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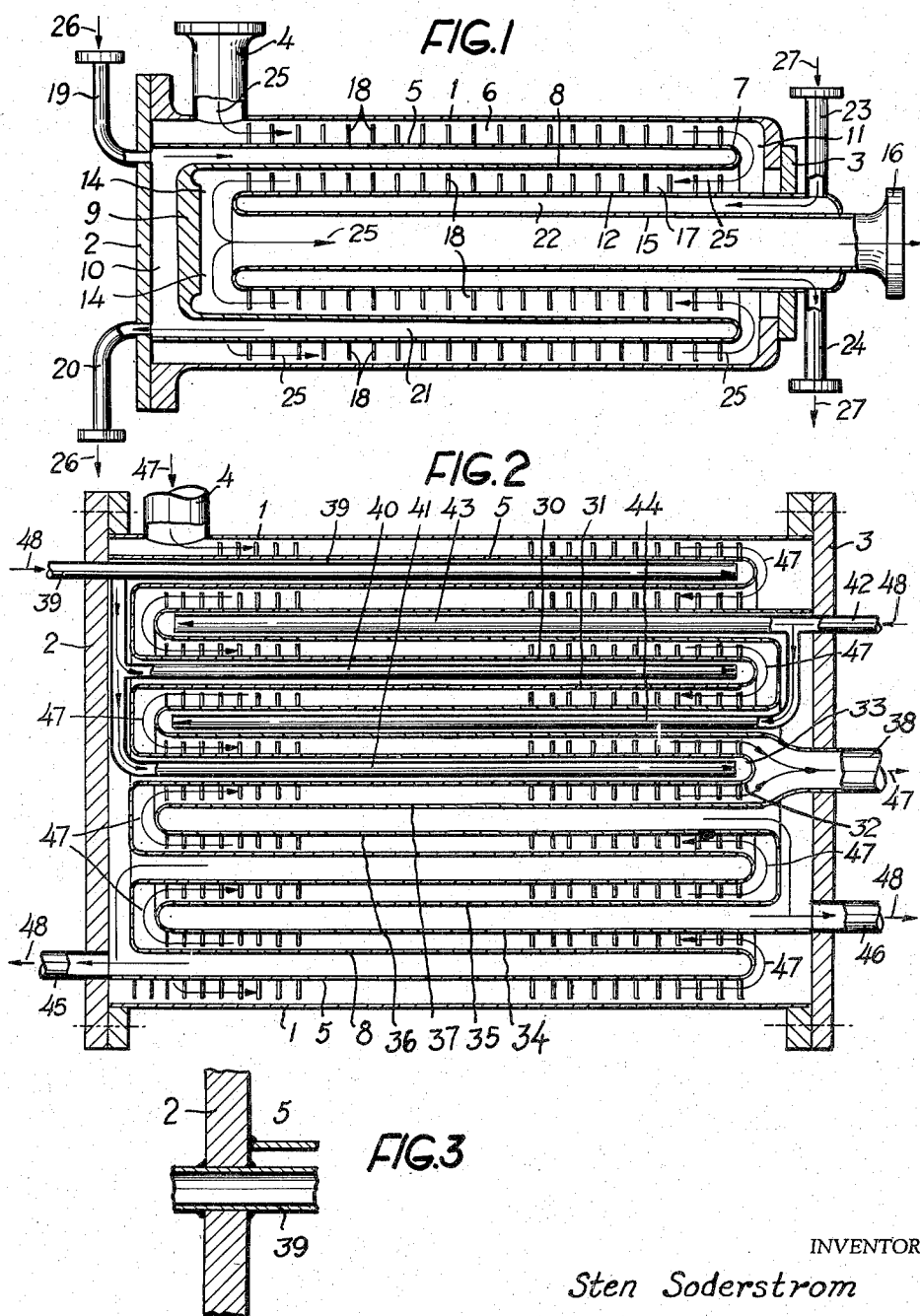
S. SÖDERSTROM

