L. D. LOVEKIN.

FLUID HEATER AND COOLER.

APPLICATION FILED MAY 1, 1909.

983,913.

Patented Feb. 14, 1911.

3 SHEETS—SHEET 1.

Fig. 1.

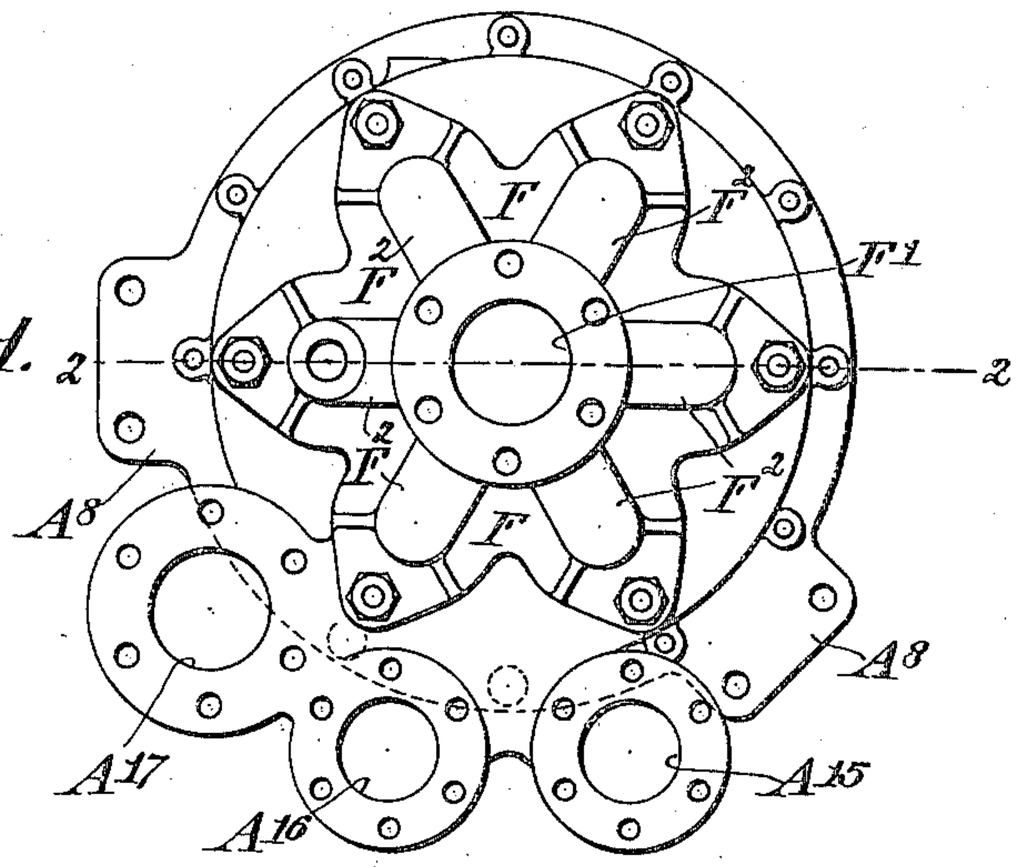
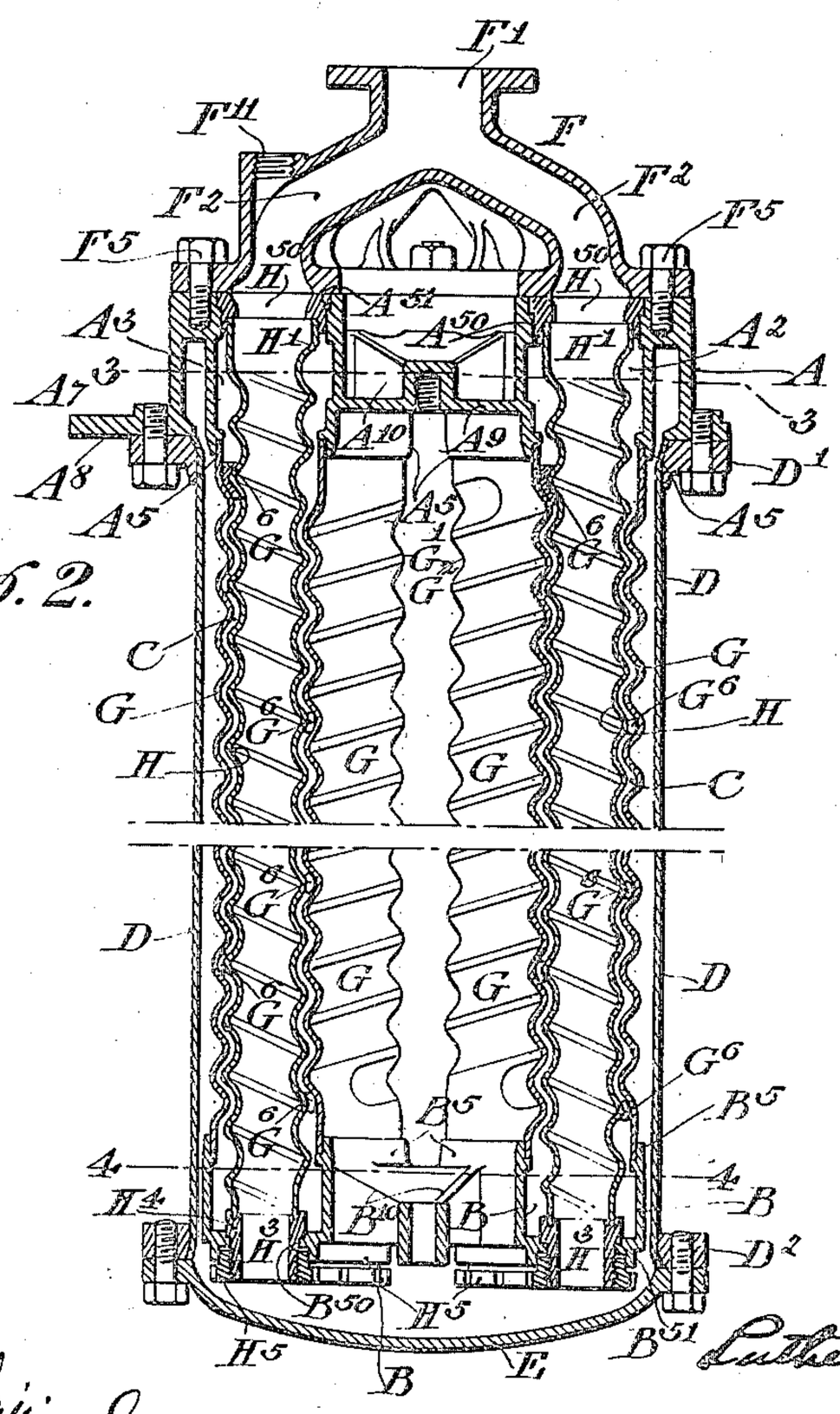


