Oct. 31, 1950 A. J. MORRIS 2,528,013

PLATE TYPE HEAT EXCHANGER

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Fig. 1.

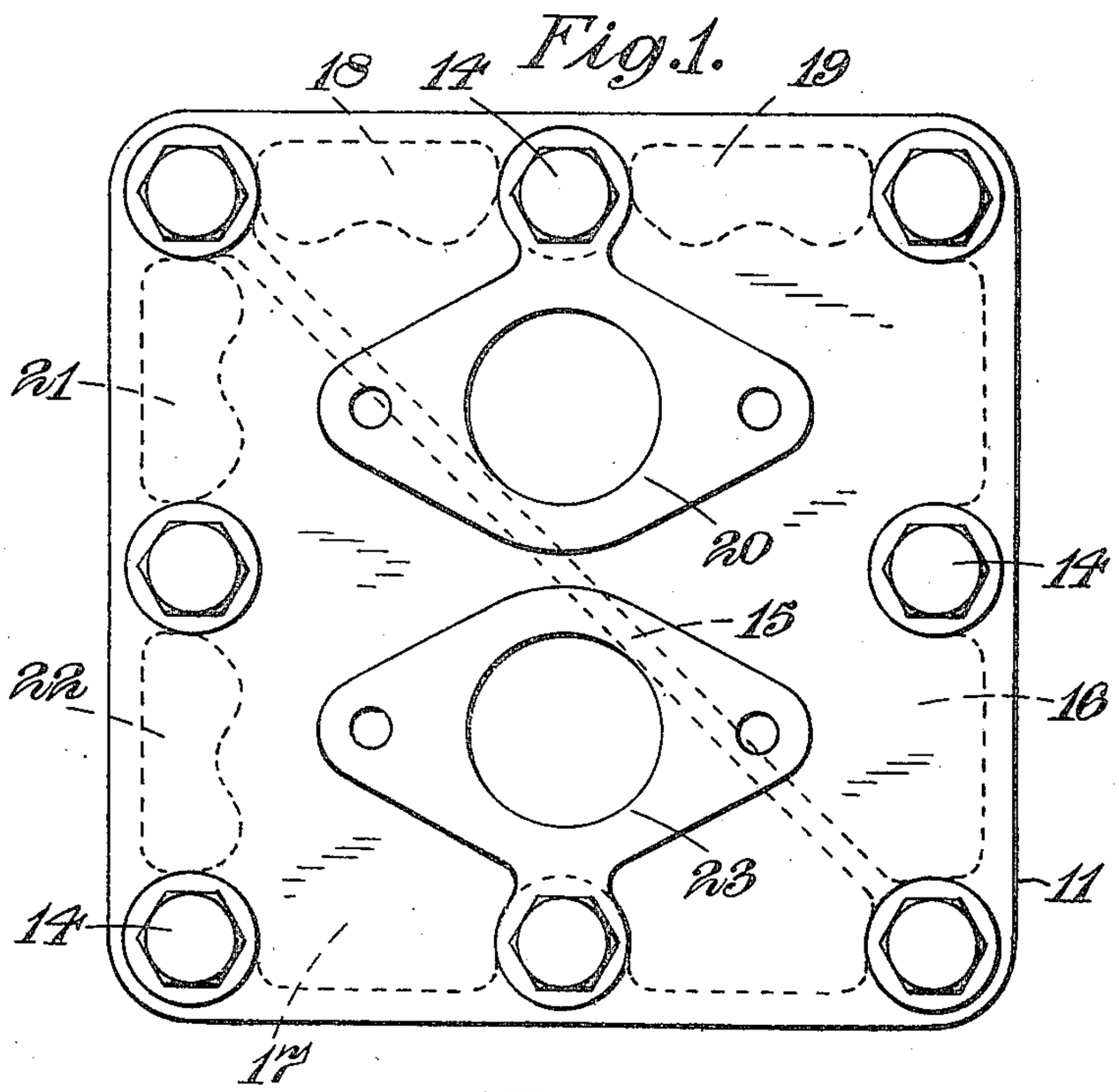

Fig. 2.

