H. D. HILDEBRAND.

HEAT EXCHANGER.

APPLICATION FILED JAN. 2, 1917.

1,340,266.

Patented May 18, 1920.

2 SHEETS—SHEET 1.

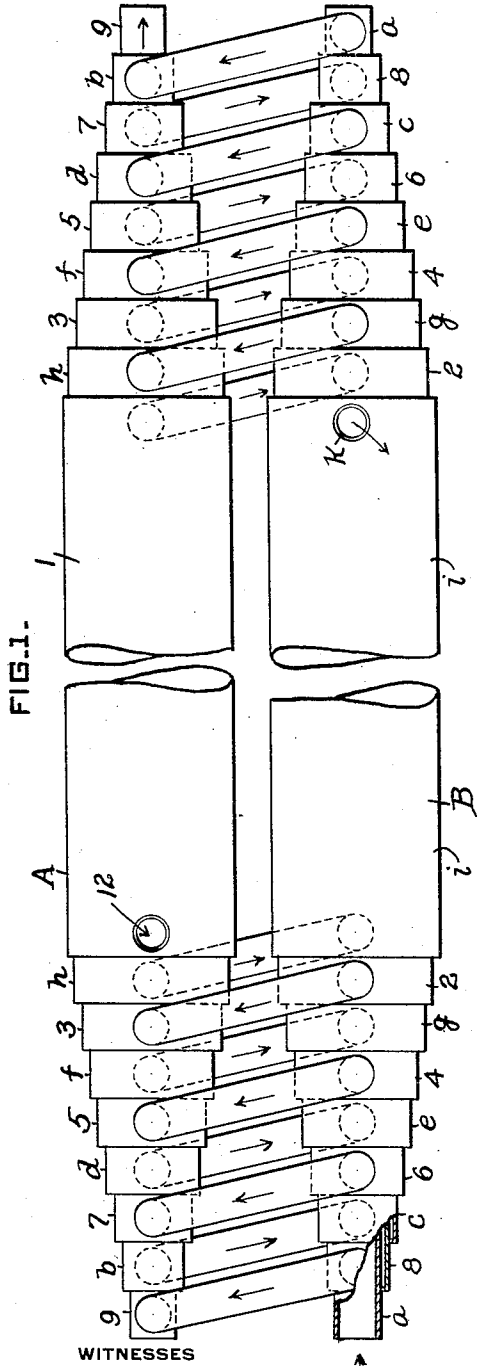


FIG. 1.

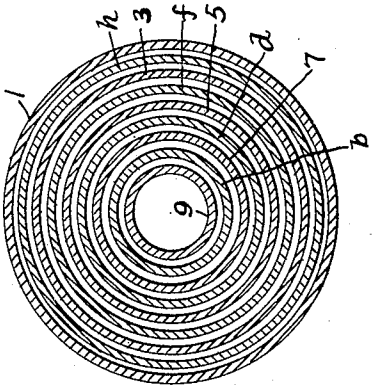


FIG. 3.

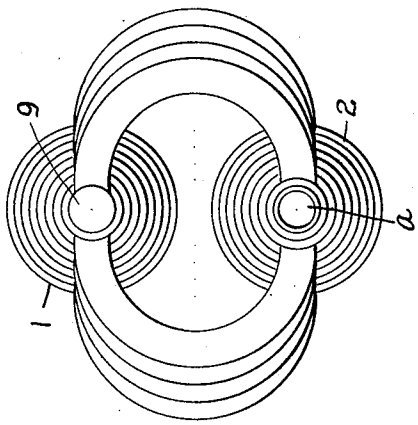


FIG. 2.

