June 19, 1928. 1,673,918

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HEAT EXCHANGER

Filed Nov. 8, 1924 4 Sheets-Sheet 1

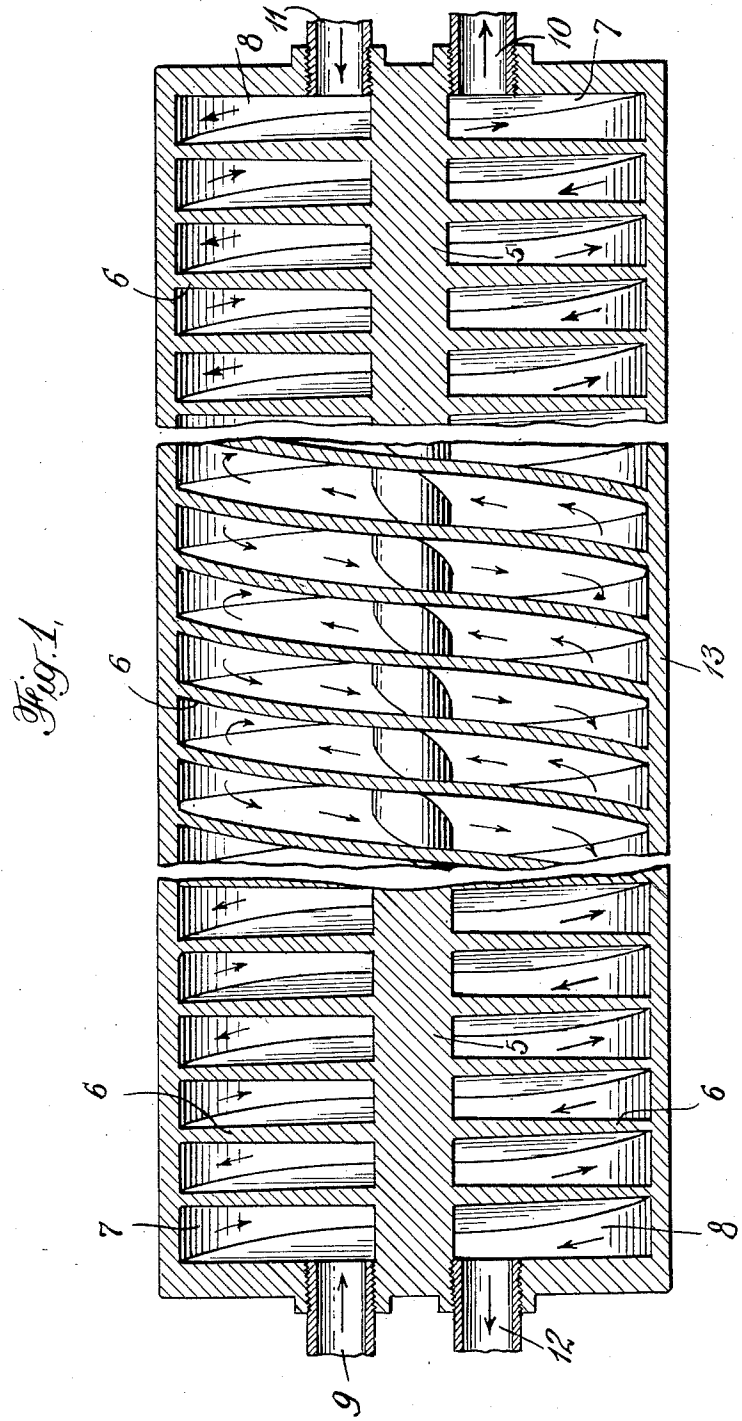


Fig. 1.