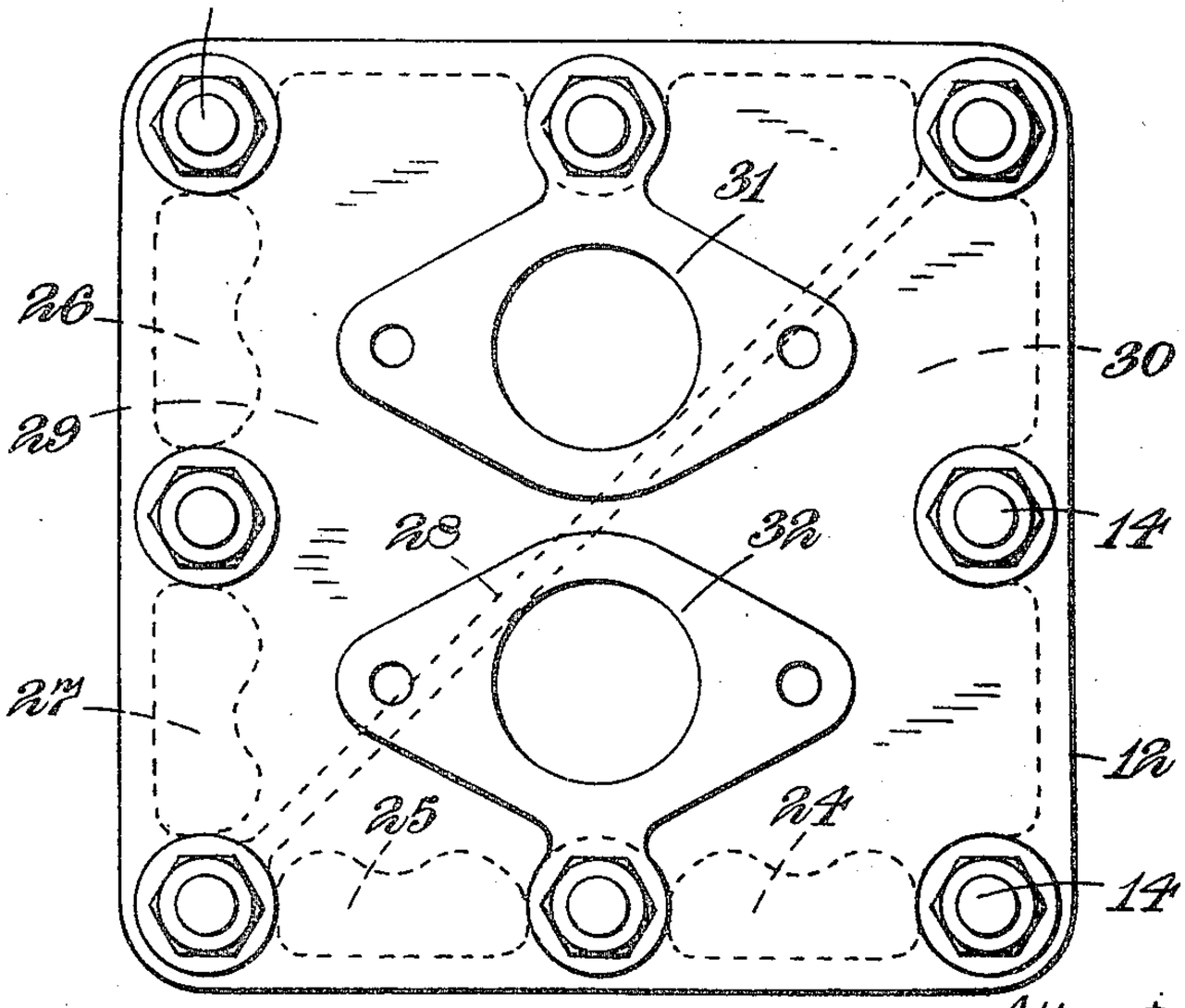

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Fig. 3.