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HEAT EXCHANGER

Filed June 4, 1954

3 Sheets-Sheet 1



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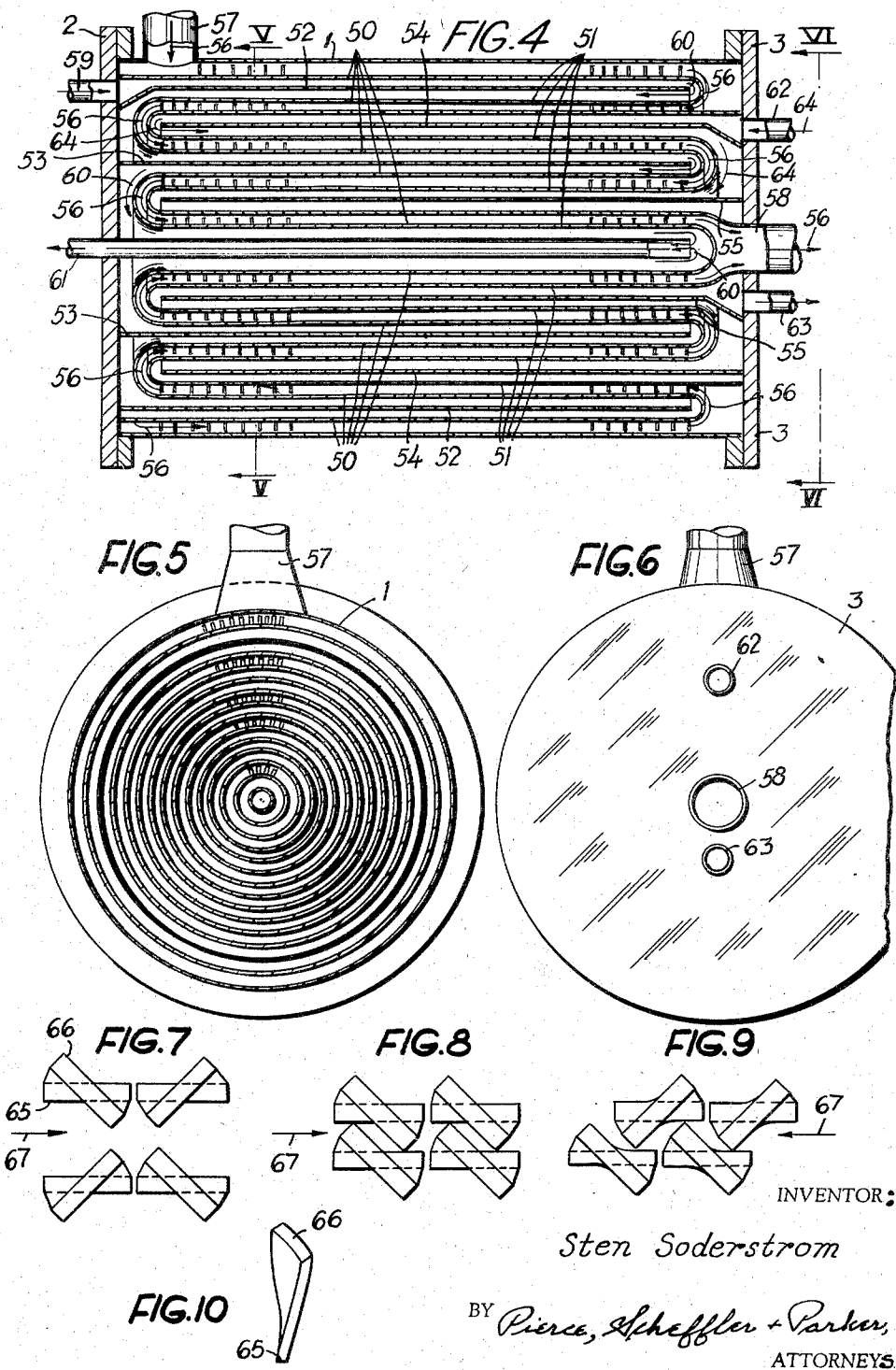
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## HEAT EXCHANGER

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7 Claims. (Cl. 257-237)

The present invention refers to heat exchangers and particularly to heat exchangers of the type intended for the heating of viscous media, such as certain kinds of oils, or for the cooling of media that become viscous at a lower temperature. The invention has for its object, above all, to design the heat exchanger so as to give it a large capacity in connection with moderate dimensions, and so that the heat transfer can take place at a high efficiency. A further object of the invention is to select a construction of the heat exchanger such that heat tensions owing to expansions and contractions of the parts comprised in the heat exchanger will be avoided as far as possible.