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3.

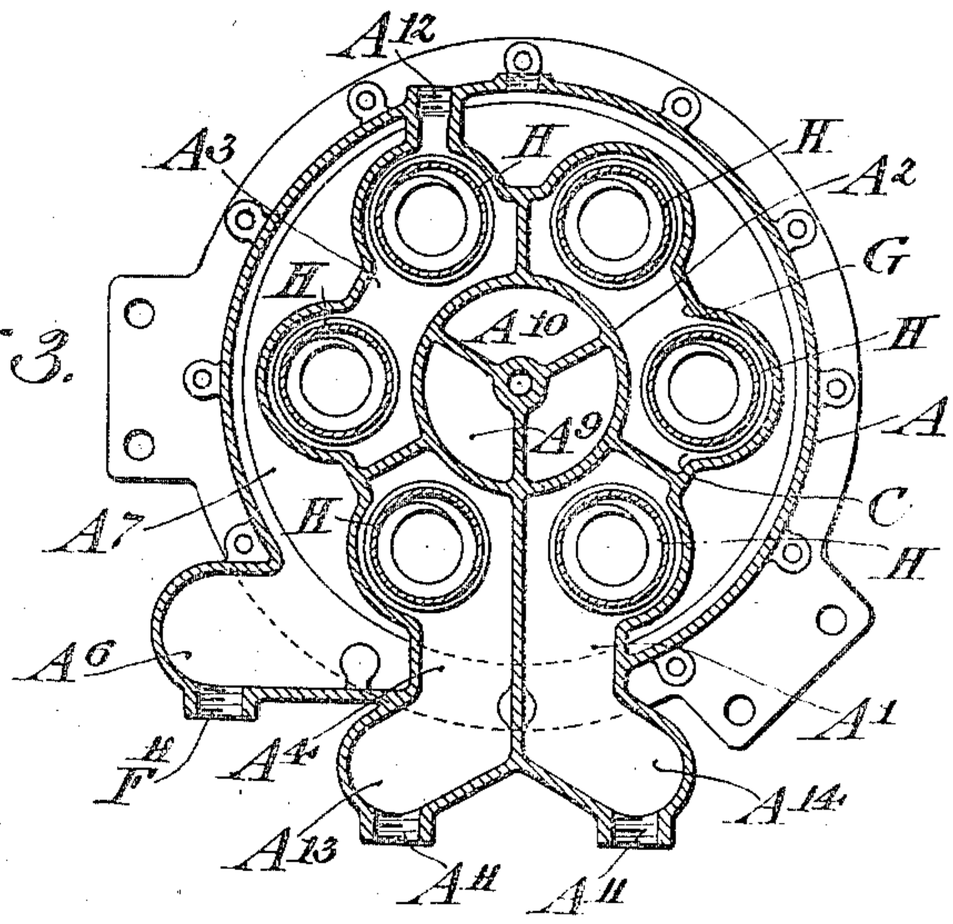


Fig. 4.

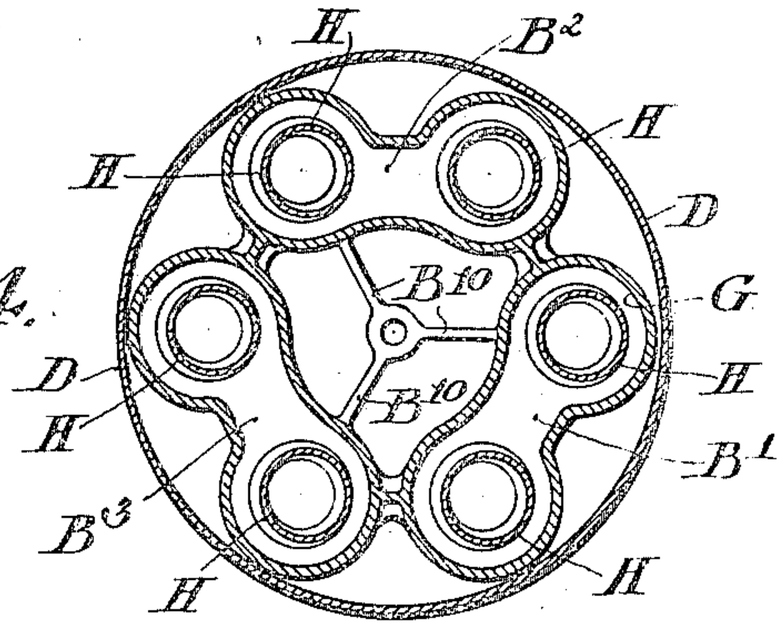
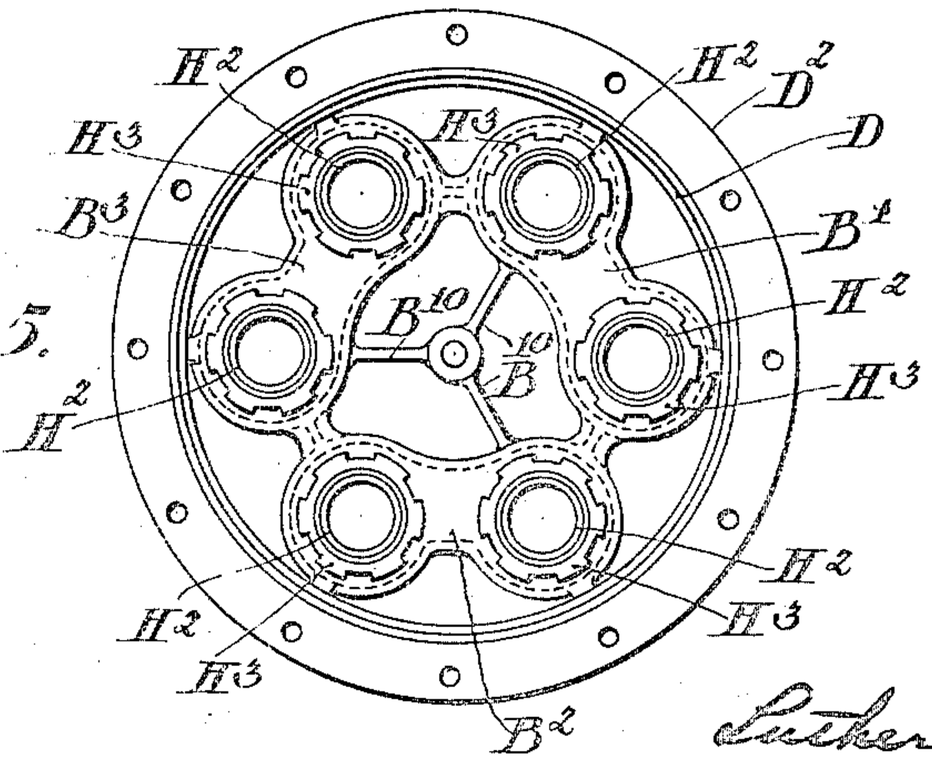