WITNESSES

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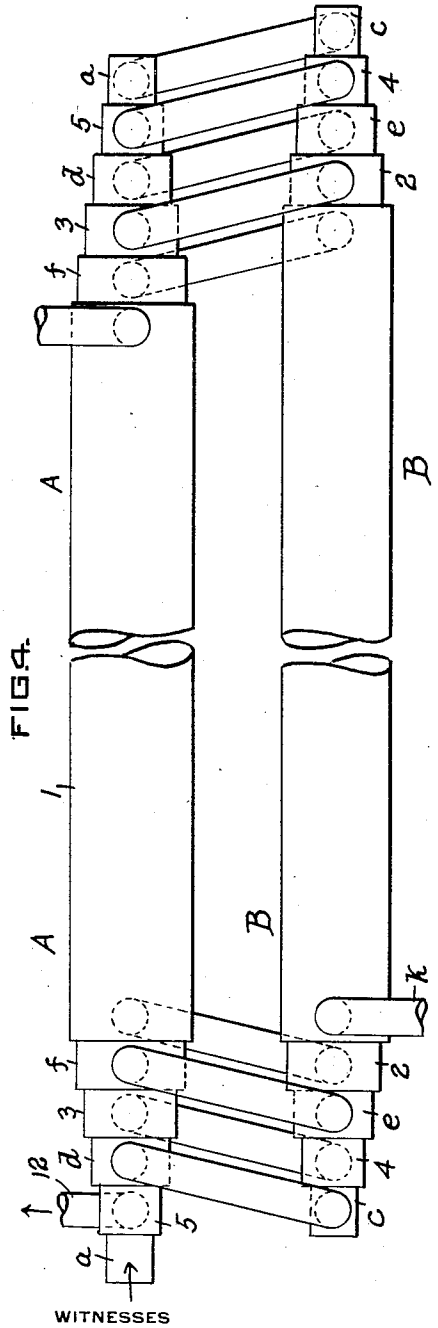


FIG. 4.

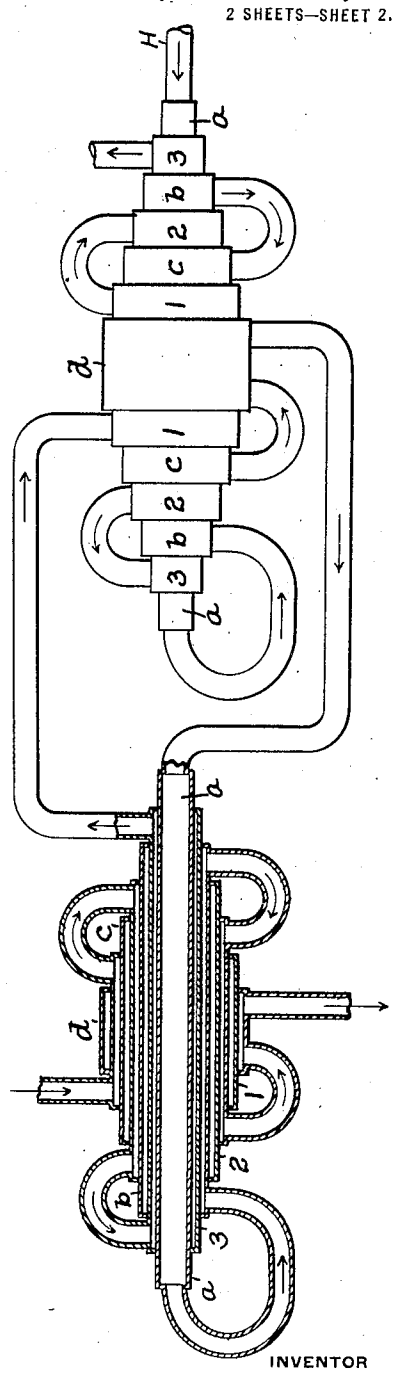


FIG. 5.

WITNESSES

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UNITED STATES PATENT OFFICE.

HARRY D. HILDEBRAND, OF PITTSBURGH, PENNSYLVANIA.

HEAT-EXCHANGER.

1,340,266. Specification of Letters Patent. Patented May 18, 1920.

Application filed January 2, 1917. Serial No. 140,093.

To all whom it may concern:

Be it known that I, HARRY D. HILDEBRAND, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in Heat-Exchangers, of which improvement the following is a specification.