According to the invention, the heat exchanger consists of preferably concentric tubes thrust into each other and secured to the opposite ends of a housing, the inner ends of said tubes being free and the walls of the same being located at a distance from each other, so that flow passages or channels are formed in the space between them for the media between which heat is to be exchanged. The free inner ends of the tubes secured at the opposite ends thereof are movable, without being prevented by their attachments, at the elongation or shortening of the tubes setting in at temperature variations. At the same time, the tubes thrust into each other form suitable passages for the heat-exchanging media and may be enclosed within a housing of moderate dimensions at a relatively high capacity of the heat exchanger.

When the heat exchanger is constructed as a heater for a medium which is viscous when introduced into the heater, it will be found advantageous to construct the system so that the flow passage for said medium is reduced successively with respect to its passage area from an inlet for the medium to an outlet for the same. According as the medium is successively heated during its flow through the heat exchanger and becomes more liquid, the velocity of flow will increase, whereby the efficiency of the heat exchanger is improved. The flow losses may also be maintained at moderate values in spite of the increased velocity.

If the heat exchanger is to be constructed as a cooler for a medium that becomes more viscous at a lower temperature, a reversed arrangement will be serviceable, that is to say, the heat exchanger is then constructed so that the passage area for the medium to be cooled increases successively from an inlet for the medium to an outlet for the same.

According to a special feature of the invention, guide blades are arranged in the flow passages, preferably on one of the walls delimiting every passage, said guide blades extending in the transverse direction of the passage while being secured to the wall with one end and having the other end thereof free, the guide blades thus forming a meandering passage for the medium flowing therein. Each guide blade may be twisted from its base to its top to a configuration such that the medium flowing between the guide blades will also, when moving

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along the passage, perform a meandering motion in the transverse direction thereof so as to move alternately inwardly toward and outwardly from that one of the walls delimiting the passage which is the warmest.

Further features of the invention will appear from the following description of a few forms of embodiment of the invention as illustrated by way of example in the accompanying drawings. Fig. 1 is a diagrammatic representation of a longitudinal section through a heat exchanger according to a simple first embodiment of the invention, and Fig. 2 shows a similar section of a heat exchanger of a larger capacity according to a second embodiment. Fig. 3 shows a section of a detail of the embodiment according to Fig. 2. Figs. 4-6 show a third embodiment by way of diagrammatic representation, Fig. 4 being an axial section, Fig. 5 a radial section on line V-V in Fig. 4, and Fig. 6 an endwise view on line VI-VI in Fig. 4. Figs. 7, 8 and 9 show different mutual arrangements of guide blades or cams viewed toward the top. Fig. 10 shows such a cam in a perspective view. Figs. 11-16 are diagrammatic views of the embodiment shown in Fig. 2, the main parts being also illustrated separately; Figs. 11, 12, 13 and 14 are axial sections, while Fig. 15 is a cross section on line XV-XV in Fig. 13, and Fig. 16 is a cross section on line XVI-XVI of Fig. 14. Fig. 17 is an axial section of a further embodiment, and Fig. 18 a cross section on line XVIII-XVIII of Fig. 17.