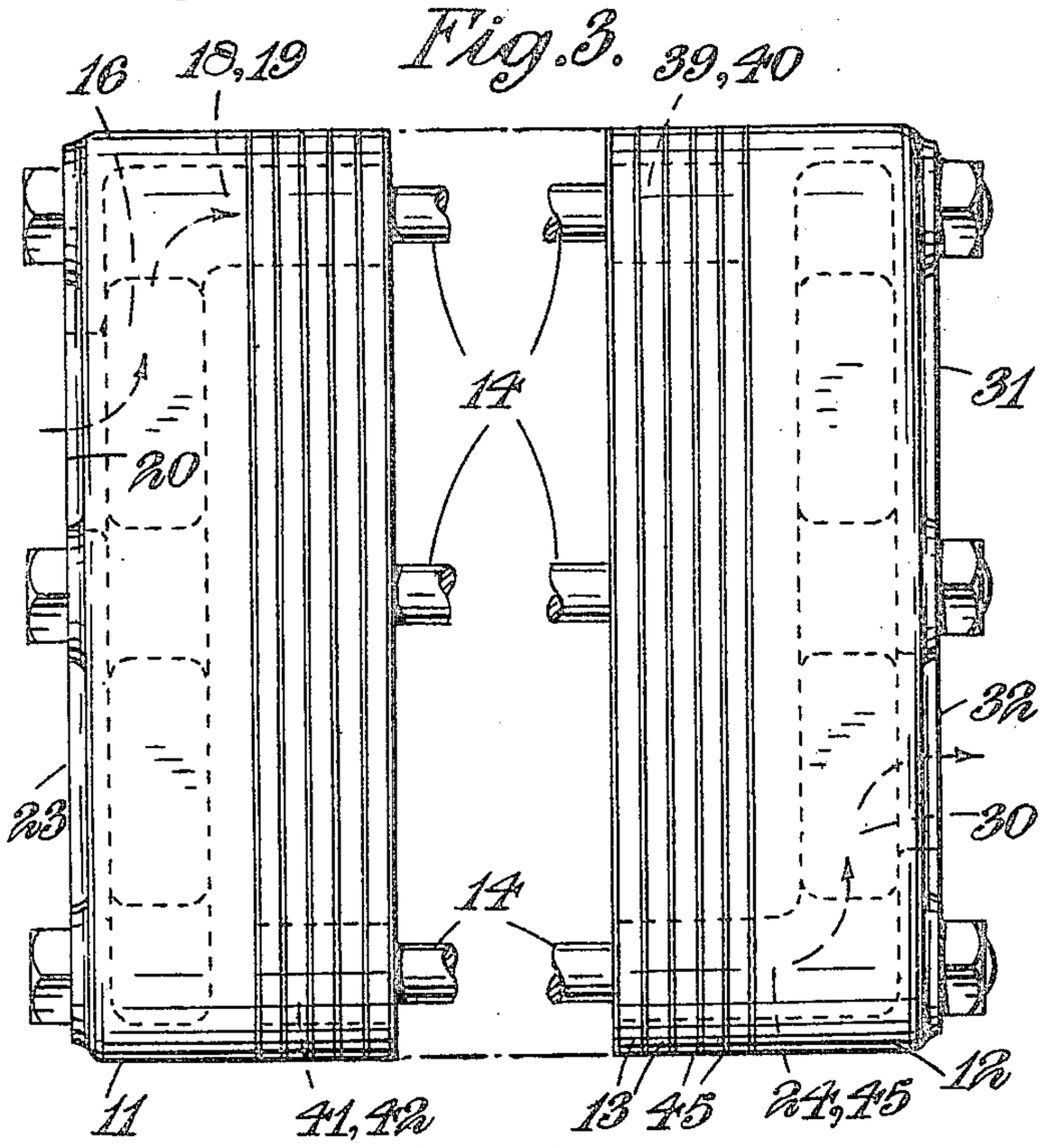

Fig. 5.

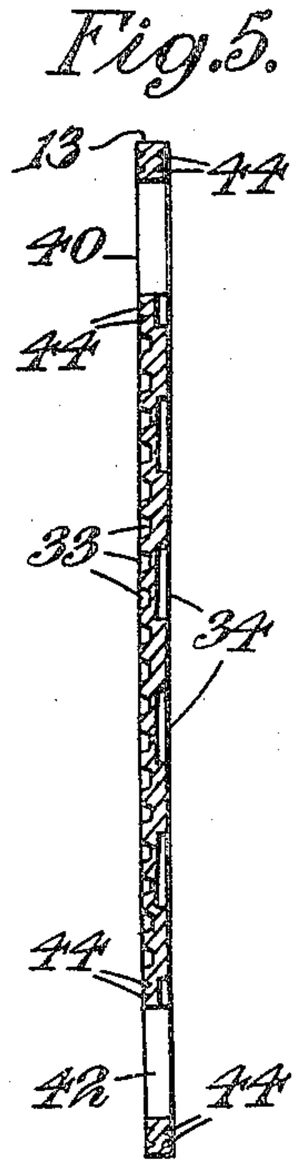

Fig. 6.

Fig. 4.

