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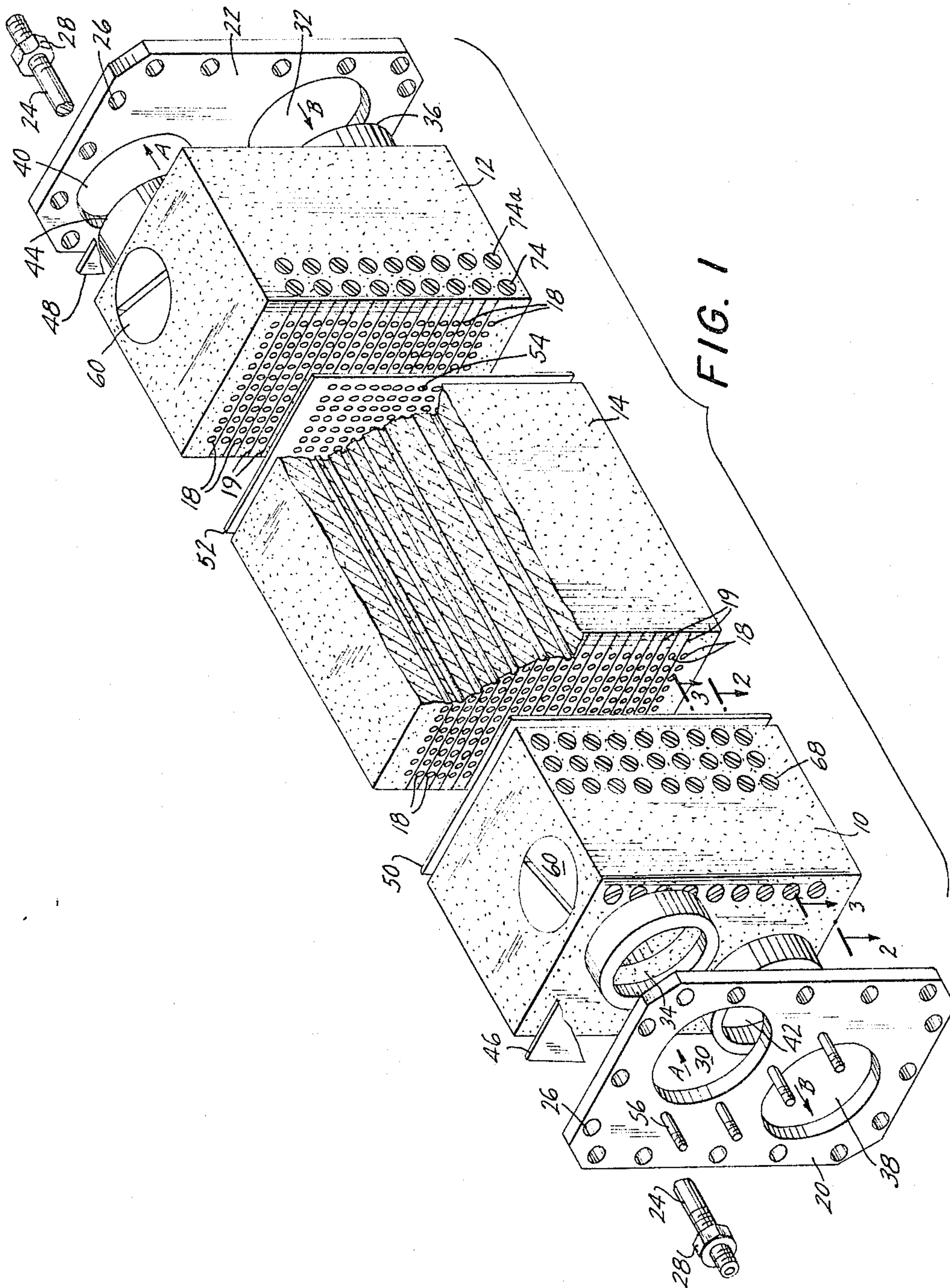
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CORROSION RESISTANT HEAT EXCHANGER