As shown in Fig. 1 of the drawings, the heat exchanger according to the embodiment in consideration consists of an outer, preferably cylindrical housing 1 with an end wall or plate 2 removably secured thereto and with an end wall or plate 3, which is likewise removably secured to said housing. In the proximity of the end wall 2, the housing 1 is provided with an inlet socket 4 for a medium, such as viscous oil, intended to be heated, for instance for the purpose of making it more liquid. Arranged in the housing 1 and preferably in concentric relation thereto, is a tube 5 of a relatively large diameter, said tube being secured at one end thereof to the end wall 2 and extending axially through the housing to a point 7 in the proximity of, but spaced from the opposite end of the housing. A flow passage 6 is formed for the medium to be heated between the outside of the tube 5 and the housing, said passage extending longitudinally of the tube 5 and around the same. The opposite end 7 of the tube 5 merges by turning inwardly, into and to form the corresponding end of an inner tube 8 coaxial with the tube 5 and extending back toward the end of tube 5 secured to end wall 2 where it is closed at its opposite end by an end wall 9, which is preferably located at some distance from the end wall 2, so that a space 10 is provided between said end walls. Provided at the transition 7 between the tubes 5 and 8 is a space 11, through which the medium from the flow passage 6 may pass. Here, the tubes 5 and 8 may be said to form a double-tube, the outer tube 5 only being attached to an end wall 2 of the housing 1.

Thrust into the opposite, open end of the inner tube 18 is a tube 12, which is secured at one end to and passes through the end wall 3 but has its opposite end located freely at a distance from the end wall 9, where the passage 14 is formed. At the passage 14, the tube 12 merges by turning inwardly into and to form the corresponding end of an inner tube 15 which extends back through the tube 12 and out through the end wall 3, where it forms an outlet socket 16 for the heated medium. Between the tubes 8 and 12, the flow passage 6 continues from the passage 11 to the passage 14 by merging into a space 17, which then merges into the inside of the tube 15. The tubes 12, 15 thus also form a double-tube.

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Cams or guide blades 18 are preferably secured to the wall delimiting the flow passages 6, 17 in an inward direction, that is to say, to the outsides of the tubes 5 and 12, in a manner such that said cams or guide blades have their bases at said wall and their tops at or in the proximity of the opposite wall of the clearance, that is to say, at the housing 1 and at the tube 8, respectively. Said cams or guide blades are intended to improve the heat transfer. Examples of their construction are shown in Figs. 7-9.

Secured in the end wall 2 is an inlet pipe 19 for the heating medium, such as steam, and an outlet pipe 20 for the heating medium or for condensate formed by the same. These pipes are open toward the space 21 formed about the tube 8 between the latter and the tube 5. Likewise, the space 22 within the double-tube 12, 15 is in communication with an inlet socket 23 for a heating medium, such as steam, and with an outlet socket 24 for said medium or for condensate formed thereby.

Arrows 25 indicate how the medium to be heated flows from the inlet 4 into the flow passage 6, through the passage 11 and the passage 17 in a direction back toward the passage 14, and from the latter through the innermost tube 15 to the outlet 16.

Arrows 26 and 27 indicate the path of the heating medium from the inlets 19 and 23 to the outlets 20 and 24, respectively.

The arrangement described may be simplified by single tubes being substituted for the double-tubes, inlet and outlet sockets being then arranged correspondingly for the different media.

The capacity of the heat exchanger may be increased considerably without changing the length thereof, by forming the heat exchanger with a plurality of double-tubes within one another. Such a tube might be designated a multiple-tube. Examples of such tubes are shown in Fig. 2. Here, the outer housing 1, the end walls or plates 2, 3, the inlet socket 4 for the medium to be heated, such as oil, and the outermost double-tube 5, 8 have the same designations as in Fig. 1. Instead of terminating in an end wall 9, as in Fig. 1, the inner tube 8 here merges into a further double tube 30, 31 located within the tube 8, said double-tube continuing at the end wall 2 into an inner tube 32 having a closed end 33 in the propinquity of the opposite end wall 3. Arranged in the end wall 3 is also a multiple-tube composed of two double-tubes, namely the multiple-tube 34, 35, 36, 37, the several tubes of the multiple tubes projecting into one another. The innermost tube 37 projects through the end wall 3 of the exterior thereof and here forms an outlet 38 for the medium that has been heated. The heating medium is introduced into the tube 5 through a pipe 39 extending into the space between the tube walls 5 and 8 and through pipes 40 and 41 branched off from the pipe 39 and extending into the intermediate space between the tubes 30 and 31 and into the tube 32, respectively. Likewise, heating medium is introduced through an inlet 42, arranged in the opposite end wall 3, into pipes 43, 44, the latter of which is branched off from the pipe 43. On having given off heat, this medium escapes, perhaps in the form of condensate, through an outlet 45 in the end wall 2 and an outlet 46 in the end wall 3. How the heat-absorbing medium flows is shown by the arrows 47, the path of the heat-yielding medium being indicated by the arrows 48.