Fig. 5.



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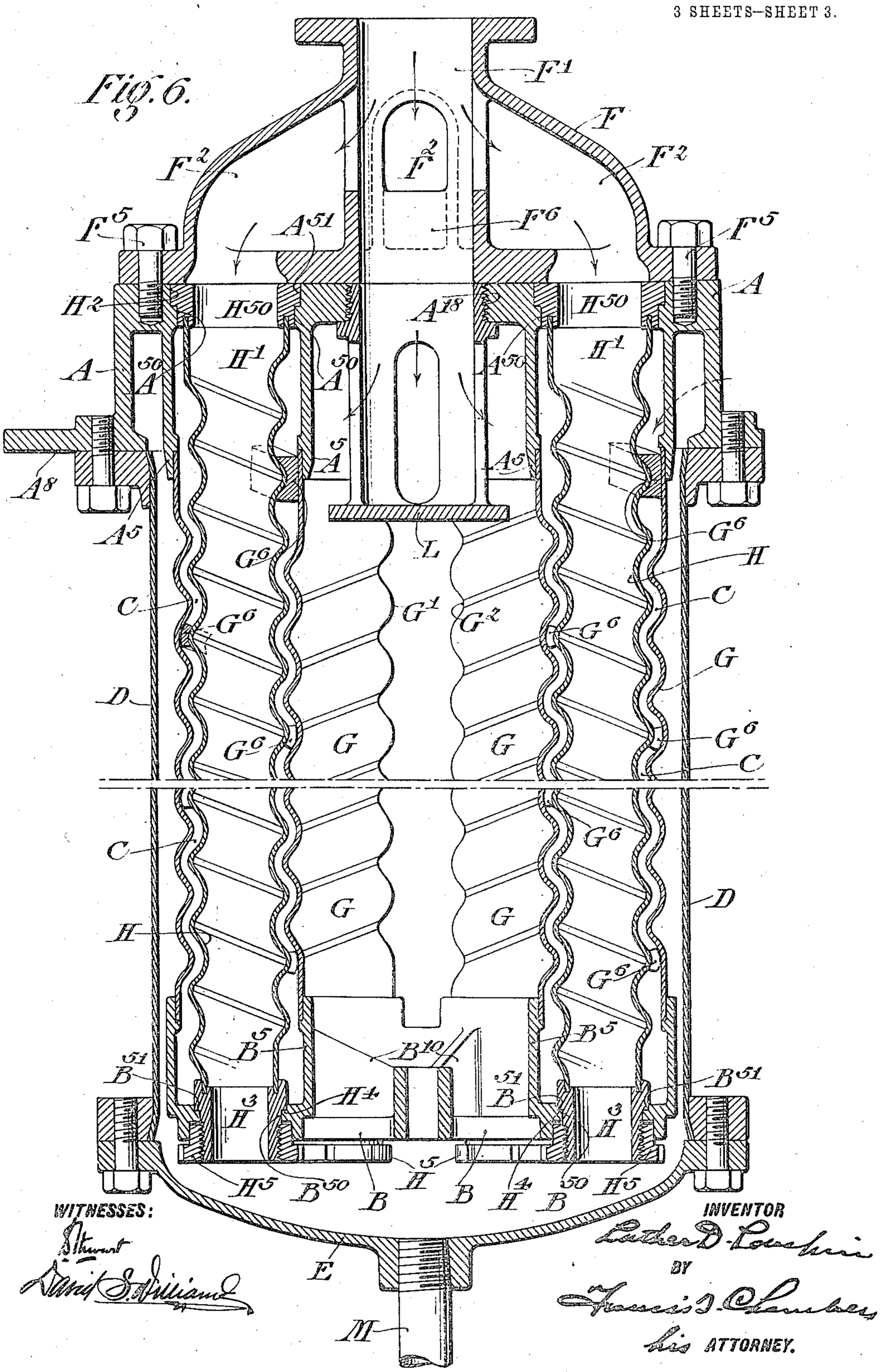
3 SHEETS—SHEET 3.

