cylindrical skirt embracing the outside of the exteriorly extending end portion of the second tube, a flat annular shoulder from the edge of the skirt overlying and completely closing the end of the third tube and the space between it and the second tube, a contiguous secondary skirt embracing the outside of the exteriorly extending end of the third tube, said skirt terminating in another flat annular shoulder overlying and completely closing the end of the outside tube and the space between it and the third tube, and a final contiguous cylindrical skirt embracing the outside of the end of the outside tube; means providing a liquid flow opening through the primary cylindrical skirt of each cap and the second into the space between the first and second tubes, means providing a liquid flow opening through the secondary cylindrical skirt of each cap and the third tube into the space between the



second and third tubes, means providing a liquid flow opening through the final skirt of each cap and the outside tube into the space between the third and outside tubes, and means in the annular chamber between each adjacent pair of tubes directing the flow of liquid therethrough in a longitudinally-advancing circumferential path.


**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,005,442 | Lovekin | Oct. 10, 1911 |
| 1,854,619 | Mortensen | Apr. 19, 1932 |
| 2,047,757 | Welch | July 14, 1936 |
| 2,057,804 | Twomey | Oct. 20, 1936 |
| 2,578,550 | Holm et al. | Dec. 11, 1951 |
| 2,707,098 | Turbin | Apr. 26, 1955 |
| 2,730,337 | Roswell | Jan. 10, 1956 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 363 | Italy | 1857 |
| 6,285 | Great Britain | Mar. 12, 1910 |