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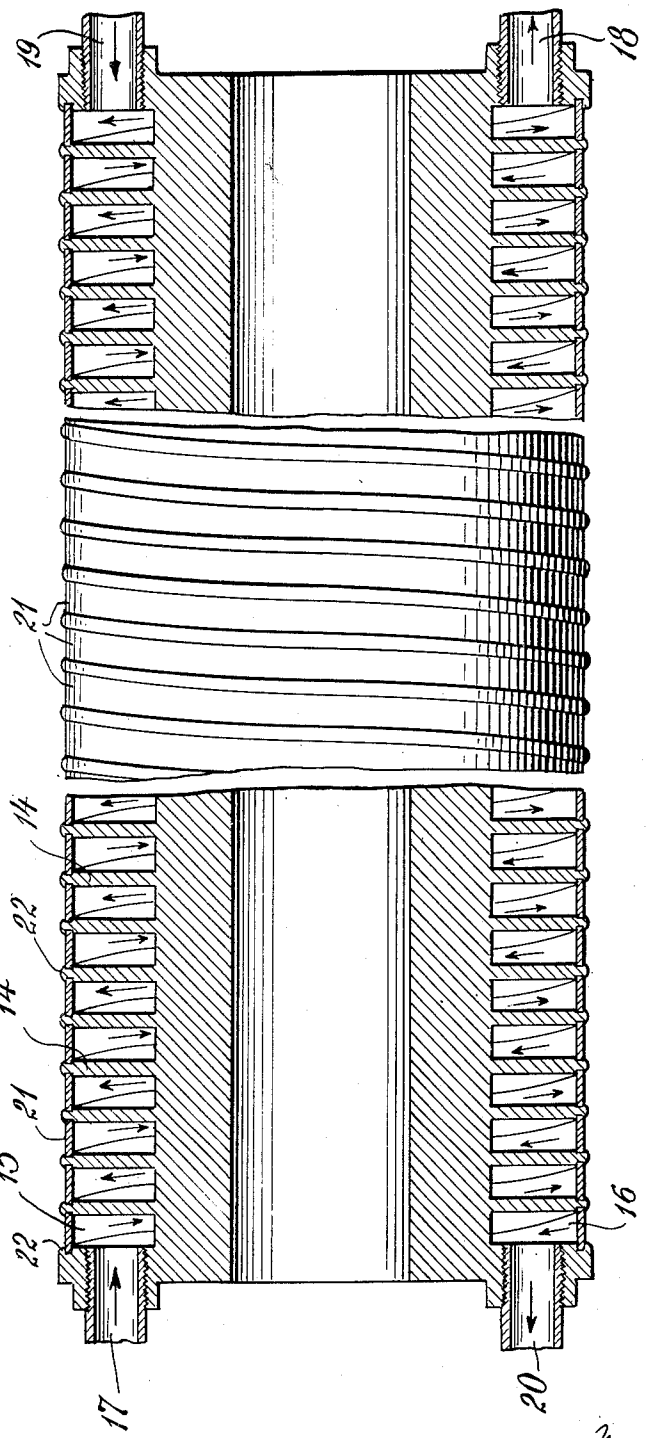


Fig. 2.