In many of the arts, fluids, after being treated or after performing some function or purpose, are in a highly heated condition, and it is desirable to utilize the heat contained in such discharged fluid in raising the temperature of another quantity of fluid. This exchange of heat is effected by causing the two fluids to flow along opposite sides of a conducting diaphragm, which will receive heat from one of the fluids and transmit it to the other. It is usual to cause the two fluids to flow in opposite directions, the fluid to be heated entering the exchange system at or adjacent to the point of discharge of the other fluid from such system. While several conditions may affect the efficiency of a heat exchanger, the main condition is the relation of the areas of the surfaces of the fluids in contact with the transmitting diaphragm to the quantity of fluid flowing on opposite sides of the diaphragm at a given time, hence the greater the areas of the surfaces of the fluids in contact with the diaphragm, relative to the quantities of the fluids, the greater the velocity of heat exchange which may be imparted to the fluids through the exchanger.

The invention herein described has for its object a construction of heat exchanger in which each of the fluids is caused to flow in thin annular streams between the two transmitting diaphragms which have their opposite surfaces in contact with annular streams of the other fluid. It is a further object of the invention to prevent any material loss of heat from radiation by inclosing the more highly heated fluids within the annular streams of cooler fluids, the fluid to be cooled flowing from an annular passage surrounded by a cooler annular stream to a passage outside the latter, and the fluid to be heated flowing inwardly through annular passages alternating with passages through which flow progressively hotter outwardly flowing fluids. The invention is hereinafter more fully described and claimed.

In the accompanying drawing forming a part of this specification, Figure 1 is a side elevation of my improved heat exchanger; Fig. 2 is an end view of the same; Fig. 3 is a transverse section of one of the elements of the exchanger, and Fig. 4 is a view similar to Fig. 1, illustrating a modification in the manner of assembling and connecting the elements; and Fig. 5 is a view partly in section and partly in elevation illustrating a further modification.

In the practice of the invention, the elements A and B consist respectively of two series of pipes, *a*, *b*, *c*, etc., and 1, 2, 3, etc., of successively larger diameters, arranged one within the other, each succeeding outer section being made sufficiently shorter than the adjacent inner section to permit of connecting each section of one element with a corresponding section of the other element of the exchanger. Each succeeding section is hermetically secured to the inner adjacent section at its ends by any suitable means, preferably by welding. As hereinbefore stated, two elements constructed as above stated, will form a part of the heat-exchanger system and are connected together by transversely arranged pipes 11, as clearly shown in Figs. 1 and 2. One of the fluids, preferably the hot fluid, enters at one end of the inner pipe, as *a*, of one element as B, said pipe having its opposite end closed but connected to the second pipe as *b*, of the other element A. This pipe *b* has its opposite end connected to the end of the pipe *c* of the element B. In like manner, the alternate pipes *c*, *e* and *g* of the element B are connected to one end of pipes *d*, *f* and *h* of the element A, and the opposite ends of these latter pipes *d*, *f* and *h* are connected to pipes *e*, *g* and *i* of element B, which has an outlet *k* for the cooled fluid.

The fluid to be cooled enters through the inlet 12 of the pipe 1 which is the outermost pipe in series A and flows through a connecting pipe into pipe 2 of element B, the opposite end of the pipe 2 is connected to the pipe 3 of element A, which in turn is connected to pipe 4 of element B. In like manner, the alternate pipes 6, 8, of element B have one end connected to pipes 7 and 9 of element A, and the opposite end of pipe 7 is connected to pipe 8 of element B, and the right hand end of pipe 9 of the element A is the discharge outlet for the oil which has been heated in passing through the system.

It is characteristic of the operation of this

improved system that the highly heated oil will pass through alternate pipes of each element and be discharged from the outer pipe of one element, while the oil to be heated enters the outer pipe of one of the elements and flows through pipes alternating with those through which the hot fluid passes and is finally discharged from one end of the inner pipe of one of the elements. It will be observed that as the cold fluid enters pipe 1, through inlet 12, it is outside of the pipe *h*, through which passes the comparatively cooled fluid and the fluid to be heated passes to the pipe 2, which is surrounded by the pipe *i*, which forms the last pass of the fluid to be cooled and has the outlet *k* for the discharge of the cooled fluid. As fluid to be heated flows along the several pipe sections, it is gradually raised in temperature and the next to the last pass of the fluid to be heated is through the pipe 8, which is immediately outside of the pipe *a*, through which the hot fluid first passes.