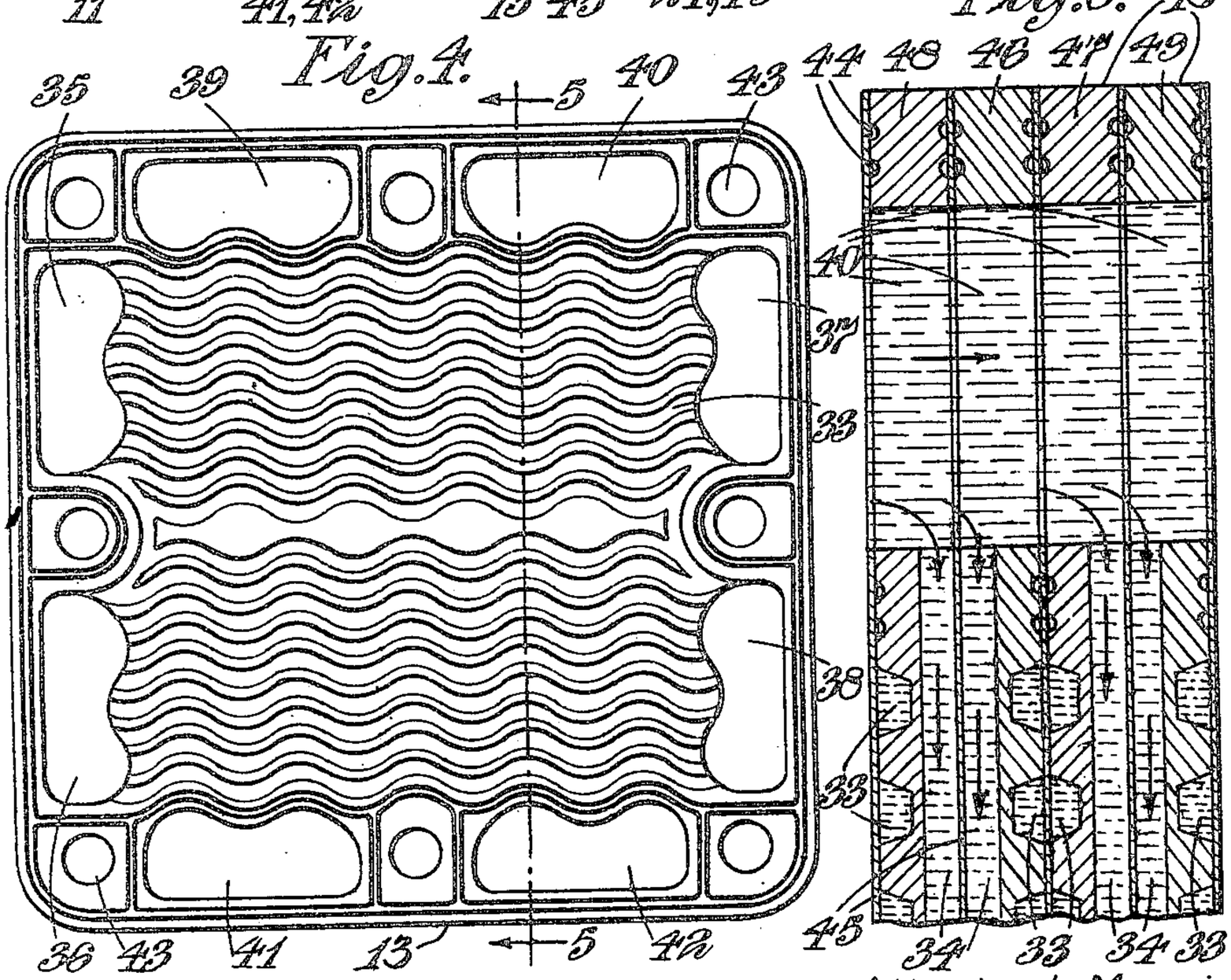

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Fig. 8.

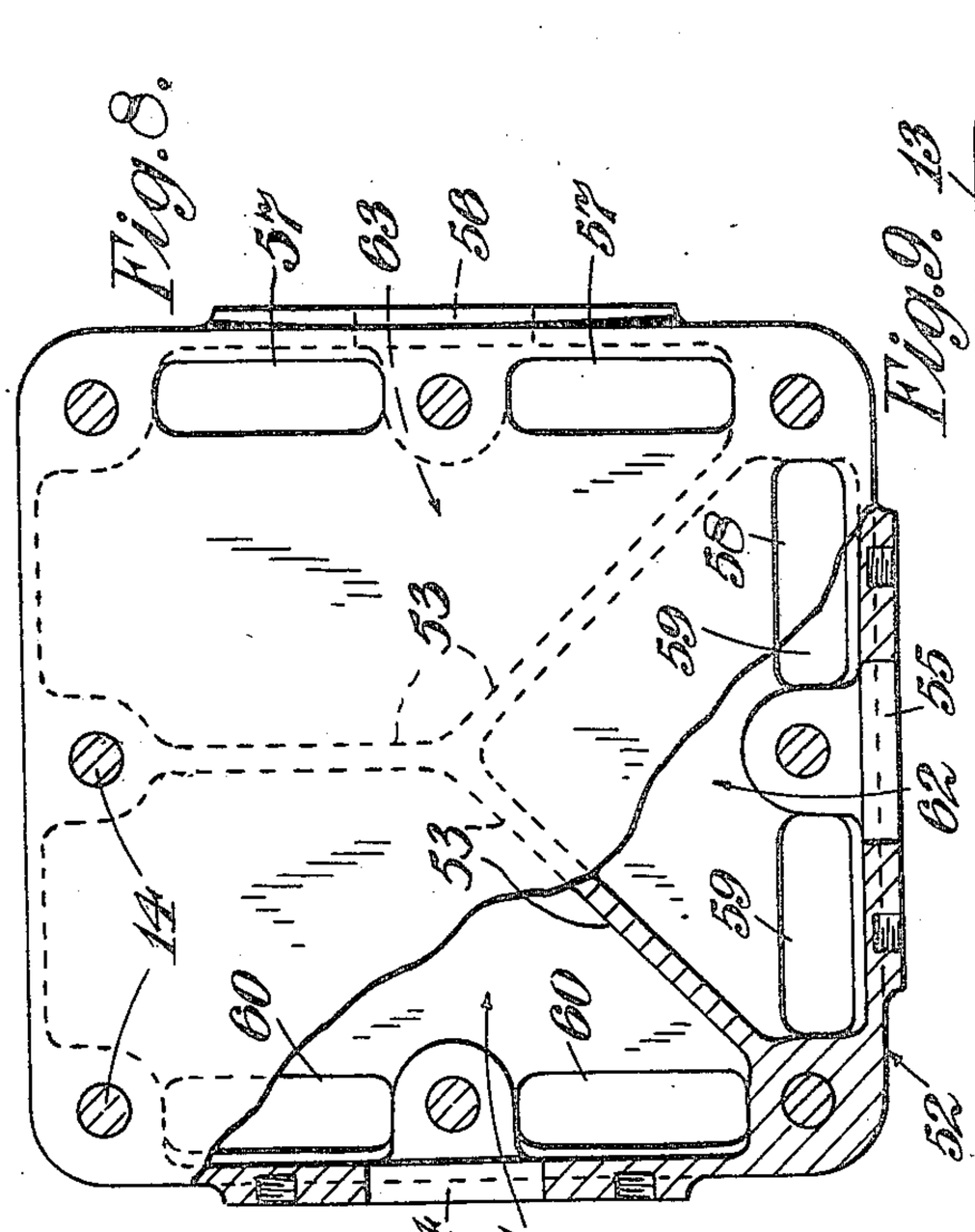


Fig. 9.