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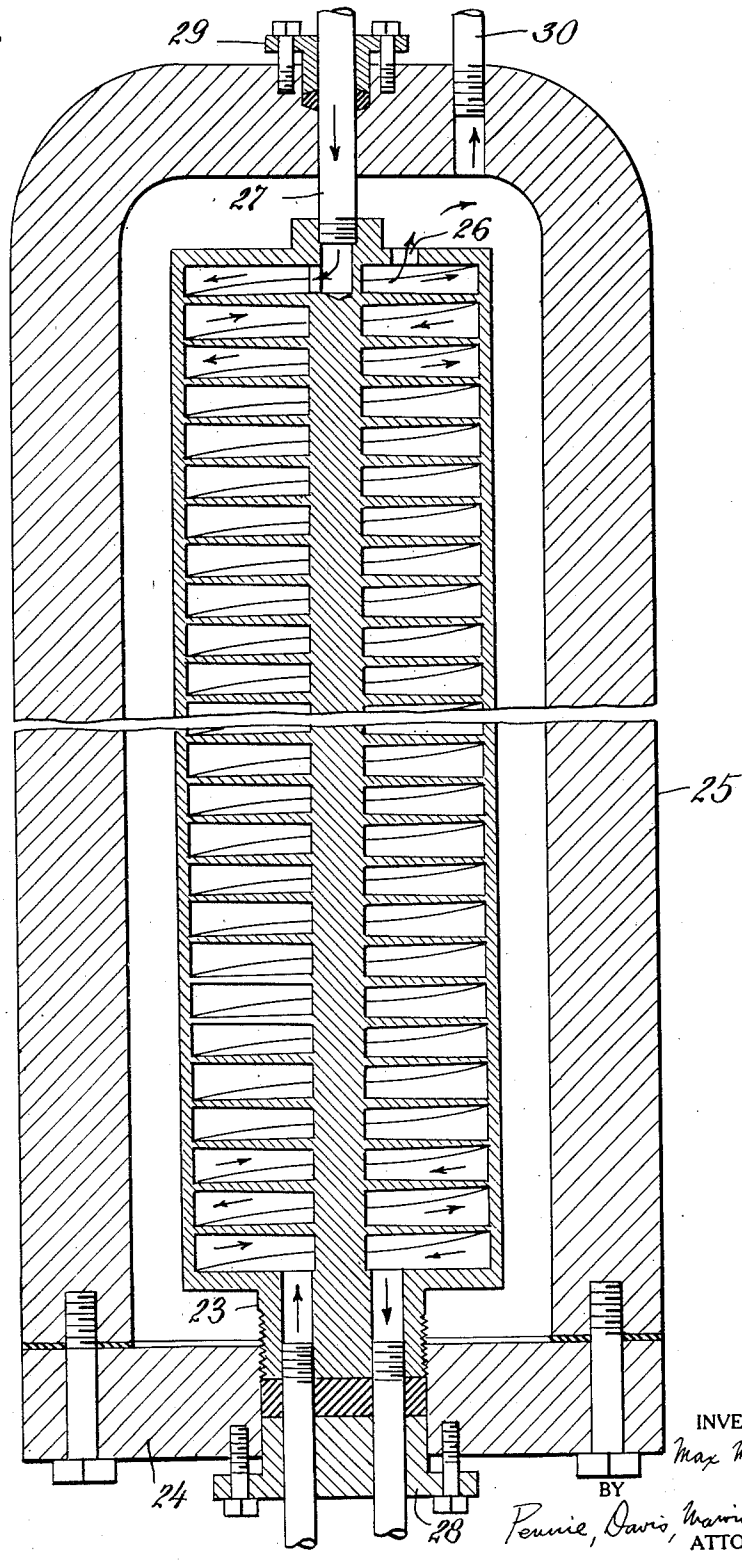
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Fig. 3



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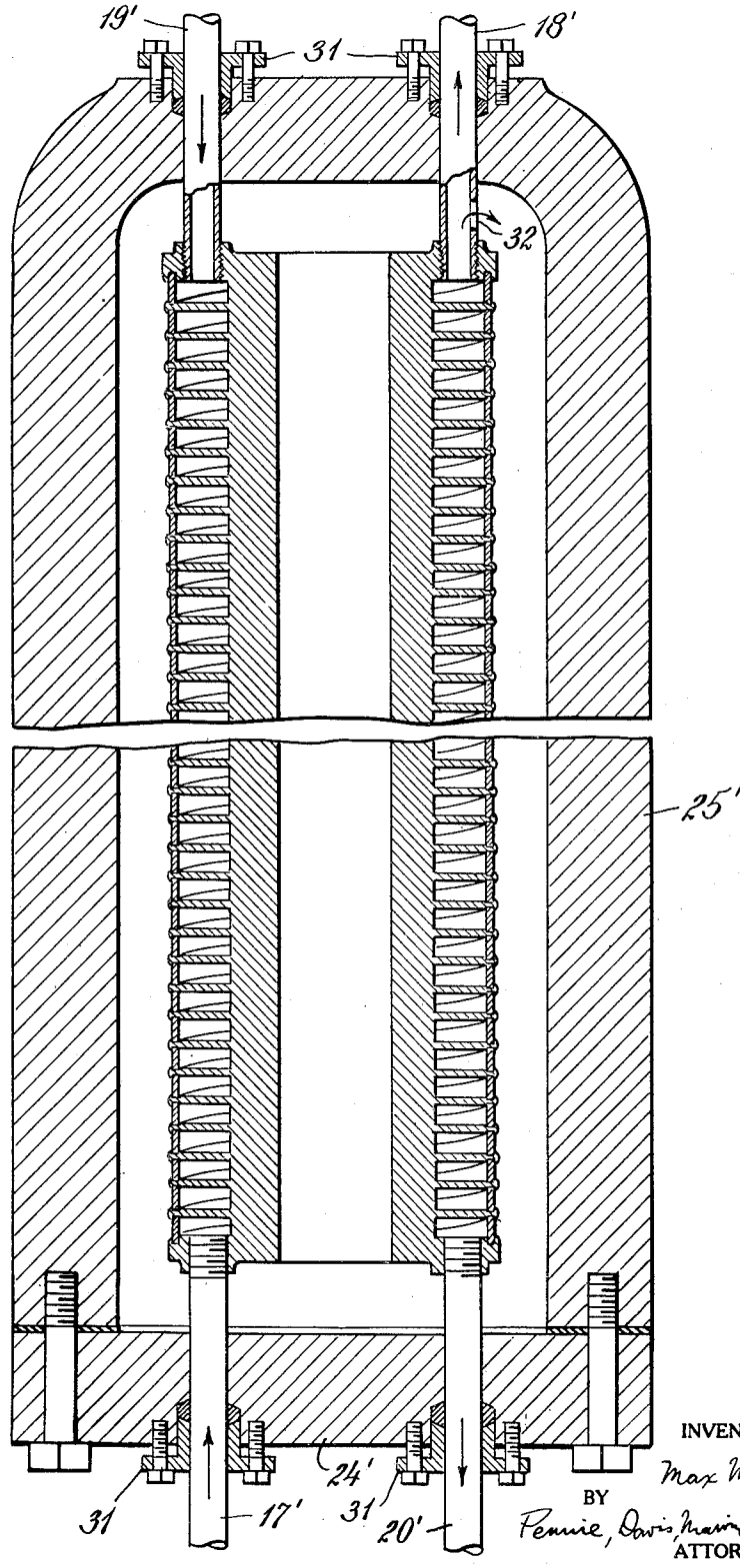
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Filed Nov. 8, 1924 4 Sheets-Sheet 4