In the construction shown in Fig. 1, each element consists of the same number of pipe sections, and hence the fluid to be heated is not discharged immediately after it has been subjected to the influence of the most highly heated outflowing fluid, but passes to the innermost pipe of the other element, and in flowing therethrough is surrounded by outgoing fluid which has been somewhat cooled. It is not believed that such reduction of temperature will be substantial or material, but may be entirely avoided by including one more pipe section in one of the elements as shown in Fig. 4. As shown in Fig. 4, the highly heated outgoing fluid enters one end of pipe section *a*, which has its opposite end connected to one end of element B. The latter is connected to section *c*, and section *d* is connected at one end of section *c* and at the opposite end to section *e*. The opposite end of section *e* is connected to one end of section *f* of element A, said section being connected to outer section of element B having an outlet *k*. These sections alternate with sections 1, 2, 3, 4 and 5, through which flows the fluid to be heated, the latter entering through the inlet 12 and passing successively through the several sections, and escaping through the outlet port in section 5. This outlet is adjacent to the inlet end of section *a*. In this arrangement it will be observed that the pipe section *a* into which the outgoing fluid enters is surrounded by the pipe section 5, forming the last pass of the fluid to be heated, and therefore the latter fluid is discharged without any lowering of its temperature, such as results when both elements consist of the same number of pipe sections as shown in Fig. 1.

In the construction shown in Figs. 1 and 2, the fluids flow alternately from one element to the other, but if preferred, the alternate sections of an element may be connected as shown in Fig. 5 and the elements connected in tandem. The highly heated outgoing fluid enters one end of the innermost pipe section *a*, and thence successively through pipe sections *b*, *c* and *d*. The ingoing fluid enters the pipe section 1 through inlet 12, and flows thence through sections 2 and 3, and escapes from the latter at a point adjacent to the inlet pipe section *a*.

It is characteristic of the improvement described herein, that the fluid from which the heat is to be extracted is transferred outwardly in successive steps, while the fluid to be heated moves in a similar manner inwardly, so that the inner streams are hottest.

It will be understood that an element may consist of any desired number of sections, but care should be taken to employ so many sections that there will be so small a difference of temperature between any two adjacent pipe sections that rupture will not result from differences of elongation due to differences of expansion of the successive sections.

It is also characteristic of my improvement that the pipes through which both fluid, in their coolest condition or state, pass, are the outermost of the series of pipes of each element and hence there is little loss of heat from radiation, as all the other pipes are protected, except for short distances from the ends thereof, from loss of heat by radiation.

In practice, it is preferred to make the annular spaces between adjacent pipe sections as small as possible, due regard being had to the frictional resistance of the fluid flowing through these spaces. The elements may be so connected that the fluids will pass from a pipe section in one element to a section in the other element, as shown in Figs. 1 and 4, or the elements may be connected in tandem as shown in Fig. 5.

No claim is made herein to the method of effecting an exchange of heat as the same forms the subject matter of an application filed April 21, 1919, Serial Number 291425.

I claim herein as my invention:

1. A heat exchanger having in combination a plurality of elements, each element consisting of a plurality of nested pipe sections, alternating sections of one element being connected to alternating sections of the other element.

2. A heat exchanger having in combination a plurality of nested pipe sections differing in lengths and diameter, said sections being nested in accordance with their relative lengths and diameters, the ends of outer shorter sections being hermetically secured to the next adjacent and longer section, and the inner and succeeding alternate sections being connected for the passage of one fluid and the second and succeeding alternate sec-

tions being connected for the passage of another fluid.

3. A heat exchanger having in combination a plurality of nested pipe sections, the inner and succeeding alternate sections being connected for the passage of one fluid, and the second and succeeding alternate sections being connected for the flow of the other fluid.

In testimony whereof, I have hereunto set my hand.

HARRY D. HILDEBRAND.

Witness:

ALICE A. TRILL.