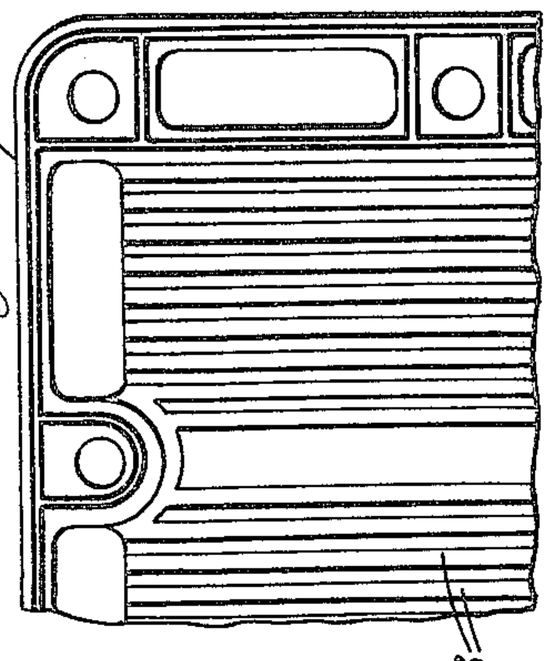


Fig. 10.

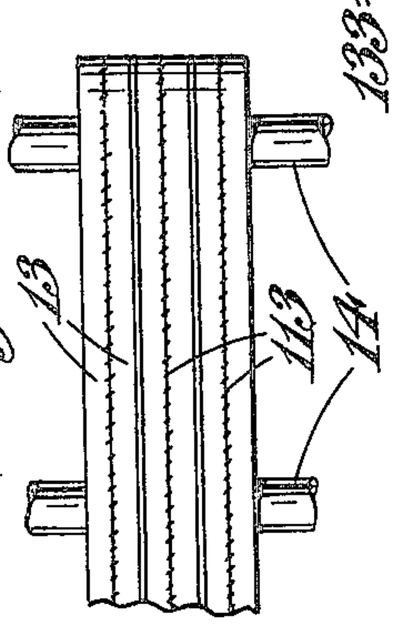
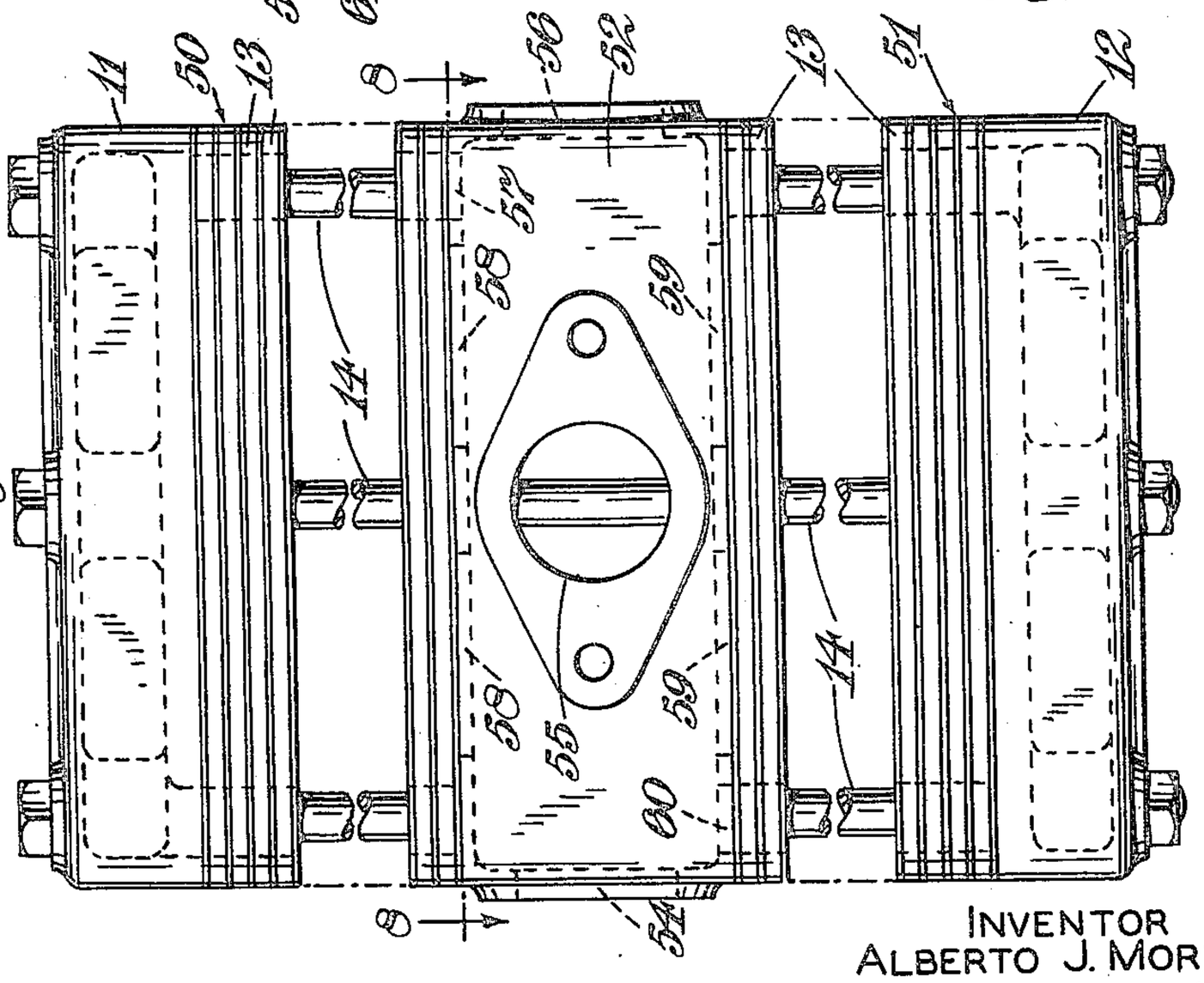


Fig. 7.