Fig. 3 is a detail view illustrating the manner of securing the tube 5 to the end wall 2 and the manner in which the pipe 39 passes therethrough.

In Figs. 11-16 the same reference numerals are used as in Fig. 2 to indicate corresponding elements. Fig. 11 illustrates the same section as Fig. 2, i. e. an axial section of the assembled heat exchanger in a somewhat simplified manner, Fig. 12 shows the housing 1 with its inlet socket 4 for the medium to be heated, Fig. 13 the left end plate 2 with its multiple tube 5, 8, 30, 31, 32,

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Fig. 14 the right end plate 3 with its multiple tube 34, 35, 36, 37 and Figs. 15 and 16 cross sectional views of the parts of the heat exchanger shown in Figs. 13 and 14 respectively. It is clear from Figs. 12-13 in what manner the heat exchanger may be assembled, i. e. simply by thrusting the end plates 2 and 3 with their corresponding multiple tubes from opposite directions into the housing 1 to the position illustrated in Fig. 11. It is also clear from Fig. 11 that the multiple tube 5, 8, 30-31, 32 is secured to its end plates 2 only at its one end but is free at its other end so as to be able to expand at changes of temperature without influencing the opposite end plate 3. The same applies to the multiple tube 34, 35, 36, 37 with regard to the end plates 3 and 2.

In the construction according to Figs. 4-6, a multiple-tube 50, consisting of five tubes located within each other and integral at the ends thereof, is united with the end wall 2, that is to say through the left end of the outermost tube, as shown in Fig. 4. In a similar manner, a multiple tube 51, consisting of four tubes located within each other and integral at the ends thereof, is secured to the end wall 3 by the outermost tube of said multiple-tube, so that said tubes are caused to project in between the part tubes of the multiple tube 50 while being free from said tubes and forming flow passages for the heat-exchanging media. In order that the heat-yielding medium, which may be constituted by a liquid, shall be conveyed from one end to the other of the tubes, special guide tubes are provided in the spaces traversed by the heat-yielding medium. Thus there are two such coaxial guide tubes 52, 53 secured to the end wall 2 and two similar guide tubes 54, 55 secured in the end wall 3. The medium to be heated flows as indicated by the arrows 56 from the inlet 57 to the outlet 58, whereas the heat-yielding medium flows from the inlet 59 in the end wall 2 to the outlet through a central pipe 61, as shown by the arrows 60, and from the inlet 62 in the opposite end wall 3 to an outlet 63, as shown by the arrows 64.

Inasmuch as the heat-absorbing medium flows from a passage or channel adjacent to the inlet with a progressively smaller diameter inwardly toward the center of the apparatus, where it escapes, it is obvious that the passage area thereof is reduced, according as the heating proceeds. Hereby the velocity of the medium is also increased. At the inlet, where the medium may be conceived of as being comparatively viscous, the resistance to the flow will still be moderate owing to the large passage area, and when heated the medium becomes more liquid, for which reason the velocity thereof may be increased, without the resistance to the flow becoming too great.

Figs. 7, 8 and 9 show various arrangements of the cams or guide blades 18 arranged in the channels for the heat-absorbing medium. These cams may be welded or secured otherwise in rows along the tube walls and the cams in each row extend in a generally radially outward direction as related to the longitudinal axis of the tube. Each cam is twisted, so that the base 65 and the top 66 thereof form an angle with one another. In Figs. 7-9, where the arrows 67 indicate the longitudinal direction of the tubes (the principal direction of flow of the medium), two cams are shown in each of two adjacent rows. In Fig. 7, the cams are arranged peripherally and axially opposite one another while being twisted in opposite directions; in Fig. 8, the cams are likewise arranged peripherally and axially opposite one another, but are twisted in the same direction; and in Fig. 9 they are displaced axially by half a cam width and twisted in opposite directions.