Fig. 6.



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FLUID HEATER AND COOLER.

983,913. Specification of Letters Patent. Patented Feb. 14, 1911.

Application filed May 1, 1909. Serial No. 493,277.

To all whom it may concern:

Be it known that I, LUTHER D. LOVEKIN, a citizen of the United States of America, residing in the city and county of Philadelphia, in the State of Pennsylvania, have invented a certain new and useful Improvement in Fluid Heaters and Coolers, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

My present invention relates to apparatus of the kind in which provisions are made for the flow of two separate fluids of different temperatures in proximity to each other in order that heat may be transferred from one fluid to the other.

The general object of the present invention is to provide apparatus of the kind, and for the purpose specified, which is simple and relatively inexpensive to manufacture, which is compact, and which is efficient and durable in operation.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention and the specific objects obtained with it, and the advantages possessed by it, reference may be had to the accompanying drawings and descriptive matter in which I have illustrated and described forms in which the invention may be embodied.

Of the drawings, Figure 1 is a plan view of a device primarily intended for use as an oil cooler. Fig. 2 is a sectional elevation on the line 2—2 of Fig. 1. Fig. 3 is a sectional plan on the line 3—3 of Fig. 2. Fig. 4 is a sectional plan on the line 4—4 of Fig. 2. Fig. 5 is an inverted plan, or bottom end view, of the heater shown in Figs. 1 and 2 with the lower casing end removed. Fig. 6 is a view, similar to Fig. 2, of a modified construction particularly adapted for use as a feed water heater where the temperature of the water is to be raised by the use of steam.

The device shown in Figs. 1, 2, 3, 4 and 5 is primarily designed for cooling a liquid such as oil by the use of a cooling fluid such as cold water. The device comprises a plurality of tubular elements each consisting of an inner tube H and an outer tube G surrounding the tube H and separated from it by a space C, a pair of disk like chambered members A and B to which the opposite ends of the tubes G and H are connected, a casing surrounding the bodies of the tubular elements and the member B, said casing being formed by the member A, a casing D connected at one end to the member A and a casing end member E and a supplemental end member F connected to the end member A. The form of the invention shown in Fig. 6 does not differ from that shown in Figs. 1 to 5 in the manner in which the tubes G and H are connected into the members A and B and various common features can be seen more readily in Fig. 6 than in Fig. 2 owing to the larger scale on which Fig. 6 is drawn.