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2 Sheets-Sheet 1



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FIG. 2

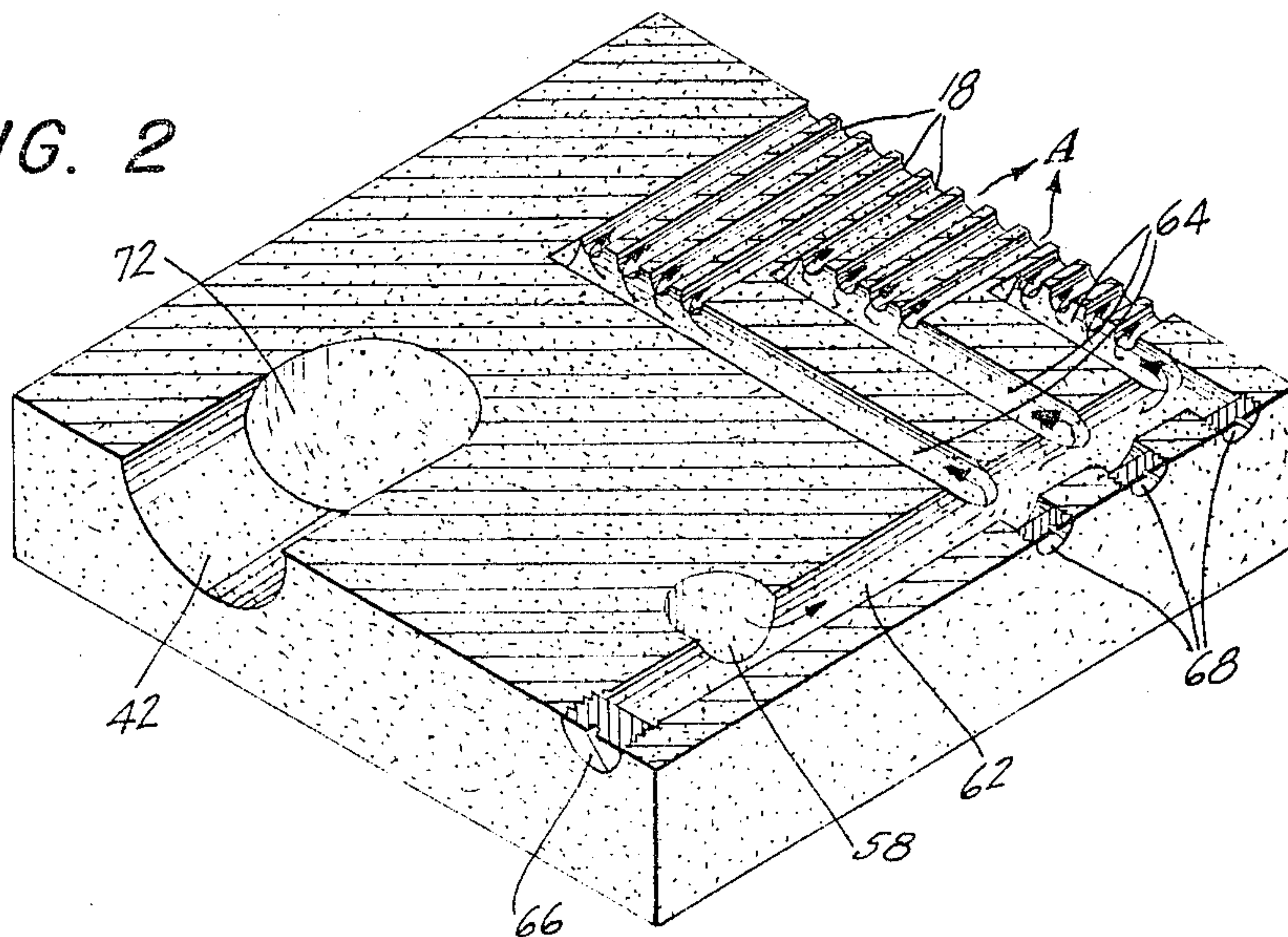
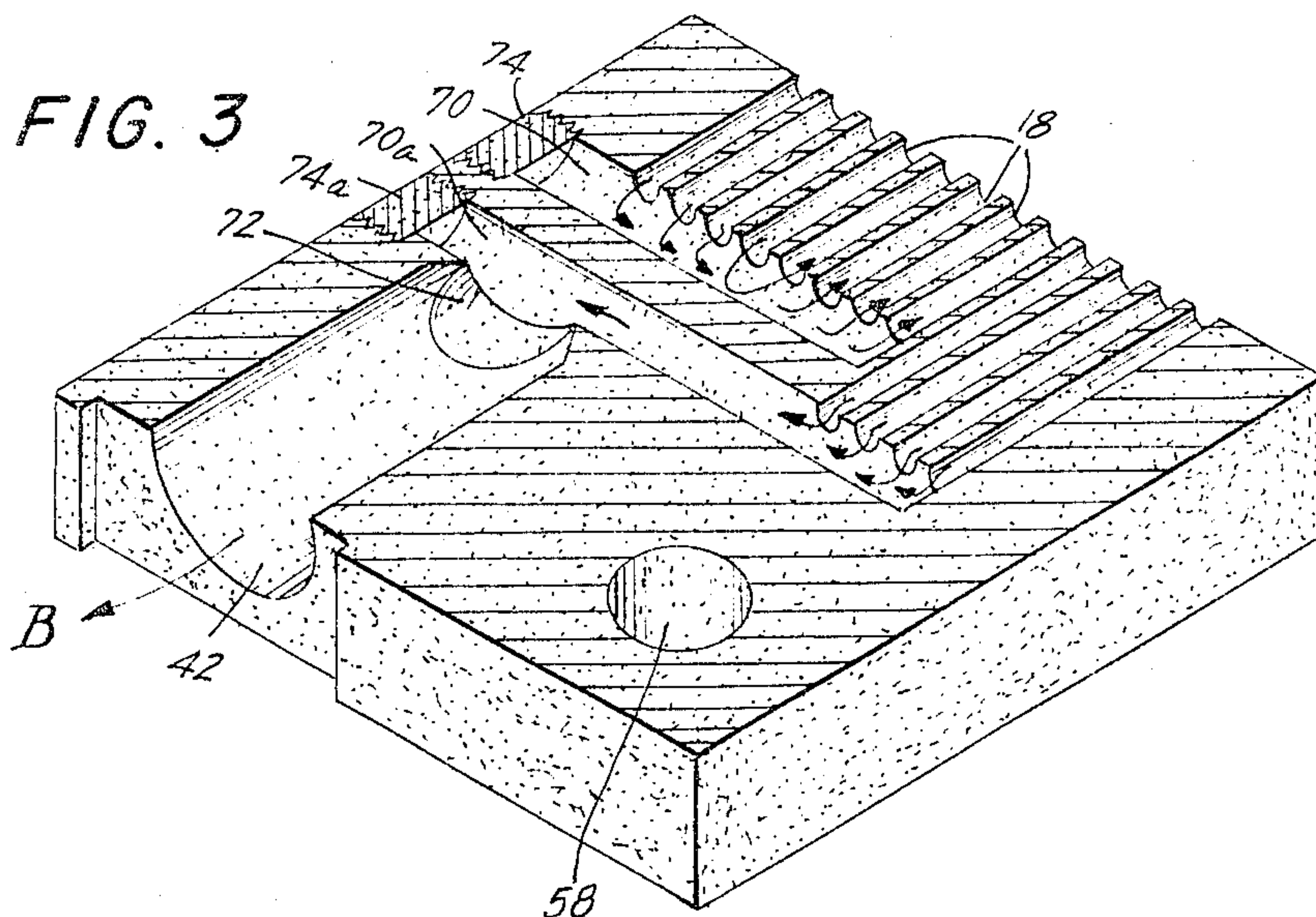