Fig. 4,



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UNITED STATES PATENT OFFICE.

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HEAT EXCHANGER.

Application filed November 8, 1924. Serial No. 748,625.

This invention relates to heat exchangers adapted for effecting the transfer of heat between gases or vapors, between liquids, or between gases or vapors and liquids. More particularly, the present invention relates to heat exchangers specially adapted for effecting heat transfer between gases under very high pressures.

Heat exchangers are utilized in processes where the conservation of heat or cold is essential to economical operation. Such exchangers have heretofore usually been constructed of pipes or tubes arranged within a suitable casing. The tubes may be straight or arranged in coils, but in either case the exchanger, though effective, is costly because of the numerous joints, and is, moreover, more or less bulky. Coiled tube exchangers are particularly expensive because of the difficulty experienced in forming the tubes. In straight tube exchangers, the efficiency of the heat transfer is frequently low due to a tendency for a part of the fluid to flow centrally through the tubes without effective heat exchange therewith. Another difficulty experienced with tubular heat exchangers is the possibility of leakage through one or more of the numerous joints which frequently open because of the relative difference in expansion or contraction of the tubes and casing due to temperature changes. In heat exchangers where very high pressures are employed such difficulties are multiplied. The possibility and the amount of leakage is increased by the high pressure prevailing in the exchanger. High pressures also set up strains which are difficult to take care of mechanically in the usual structures, particularly where coiled tubes or numerous joints are used, or in exchangers having relatively large flat surfaces. Moreover, in heat exchangers employed in connection with gases under very high pressures, the size of the passages is usually very small due to the compression of the gases and tubes cannot be employed successfully to produce an efficient exchanger because the relatively minute size of the tubes precludes proper fastening and the provision of gas-tight connections.

It is one of the objects of the present invention to provide a simple and relatively inexpensive and compact heat exchanger having a relatively large area of heat transferring surface with reference to the bulk of the exchanger exposed to the fluids and in which contact of the fluids with the heat tranferring surface is promoted so that the desired heat transfer is accomplished effectively. It is another object of this invention to provide a heat exchanger of this character which is adapted for use at high pressures and which may be constructed in small sizes without sacrifice of efficiency.

Further objects and advantages of the invention will be apparent as it is better understood by reference to the following description and the accompanying drawings in which:

Fig. 1 is a longitudinal section through an exchanger embodying the principles of the invention, the middle portion being a section with the integral outer wall removed on one side and showing the heat transferring walls on both sides of the central core,

Fig. 2 is a similar view illustrating a somewhat different form of exchanger,

Fig. 3 is a longitudinal section through an exchanger embodying the principles of the invention adapted for use at high pressure, and

Fig. 4 is a view similar to Fig. 3 illustrating a somewhat different form of exchanger adapted for use at high pressure.