The member A is formed on its inner side or end with a plurality, six in the present instance, of hollow bosses or seats A^5 arranged in a circle. In each boss is secured, as by brazing, one end of the corresponding one of the tubes G of which there are six. The other ends of the tubes G are connected in the same or similar manner into bosses B^5 formed on the inner end or side of the end member B. Openings A^{50} each coaxial with a corresponding one of the seats A^5 are formed in the outer end wall of the member A. These openings are enlarged at their upper ends, as indicated, at A^{51}. Each tube H is formed with an end portion H^1 passing through and filling the corresponding opening A^{50}. Each end portion H^1 is provided with a collar or rib H^{50} which fills and seats against the bottom of the enlargement A^{51} and makes a tight joint therewith, when the end portion H^1 is clamped in place by suitable means, as in the constructions shown, by the end member F which is clamped against the end member A by bolts F^5. The end portions H^1 of the tubes H are formed, in the construction shown, by collars brazed on the ends of the body portion of the tubes H. Similarly, the tubes H are provided at their opposite ends with end portions H^3 adapted to pass through apertures B^{50} formed for the purpose in the outer or bottom wall of the end member B. The end portions H^3 are provided with shoulders H^4 adapted to bear against and make a tight joint with the seats B^{51} provided on the inner side of the outer wall of the end member B. The end portions H^3 are externally threaded and nuts H^5 are provided for clamping the end portions H^3 in place and

thereby insuring tight joints between the end portions H^3 and the outer wall of the end member B.

Preferably, as in the construction illustrated, the tubes G and H are formed of thin metal and are spirally corrugated, with the space between each pair of tubes less in thickness than the depths of the corrugations, so that while the tubes can be assembled and disassembled by threading the inner tubes in place in the outer tubes, the surface of the intertube space is large relative to its volume. Moreover, the corrugation of the tubes G and H permit them to expand and contract relative to each other without producing any injurious strains or leaky joints. The heater, in so far as the corrugated bodies of the tubes G and H are concerned, embodies the invention of my prior Patent, No. 904,627, granted November 24, 1908.

To maintain uniform thickness of the spaces C, lugs G^6 may be brazed, soldered or otherwise formed at intervals on the tubes G. Preferably one or more of these lugs is provided at the extreme upper end of each tube G, and the lug or lugs thus located serve to clear the corresponding tube H as it is threaded into or out of the tube G carrying the lug.

In order that the device may be compact as a whole, while at the same time preserving the necessary separation between adjacent tubular elements, the external corrugation ribs G^1 of each tube G nest in the corrugation grooves G^2 of its neighboring elements.

It will be observed that the end connections shown and described are such as to readily permit the inner tubes H to be initially put into place in the members G, and to be removed and replaced. I make no claim herein, however, to the particular construction of end connections disclosed, for this construction, while novel with me, is claimed in my prior application, Serial No. 463,962, filed Nov. 23, 1908.

It will be observed that with the construction disclosed, the space C between each tube H and the surrounding tube G is open at its opposite ends to the interior of the chambered end members A and B. The space in the end member A is divided by suitable diaphragms, or partition walls, into compartments A^1, A^2, A^3 and A^4. One tube G opens at its upper end into the compartment A^1, another tube G opens into the compartment A^4, and two tubes G open into each of the compartments A^2 and A^3. Similarly, the interior of the lower end member B is divided into three compartments, B^1, B^2 and B^3, by suitable partition walls. In the case of the end member B, however, two of the tubes G open into each of the compartments B^1, B^2, and B^3. The arrangement is such, however, that a fluid entering the compartment A^1 in the end member A must pass in series through all of the tubes G, or rather, through the spaces between each tube G and the surrounding tube H, to reach the compartment A^4. This is accomplished by arranging the tubes so that one tube G is open at its upper end to the compartment A^1 and at its lower end to the compartment B^1, while the second tube G is open at its lower end to the compartment B^1 and at its upper end to the compartment A^2, the third tube is open at its upper end to the compartment A^2 and at its lower end to the compartment B^2, the fourth tube is open at its lower end to the compartment B^2 and at its upper end to the compartment A^3, the fifth tube is open at its upper end to the compartment A^3 and at its lower end to the compartment B^3, and the sixth tube is open at its lower end to the compartment B^3 and at its upper end to the compartment A^4.