The cams form a meandering passage for the medium and break the laminary flow thereof and increase the heat transferring surface, whereby the transfer of heat is highly improved.

Through the twisting of the cams, the medium flowing between them will also obtain a direction of movement inwardly toward the base of the cam, the medium being

thus compelled to move against the heat-yielding tube wall.

The cams are preferably made from the same kind of material as are the tubes, for instance from malleable iron or some acid-proof iron alloy, aluminium alloy or copper alloy.

Owing to the arrangement of the tubes as described with the tubes secured in separate end walls and having the inner ends thereof free, the heat exchanger may be readily dismantled, the cams being located in easily accessible channels so as to permit of being conveniently cleaned.

In the embodiment shown in Figs. 17 and 18 the two coaxial tubes 70, 71 are carried only by one end wall 72, which is removable, the other end wall 73 being integral with the cylindrical part 74 of the housing. The tubes 70, 71 merge one into the other at their inner ends, which are free from the end walls, the tubes thus forming a double tube with a chamber 75 therebetween for one medium, for example steam, which is admitted through the inlet 76 and escapes, usually as a condensate, through the outlet 77. There is a central inlet 78 at the end wall 73 for the other medium, for example oil, and an outlet 79 in the end wall 72 for the same. A cup shaped guide wall or member 80 is secured to the double tube 70, 71 by spider 81 and a bolt 82 and extends around the tubes 70, 71 toward the carrying end wall 72. It terminates in spaced relation from the latter to form an annular passage 83 for the medium which flows in the direction indicated by the arrows 84.

It is evident that the capacity of the heat exchanger of the type illustrated in Figs. 17-18 can be improved by substituting for the double tube 70, 71 a multiple tube of the type illustrated in Fig. 2, a plurality of coaxial guide cups of the same type as the guide wall 80 being mounted one within the other and in the spaces between the double tubes of the multiple tube.

The embodiment shown in Figs. 17-18 brings the advantage that all tubes are carried by one end wall and are carried along with the latter at the removal from the housing. Furthermore an even distribution of the medium entering the inlet 78 is also gained by this embodiment, and if the entering medium has the temperature of the surrounding atmosphere the heat exchanger need not be heat-insulated outwards, since the entering medium flows in contact with the housing 74 before contacting any wall heated by the other medium.

In connection with the examples of embodiment shown, the invention has been described as referring to a heating apparatus, but obviously the same principle may be applied to coolers.

What I claim is:

1. Heat exchanger comprising a housing including opposite end walls and a side wall therebetween, a first multiple tube comprising an outer tube secured at one end thereof to one end wall of said housing, the opposite end of said outer tube being turned inwardly to form the corresponding end of an inner tube within said outer tube, the opposite end of said inner tube being closed and being located in the proximity of but in spaced relation from that end wall of said housing to which said outer tube is secured; a second multiple tube comprising an outer tube secured at one end to the opposite end wall of said housing and extending into an end of the inner tube of said first multiple tube, the opposite end of said outer tube terminating in the proximity of but in spaced relation from the closed end of said inner tube of said first multiple tube and being turned inwardly to form the corresponding end of an inner tube within said outer tube and which extends longitudinally within said outer tube, the opposite end of said inner tube being closed and being located in the proximity of but in spaced relation from said opposite end wall of said housing, said tubes of said first and second multiple tubes being spaced from each other and from the side wall of said housing; a pipe connection for a first

medium into one end of said housing between said housing and the outer tube of said first multiple tube, a pipe connection for that said first medium into the inner tube of said second multiple tube at the opposite end of said housing, inlet and outlet pipe connections for a second medium through one end of said housing and into the space between the inner and outer tubes of said first multiple tube, and inlet and outlet pipe connections for said second medium through the opposite end of said housing and into the space between the outer and inner tubes of said second multiple tube.