In one specially advantageous form of the invention, the exchanger is an integral structure in the form of a casting. It may be made of any suitable metal adapted to be cast in the desired shape. The exchanger comprises adjacent double spiral or helical passages, separated by a relatively thin heat-transferring wall, through which passages the fluids pass, preferably in opposite directions, so that the heat transfer is effected through the relatively thin wall separating the passages. The passages may be closed by an integral outer wall, though this structure can be varied as hereinafter indicated by securing the outer wall to the passage walls. Inlets and outlets to the spiral passages are provided at opposite ends of the exchanger so that the fluids can be directed properly therethrough.

Referring to Fig. 1, 5 indicates the core of the exchanger and 6 thin walls separating the passages which are disposed spirally or helically therein to provide passages 7 and 8 extending throughout the length of the exchanger. An inlet 9 at one end of the exchanger communicates with the passage 7,

the outlet from this passage being indicated at 10. Similarly, an inlet 11 at one end of the exchanger communicates with the passage 8 which terminates at its opposite end in the outlet passage 12. Suitable connections (not shown) may be arranged to deliver the fluids to and from the respective inlets and outlets, and with such an arrangement the fluids are adapted to pass continuously through the spiral passages in opposite directions and in contact with the walls 6.

The walls 6 are relatively thin and are common to both passages and permit the transfer of heat between the flowing fluids. Thus, the warmer fluid will enter the exchanger at one end and the colder fluid at the other, and in passing through the exchanger the temperature of the warmer fluid will tend to approach that of the colder fluid while the temperature of the colder fluid will be raised and will tend to approach the temperature of the warmer fluid. The configuration of the passages also tends to set up eddy currents in the fluids so that they pass therethrough in a more or less turbulent condition whereby the heat transfer is further promoted. The exchanger will have warm and cold ends and the fluid which enters it at a higher temperature will leave at a lower temperature and vice versa.

In the form of the invention illustrated in Fig. 1 the outer wall or casing 13 of the exchanger is formed integrally with the walls 6 by casting. There are no joints in the structure except where the pipes or conduits deliver the fluids thereto. Consequently there can be no substantial leakage of the fluids and no mixing will occur in the exchanger owing to such leakage. The end sections shown in Fig. 1 are central sections through the exchanger. The middle section, however, is a section with the integral outer wall removed on one side showing the heat transferring walls on both sides of the central core.

In the structure illustrated in Fig. 2 the principal modification is the substitution of an outer wall or casing which is not integral with the heat transferring walls. In this form of the exchanger the walls 14 are cut in a bar or tube of steel or other suitable metal having good conducting properties, so as to provide passages 15 and 16 spirally or helically disposed and communicating with inlets and outlets 17 and 18 and 19 and 20 respectively. The provision of relatively narrow passages between the enclosing heat-transferring walls assists in preventing channelling of the fluids or flow of the fluids therethrough without thorough contact with the heat transferring surfaces. The outer wall or casing of the exchanger is formed by a metallic ribbon 21 which may be secured to the edges of the heat transferring walls in any suitable manner. The edges of these walls may be rabbeted as indicated at 22 to permit insertion of the metallic ribbon, and the edges of the walls then spun over the ribbon to hold the latter firmly in place. Instead of spinning the edges of the walls, the ribbon can be secured by welding or otherwise. This structure has the advantage that the joints can without difficulty be closed to prevent leakage of the fluids about the edges of the walls.

In both forms of the invention illustrated, the heat transferring walls are of uniform width throughout the exchanger and the rate of heat transfer per unit of temperature difference is approximately uniform throughout the exchanger. The width of the passages and the area of the heat transferring walls may, however, be progressively increased through the exchanger, or otherwise adjusted to regulate the rate of heat transfer as may be desired.

The heat exchanging apparatus illustrated in Fig. 3 is adapted for use at high pressures and consists of a heat exchanger of the general construction illustrated in Fig. 1 arranged within a heavy shell or casing adapted to withstand the pressure employed. The heat exchanger proper differs from that illustrated in Fig. 1 principally in the arrangement of the fluid inlets and outlets. At the lower end of the exchanger the fluid connections are arranged through a common boss 23 which is threaded externally and screwed into a corresponding thread on the cover 24 of the shell 25 supporting the heat exchanger proper inside of the shell. At the upper end of the exchanger one of the passages opens directly into the interior of the shell 25 through an aperture 26 and a connection 27 extending through the shell is arranged in communication with the other passage. The shell 25 may consist of a heavy steel casting and is closed by the cover 24 which supports the heat exchanger. A single packed joint 28 is arranged about both fluid connections passing through the common boss 23 and a similar packed joint 29 is arranged about the connection 27 from the upper end of the exchanger. A connection 30 communicating with the interior of the shell is also arranged so that it communicates with one of the passages in the exchanger through the aperture 26.