In the particular construction illustrated in Figs. 1 to 5, inclusive, the oil to be cooled, and in general the fluid which it is the primary object to change the temperature of, is passed through the space between the tubes H and G of the tubular elements. In the particular construction illustrated, the compartments A^1 and A^4 are expanded at A^{13} and A^{14} to form spaces from which lead the inlet and outlet oil ports A^{15} and A^{16}, respectively. In the construction illustrated, the cooling fluid, for instance water, is admitted to the interiors of the tubes H at their upper ends through channels F^2 formed in the end member F and all diverging from the central water inlet port F^1 at the upper end of the member F. The water passing down through the tubes H is discharged at the lower end of the latter into the inclosing casing formed by the members A, D and E. The outlet port A^{17} for the cooling water leads from the outlet space, or chamber, A^6 formed in the end member A. The end member A is provided with ears A^8 by means of which the device may be supported. Various ports A^{11} and F^{11} may be provided for the insertion of thermometer tubes for measuring the temperatures existing in various portions of the apparatus. A^{12} represents an opening in which an oil drain cock may be inserted. As shown, the end members A and B are provided with stiffening ribs A^{10} and B^{10}, respectively, and in the construction shown in Figs. 1 to 5, inclusive, the ribs A^{10} are connected by a horizontal imperforate web A^9, though this is not essential.

The construction shown in Fig. 6 is primarily intended for heating some fluid, such as water, by the use of steam. This construction differs from that first described in the manner in which the steam is circulated. In this construction the member F is pro-

vided with an inlet port F^1 for the steam, with channels F^2, and in addition, with a passage F^6 through which the steam may pass through the port A^{18} directly into the upper end of the space surrounding the tubes G, a deflector L being provided for directing the steam laterally against the tubes G. In this form the port A^{17} in member F is dispensed with and a discharge pipe M for water condensed from the heating steam is provided which leads from the member E and may be provided with any suitable valve, trap or cock (not shown).

It will be observed that in both forms of the invention disclosed relative expansion between the tubular elements and the casing may occur without putting any strain on the apparatus, the end member B being free to move relative to the casing end E toward and away from the latter. The inlet and outlet ports for the fluid passing through the intertube spaces C is formed in the cast member A, and the port F′ is formed in the relatively heavy cast member F directly secured to the member A. In both forms the apparatus is compact and durable and highly efficient since provision is made for a highly effective circulation of the working fluid and the fluid acted upon particularly the latter. The device may be readily assembled initially and disassembled and reassembled when necessary for inspection, cleaning or repairs.

While the device shown in Figs. 1 to 5 is especially designed for use in cooling oil and that shown in Fig. 6 for heating water, it is apparent that either form may be used, with or without slight modifications, for a variety of heating or cooling purposes. For instance, by removing the casing end member E of Fig. 6, the apparatus there shown could be used without other change as a heater deriving heat from any source such as a gas burner, the products of combustion passing out of the casing through the port F^1.

While the forms described and illustrated are the best forms of the device now known to me, it will be apparent to those skilled in the art that numerous changes may be made in the form of my invention without departing from its spirit, and I do not wish the claims hereinafter made to be limited to the particular embodiment of my invention disclosed more than is made necessary by the state of the art.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is:

1. In a fluid heater or cooler, the combination of a structure formed with a series of parallel passages, said member having openings at one edge, one at the end of each of said passages and having each opening enlarged at its outer end to provide an annular shoulder surrounding the body of the opening, tubular members, one passing through but not filling each of said tubular passages, and each having an end portion provided with a rib adapted to seat on said annular shoulder of the corresponding opening, and a one piece end member, detachably clamped against said one edge of said structure and engaging the end portions of the tubular members to hold them in place, and formed with ports communicating with the interiors of said tubular members.

2. In a fluid heater or cooler, the combination of a plurality of pairs of tubular elements, each consisting of an inner tube and an outer surrounding tube separated from the inner tube by a space, and a member to which one end of each tube is connected, said member being formed with compartments arranged to connect the intertube spaces of said elements together in pairs.