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UNITED STATES PATENT OFFICE

2,528,013

PLATE TYPE HEAT EXCHANGER

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Application August 17, 1945, Serial No. 611,013
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4 Claims. (Cl. 257—245)

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This invention relates to heat-exchangers for effecting a transfer of heat between two or more substances and has for its object to provide an improved construction which is easy to manufacture on a production basis and in particular, can be dismantled and reassembled without increasing the liability to leakage.

According to the invention a heat-exchanger comprises a series of heat-transfer plates, each plate having in one face a number of grooves extending in the same general direction to form a set of fluid passages and having in its other face a number of grooves directed at an angle to those in the first face and forming a second set of fluid passages independent of the first set, the plates on assembly having similarly directed grooves on adjacent faces and having alternate pairs of groove sets angularly displaced.

The grooves in each face of a heat-transfer plate may be connected at each end with one or more ports formed in the plate, the ports connected to the grooves on one face of the plate being separate from the ports connected to the grooves on the other face of the plate and corresponding ports registering with one another on assembly of the plates to form ducts for leading fluid to and from the grooves.

The ducts for leading the fluid to and from the grooves may be connected in parallel.

The heat-transfer plates may be combined with headers disposed at each end of the assembled plates.

One or more distributing blocks may be arranged intermediately in the heat-transfer plates of the heat-exchanger between the headers so that the heat exchanger is divided into two or more sections, the distributing blocks being arranged with appropriate compartments and ports so that heat-transfer may be effected between more than two fluids.

A typical embodiment of the invention is illustrated in the accompanying drawings wherein:

Figure 1 is a front end elevation of one embodiment of a heat-exchanger according to the invention, while

Figure 2 is a rear end elevation.

Figure 3 shows a side elevation of the heat-exchanger illustrated in Figures 1 and 2 with a number of the heat-transfer plates removed.

Figure 4 is a front elevation of one of the heat-transfer plates of the heat-exchanger illustrated in Figures 1, 2 and 3, while

Figure 5 is a cross-section on the line 5—5 in Figure 4.

Figure 6 is an enlarged part-section of four of

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the assembled plates of the heat-exchanger illustrated in Figures 1, 2 and 3.

Figure 7 is an elevation of a modified form of heat-exchanger according to the invention.

Figure 8 is a section on the line 8—8 of Figure 7.

Figure 9 is a partial view corresponding to Figure 4 showing a modified form of heat-exchanger plate.

Figure 10 illustrates a minor modification.

In one embodiment of the invention as illustrated in Figures 1 to 3, the heat-exchanger comprises headers 11 and 12 with which the required number of heat-transfer plates 13 are assembled. The headers 11 and 12 and the plates 13 are secured together by through-going bolts 14.

The header 11 is divided diagonally by a partition 15 into two compartments 16 and 17 which are separate from each other. The compartment 16 is formed with two ports 18 and 19 on its inner face and with a pipe connection 20 on its outer face, while the compartment 17 is similarly formed with two ports 21 and 22 and a pipe connection 23.

The header 12, Figure 2, is similarly formed to the header 11 but in this case the ports 24 and 25 in the header 12 which communicate with the ports 18 and 19 through the heat-transfer plates 13 as hereinafter described, are arranged at the bottom of the header 12, while the ports 26 and 27 which similarly communicate with the ports 21 and 22 in the header 11 are arranged at the side of the header 12 which is opposite the ports 21 and 22 when assembled in opposed spaced relation to the header 11. A partition 28 divides the header 12 diagonally into two separate compartments 29 and 30, the compartment 29 containing the ports 26 and 27, and the compartment 30 containing the ports 24 and 25. The compartment 29 is fitted with a pipe connection 31 and the compartment 30 is fitted with a pipe connection 32.

The heat-transfer plates 13 have an external shape corresponding to that of the headers 11 and 12 and in the present embodiment both headers and plates are of square shape with rounded corners. Each of the plates 13 has a series of sinuous grooves 33, Figures 4 to 6, on, say, its front face and a series of similar grooves 34 on its rear face, the general direction of the grooves 33 and 34 being at right angles to one another. The grooves 33 at their left-hand ends open into ports 35 and 36 formed in the plate 13 and at their right-hand ends open into ports 37 and 38 also formed in this plate. The grooves 34, Figure 5, at their upper ends open into ports

39 and 40 and at their lower ends open into ports 41 and 42. The ports 39, 40, 41 and 42 are formed in the plate 13. The plates 13 are provided with holes 43 for the bolts 14 which secure the headers 11 and 12 and the plates 13 together. Grooves 44, Figures 5 and 6, for sealing purposes may be formed round the jointing faces of the plates 13. If desired, gaskets 45 may be fitted between the juxtaposed faces of the plates 13 and between the end plates and the headers 11 and 12 to ensure fluidtight joints therebetween.