The heat exchanging apparatus illustrated in Fig. 4 is also adapted for use at high pressures and consists of a heat exchanger of the construction illustrated in Fig. 2 arranged within a shell 25′ provided with a cover 24′ adapted to withstand the pressure employed. The fluid connections 17′, 18′, 19′ and 20′ to the heat exchanger proper extend through the shell 25′ and packed joints 31 are provided about each of these connections closing the openings through which they extend. The heat exchanger proper is

supported within the shell by the fluid connections thereto. An opening 32 is provided in one of the fluid connections so that one of the passages in the exchanger is in free communication with the space in the shell about the heat exchanger.

In both forms of the invention illustrated in Figs. 3 and 4, the fluids to be brought in heat exchanging relation are passed through the passages in the heat exchanger proper so that the warmer fluid is cooled and the cooler fluid warmed as has been described in connection with the apparatus illustrated in Figs. 1 and 2. One of the passages in the heat exchanger proper is in free communication with the space on the interior of the shell about the heat exchanger so that the pressure interiorly and exteriorly of the exchanger is equalized and the parts of the exchanger proper do not have to withstand any great differences in pressure. The shell or casing is thus employed to withstand the high pressure and is constructed accordingly. Where the fluids circulating through the heat exchanger are at different pressures, the exchanger proper is constructed in a suitable manner to withstand this pressure difference, and the space within the shell is advantageously arranged in communication with the fluid at higher pressure although it may be arranged in communication with the fluid at lower pressure. By equalizing the pressure in this way, a very light construction may be employed in the heat exchanger proper and the heat transfer can be promoted by employing very thin heat transferring walls which it would otherwise be impossible to employ. The use of a shell adapted to withstand high pressure and equalization of the pressures on the parts of the heat exchanger in a manner which has just been described is of special advantage in connection with the heat exchanger of the present invention due to the extensive spiral or helical surfaces or walls between the adjacent passages therein.

In the synthesis of ammonia pressures of as much as 3,000 lbs. per sq. inch or more are employed and heat exchangers of the type illustrated in Figs. 3 and 4 are of special value and application in connection with such processes. The use of the apparatus as described has demonstrated its practicability and efficiency as a heat exchanger and its comparative inexpensiveness both in first cost and in maintenance as compared with exchangers of the structure usually employed. It will be apparent that heat exchangers of the type illustrated in Figs. 1 and 2 are of more or less general application. Various changes may be made in the details of the construction without departing from the invention or sacrificing the advantages thereof.

I claim:

1. In a heat exchanger, a body portion, a pair of spirally arranged heat transferring walls extending outwardly from the surface of the body portion and integral therewith, these walls being spaced from each other to provide separate passageways for fluids travelling in heat exchanging relation, inlets to the passageways disposed at opposite ends of the exchanger, outlets from the passageways disposed at opposite ends of the exchanger, and spiral ribbons disposed between the outer edges of the walls and serving to close the passageways.

2. In a heat exchanger, a shell adapted to withstand high pressure, a heat exchanger having two adjacent spirally arranged passageways separated by a common heat transferring partition arranged within the shell, and inlets and outlets for fluids connected to the passageways extending through the shell, one of said connections also opening into the space within the shell about the heat exchanger.

3. In a heat exchanger, a shell adapted to withstand high pressure, a heat exchanger having two adjacent spirally arranged passageways separated by a common heat transferring partition arranged within the shell, connections for conducting fluids to and from the passageways through the shell, and an open connection between the space within the shell about the heat exchanger and one of the passageways.

4. In a heat exchanger, a shell adapted to withstand high pressure, a heat exchanger having two adjacent spirally arranged passageways separated by a common heat transferring partition arranged within the shell, connections to one end of said passageways extending through the shell, a connection to the other end of one of said passageways extending through the shell, a connection between the other end of the other passageway and the interior of the shell, and a connection from the interior of the shell extending through the shell.

In testimony whereof I affix my signature.

MAX MAURAN.