2. Heat exchanger as claimed in claim 1, in which the spaces between said tubes form flow passages, one for the heat delivering medium and another for a viscous heat receiving medium, the cross-sectional area of the latter passage decreasing successively from an inlet for the medium being heated to an outlet for the same medium.

3. Heat exchanger as claimed in claim 1, in which the spaces between said tubes form flow passages, one for a cooling medium and another for a medium to be cooled, the cross-sectional area of the latter passage increasing successively from an inlet for the medium to be cooled to an outlet for the same medium.

4. Heat exchanger comprising a housing including opposite end walls and a side wall therebetween, a first multiple tube comprising an outer tube secured at one end thereof to a first end wall of said housing, the opposite end of said outer tube being turned inwardly to form the corresponding end of a first inner tube within said outer tube, the opposite end of said first inner tube being located in the proximity of but in spaced relation from that end wall of said housing to which said outer tube is secured, said opposite end of said first inner tube being turned inwardly to form the corresponding end of a second inner tube within said first inner tube, the opposite end of said second inner tube being closed and spaced from the second and opposite end wall of said housing; a second multiple tube comprising an outer tube secured at one end thereof to said second end wall of said housing and extending into an end of said first inner tube of said first multiple tube and being spaced therefrom, the opposite end of said outer tube of said second multiple tube terminating in the proximity of but in spaced relation from the inwardly turned end of said first inner tube of said first multiple tube and itself being turned inwardly to form the corresponding end of a first inner tube within said outer tube of said second multiple tube, the opposite end of said first inner tube of said second multiple tube terminating in the proximity of but in spaced relation from said second end wall of said housing to which said outer tube of said second multiple tube is secured, said opposite end of said first inner tube of said second multiple tube being turned inwardly to form the corresponding end of a second inner tube located within said first inner tube of said second multiple tube and spaced therefrom, said tubes of said first and second multiple tubes being spaced from each other and from the side wall of said housing; an inlet pipe for a first heat exchanging medium leading to the housing space between said end walls and the outer side of said outer tube of said first multiple tube, an exit pipe for said first heat exchanging medium connected to the opposite end of said second inner tube of said second multiple tube, an inlet pipe for a second heat exchanging medium leading through said first end wall into a first enclosed space between the outer tube and inner tubes of said first multiple tube, an outlet pipe for said second heat exchanging medium from said first enclosed space, a second inlet pipe for said second heat exchanging medium leading through said second end wall into a second enclosed space between the outer tube and inner tubes of said second multiple tube, and a second outlet pipe for said second heat exchanging medium from said second enclosed space.

5. Heat exchanger as defined in claim 1 and comprising an inlet pipe for one medium extending through said

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one end wall of said housing into the space between the outer tube and the inner tube of the multiple tube carried by said one end wall, said pipe opening into said space near the place where the inner end of said outer tube is turned inward to merge into the inner tube.

6. Heat exchanger comprising a tubular housing, an end plate removably attached to each end of said housing, first and second series of coaxial tubes merging into one another alternately at opposite ends, the outermost of the tubes in said first series being secured to one end plate at one of its ends only and the other of said ends carrying the remaining tubes of said first series, the outermost tube of said second series being secured to the other end plate and the innermost tube of said second series passing through the latter end plate, the first series being supported by its end plate only but being unsupported by and spaced from the end plate carrying the second series, the tubes of one series further extending into spaces between tubes of the other series to form a flow passage for one heat exchanging medium in the housing between said series of tubes from a point at or near the periphery of the housing to the place where the innermost tube of the second series passes through its end plate, each series of

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tubes also forming, together with the end plate carrying said series, a space for the other heat exchanging medium.

7. Heat exchanger as claimed in claim 6 and further having guide pipes each of which is secured at one end to one end plate and open at its other end, said other end extending into the space formed between the corresponding series of tubes and end plate, the inner open end of each guide pipe being located near the place of transition between two consecutive tubes of the series but spaced therefrom to allow heat exchanging medium to pass from one side of the guide pipe past the inner end thereof and to the other side thereof.

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