The heat-transfer plates 13 are interchangeable.

In assembling the heat-transfer plates, two of these plates 46 and 47, Figure 6, are arranged with the grooves 33 on their front faces facing each other as shown, a gasket 45 being interposed between their adjacent faces. Two other plates 48 and 49 are assembled one on each side of the plates 46 and 47, the grooves 34 on the rear faces of the latter plates facing the grooves 34 on the plates 48 and 49. Gaskets 45 are inserted between the rear faces of the plates 46 and 47 and the rear faces of the plates 48 and 49. The front faces of each of the next two plates to be assembled are then disposed with their rear faces adjacent to the rear faces of the plates 48 and 49 so that the grooves 33 on the latter plates face similar grooves on the plates to be assembled therewith, and so on until the required number of plates 13 have been assembled together with the headers 11 and 12. Pairs of horizontal groove sets 33 thus alternate with pairs of vertical groove sets 34 throughout the heat-exchanger.

When the plates 13 are assembled with the headers 11 and 12, the ports 35, 36 and 37, 38 of all these plates are in register with one another and form four ducts through the assembled plates. There are thus formed two ducts by the ports 35, 36 adjacent to the left-hand sides of the assembled plates 13 and two ducts by the ports 37, 38 adjacent to the right-hand sides of the plates. Moreover, two ducts are similarly formed in the assembled plates 13 adjacent to the top thereof by the ports 39, 40 and two ducts are formed adjacent to the bottom of these plates by the ports 41, 42.

The ducts formed by the ports 35, 36 are in communication with the left-hand ends of the grooves 33 in all the plates, while the ducts formed by the ports 37, 38 are in communication with the right-hand ends of the grooves 33. Similarly, the ducts formed by the ports 39, 40 are in communication with the upper ends of the grooves 34 in all the plates 13, while the ducts formed by the ports 41, 42 are in communication with the lower ends of the grooves 34 in all the plates of the heat-exchanger.

As the left-hand ends of the grooves 33 of the plates 13 open into the ports 35, 36 and as the right-hand ends of these grooves open into the ports 37, 38 the ducts formed by these ports on assembly of the plates 13 are connected in parallel by the grooves 33. Further, when the headers 11 and 12 are assembled with the plates 13, the ports 21 and 22 in the compartment 17 of the header and the pipe connection 23 in this header are in communication with the ducts formed by the ports 35, 36 in the plates 13, while the ports 26 and 27 of the header 12 are in communication with the ducts formed by the ports 37, 38. Fluid may thus flow through the pipe connection 23 to the compartment 17 and from this compartment through the ports 21 and 22 in the header 11 to the ducts formed by the ports

35, 36 to the grooves 33 and through these grooves to the ducts formed by the ports 37, 38 and thence through the ports 26 and 27 in the header 12 to the compartment 29 therein and from this compartment to the pipe connection 31 or vice versa.

Similarly, as the upper ends of the grooves 34 of the plates 13 open into the ports 39, 40 in these plates and as the lower ends of these grooves open into the ports 41, 42 the ducts formed by these ports on assembly of the plates are connected in parallel by the grooves 34. Further, when the headers 11 and 12 are assembled with the plates 13, the ports 18 and 19 in the compartment 16 of the header 11 and the pipe connection 20 in this header are in communication with the ducts formed by the ports 39, 40 in the plates 13, while the pipe connection 32 and the ports 24 and 25 in the header 12 are in communication with the ducts formed by the assembly of the ports 41, 42. Fluid may thus flow through the pipe connection 32, compartment 30 and ports 24 and 25 of the header 12 and thence through the ducts formed by the assembled ports 41, 42 and upwards through the grooves 34 to the ducts formed by the assembled ports 39, 40 and thereafter through the ports 18 and 19 in the header 11 into the compartment 16 therein and from this compartment to the pipe connection 20 or vice versa.

A cooling fluid, for example, may thus enter the heat-exchanger through the pipe connection 23 of the header 11 and after passing through the heat-transfer plates 13 in the above manner to the header 12 leave the heat-exchanger by the pipe connection 31 of the latter header, while a fluid to be cooled may enter the header 12 by the pipe connection 32 and after passing through the heat-transfer plates 13 to the header 11 leave the latter header by the pipe connection 20.

In those cases where it is desired to deal with, say, three fluids, a distributing block may be inserted between two groups of plates in a heat exchanger as above described so that the distributing block is disposed intermediately between the headers 11 and 12. In one such arrangement illustrated in Figures 7 and 8, the heat-exchanger comprises headers 11 and 12 as above described and two groups 50, 51 of plates 13 spaced apart by a distributing block 52. The distributing block comprises (Figure 8) a closed box-like structure divided by internal walls 53 into three compartments 61, 62, 63 and provided with three pipe connections 54, 55, 56 one for each compartment. In one end wall, ports 57, 58 are formed in adjacent edges to register respectively with two sets of ports in the group of plates 50 and to open respectively into compartments 63 and 62, and in the other end wall two sets of ports 59, 60 are formed in adjacent edges to register with two sets of ports in the group of plates 51 and to open respectively into the compartments 61 and 62.