3. In a fluid heater or cooler, the combination of a plurality of tubular elements, each consisting of an inner tube and an outer surrounding tube separated from the inner tube by a space, a member to which one end of each tube is connected and another member to which the opposite ends of said tubes are connected, said members being formed with chambers by which the intertube spaces of each of various elements are connected to the intertube spaces of another element in one member and to the intertube spaces of a third element in the other member.

4. In a fluid heater or cooler, the combination of a plurality of circularly arranged and parallel tubular elements, each consisting of an inner tube and an outer surrounding tube separated from the inner tube by a space, a circular chambered member to which one end of each tube is connected with the intertube spaces of each element open to the interior of said chamber, and a second circular chambered member to which the opposite ends of the tubes are connected with the intertube spaces of the elements open to the interior of said second chambered member, said chambered members being formed with diaphragm or partition walls dividing the chambers therein into compartments whereby the intertube spaces of the various elements are connected in series.

5. In a fluid heater or cooler, the combination of a plurality of tubular elements, each consisting of an inner tube and an outer surrounding tube separated from the inner tube by a space, a chambered member to which one end of each tube is connected, and a second chambered member to which the opposite ends of the tubes are connected, with the intertube spaces of the elements open to the interiors of said members, and diaphragm or partition walls in said members dividing the chambers therein into compartments whereby the intertube spaces of the various elements are connected in series.

6. In a fluid heater or cooler, the combination of a plurality of tubular elements, each consisting of an inner tube and an outer surrounding tube separated from the inner tube by a space, a chambered member provided with a pair of alined openings in its opposite walls for each element and having the outer tube of the corresponding element connected into and filling one of said openings, and the inner tube extending into and filling the other of said openings, and a cap member secured to said chambered member and bearing against the ends of the inner tubes of said elements, and formed with passages opening to the interiors of the inner tubes.

7. In a fluid cooler or heater the combination of a plurality of circularly arranged and parallel tubular elements, each consisting of an inner tube and an outer surrounding tube, separated from the inner tube by a space, a circular chambered member provided with a pair of alined openings in its opposite walls for each element and having the outer tube of the corresponding element connected into and filling one of said openings and the inner tube extending into and filling the other of said openings and a circular cap member secured to said chambered member and bearing against the ends of the inner tubes of said elements, said cap member being formed with an axial port and with passages connecting said port with the interiors of the inner tubes of the elements.

8. In a fluid heater or cooler, the combination of a plurality of tubular elements, each consisting of an inner tube and an outer tube surrounding the inner tube and separated therefrom by a space, a chambered end member to which one end of each of said tubes is connected with the intertube spaces of the various elements open to the interior of said end member, a second chambered end member to which the opposite ends of the tubes are connected with the intertube spaces of the elements open to the interior of said member, a casing formed in part by the first mentioned end member surrounding said elements and said second end member, means for passing a fluid to be heated or cooled in series through the intertube spaces of said elements, and means for causing a second fluid to flow between the interior of the casing surrounding the said elements of the second end member and the exterior of the casing through the inner tubes of the elements.

9. In a fluid heater or cooler, the combination of a plurality of pairs of tubular elements, each element consisting of an inner tube and an outer tube surrounding the inner tube and separated therefrom by a space, a chambered member to which one end of each tube is connected with the intertube spaces of each element open to the interior of the member, a second end member to which the opposite ends of the tubes are connected with the intertube spaces of the elements open to the interior of said second end member, said first mentioned end member being provided with an inlet port open to the intertube space of one element and an outlet port to the intertube space of another element, and said end members being provided with diaphragm or partition walls whereby the fluid entering said first mentioned end member through the inlet port is caused to pass in series through the intertube spaces of the various elements before reaching the outlet port.

10. In a fluid heater or cooler, a tubular element consisting of an inner externally threaded tube and an internally threaded surrounding member with the threads of the member and tube of the same pitch and nesting loosely together whereby a shallow space is provided between the member and the tube while the tube may be threaded into and out of the said member, and a lug carried by said member and adapted to fit over the thread of the tube whereby said lug serves to clean said tube as the latter is threaded into and out of position.

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