In employing such an arrangement in a marine engine plant for cooling lubricating oil and for absorbing heat from engine exhaust steam, sea water may enter by the top header 11 and flow downwards through one set of grooves in the plates 13 of the upper group 50, through ports 58 into compartment 62 in the distributing block 52 and then through this compartment 62 and downwards through ports 59 to the corresponding set of grooves in the plates 13 of the lower group 51 to the bottom header 12 from which it is discharged. The exhaust steam to be condensed

enters the compartment 63 in the distributing block 52 through pipe connection 56 and flows upwards through ports 57 to the second set of grooves in the plates 13 of group 50 to the top header 11 from which it is discharged in a condensed condition. The lubricating oil to be cooled may enter by the bottom header 12 and flow through the second set of grooves in the plates of the group 51 and ports 60 into compartment 61 in the distributing block 52 from which it is discharged through pipe connection 54 in a cooled condition. In this case, pipe connection 55 is blanked off.

Alternatively, the sea water may enter compartment 62 in the distributing block 52 through pipe connection 55 and flow in both directions through corresponding grooves in the plates 13 in the upper and lower groups 50, 51 to the top and bottom headers 11 and 12 while the engine exhaust steam enters by the top header 11 and flows downwards through the second set of grooves in the plates 13 of the upper group 50 into compartment 63 of the distributing block 52 from which it is discharged through pipe connection 56, while the lubricating oil enters by the bottom header 12 and flows upwards through the second set of grooves in the plates 13 of group 51 into compartment 61 in the distributing block 52 from which it is discharged through pipe connection 54.

Instead of the grooves in the heat-exchange plates 13 being sinuous as illustrated in Figure 4. they may be straight as indicated at 133 in Figure 9.

When a heat-exchanger as described with reference to Figures 1 to 6 is used, for example, for cooling a liquid for human consumption, the heat-transfer plates of the exchanger are secured together in pairs, the channels formed by the grooves on the abutting faces of each pair being selected to carry the coolant. The plates of each pair may be secured together in any convenient manner for example by welding their contacting edges as illustrated at 113 in Figure 10. The pairs are then assembled with one another and with the headers 11 and 12 by readily detachable means such as the through-going bolts 14.

When it is desired to clean the channels in the plates through which the liquid to be cooled is conveyed, the through-going bolts 14 are slackened-off and removed and the pairs of plates separated from one another so that the pairs of plates have their end faces, the grooves in which convey the liquid to be cooled, open for inspection and cleaning.

Further, in some cases, instead of conveying a coolant through channels between the pairs of plates a heating fluid may be passed therethrough.

It will be appreciated that as it is not necessary to disturb the joints between the plates of each pair, the dismantling of the heat-exchanger for cleaning purposes and its re-assembly are substantially expedited.

The number of heat-transfer plates employed in a heat-exchanger or in a section thereof depends upon the amount of heat to be imparted or absorbed.

The heat-exchangers above described may be used in connection with gases, vapours or mixtures thereof or with liquids. One of the fluids may be a liquid and the other fluid or fluids may be a gas, vapour, or a mixture of gas and vapour.

The heat-exchangers according to the invention may be used either for heating or cooling a fluid or fluids and are particularly applicable to condensers.

I claim:

1. A heat-exchanger comprising a plurality of like plates in a stack, each plate having a plurality of substantially parallel grooves on each face thereof, having the grooves on one face substantially at right angles to the grooves on the other face, and having four sets of port means formed in the marginal portions of the plates each set of port means having an extent peripherally of the plate to communicate with corresponding ends of the plurality of grooves on one face of the plate, the plates having similarly extending grooves on their adjacent faces, and a pair of headers one disposed at each end of the stack of plates, each header having a pair of chambers separated by a common wall, and having in the wall thereof facing the stack of plates two sets of port means, the said sets of port means respectively communicating with the chambers and respectively registering with one set of the port means of the plates.

2. A heat-exchanger comprising a plurality of like substantially rectangular plates, each having a plurality of grooves on each face thereof, the grooves on one face being substantially parallel to one pair of opposite edges of the plate and those on the other face being substantially parallel to the other pair of opposite edges, and each plate having a port formed therein along the marginal portion of each of the edges thereof, said plates being disposed side by side with the faces thereof having similarly extending grooves facing one another and the corresponding marginal ports in register, whereby the marginal ports along each pair of opposite edges communicate with one set of parallel grooves formed between the plate, and a pair of headers one disposed at each end of said plates, each header comprising a pair of header chambers separated by a partition, and each header chamber having an outlet connection and a port communicating with a marginal port in the adjacent plate.

3. A heat-exchanger according to claim 2, in which the ports in the chambers of each header communicate with marginal ports in the adjacent plate along each of two edges of said plate substantially at right angles to each other.

4. A heat-exchanger according to claim 2, in which the chamber outlet connections open out of the respective headers on two opposite sides of the heat-exchanger, so that fluid entering through any outlet connection on one end of the heat-exchanger will be guided to emerge out of a connection means on the opposite end of the heat exchanger.

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