FIG. 3



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CORROSION RESISTANT HEAT EXCHANGER
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11 Claims. (Cl. 165—164)

This invention relates to a corrosion resistant heat exchanger, and more particularly, to a heat exchanger of impervious graphite.

There are many industrial processes in which heat exchangers are used to transfer heat from one moving fluid to another moving fluid, the effect being to increase or decrease the temperature of any one fluid according to whether it enters the heat exchange system at a lower or at a higher temperature than that of the other fluid. Among the countless type of heat exchangers available, the most common are the plate type, the tube type, and the block type. Depending upon what fluids are to be involved, the heat exchangers may be made partially or totally of metal or graphite.

The principal object of this invention is to provide an improved heat exchanger of the block type which is fabricated from impervious graphite.

More specifically, an object of the invention is to provide a heat exchanger of the type described which may embody the excellent thermal efficiency of true counter-flow design.

Another object of the invention is to provide a heat exchanger of the type described wherein the distance of travel of heat flow between the two fluids is constant thereby eliminating so called hot spots.

Still another object of the invention is to provide a heat exchanger of the type described wherein the total heat transfer area available may be easily varied over a wide range as desired both at the time of manufacture and subsequent thereto.

Broadly stated, the objects of the invention are accomplished by a heat exchanger which comprises in combination two headers fabricated from monolithic blocks of impervious graphite and which are separated usually by one or more blocks of monolithic impervious graphite. The headers and the blocks have drilled therein a plurality of horizontal corresponding passageways, the axes of which are all parallel. Each of the headers is provided with a fluid inlet and outlet and conduits which connect the inlets and outlets with the horizontal rows of passageways. Usually the conduits are so disposed that each of the fluids involved are conducted through alternate rows of passageways and preferably in a counter flow direction through the heat exchanger. However, if desired the two fluids involved may be diverted into an unequally divided number of rows of passageways.

The invention will be more readily understood by reference to the drawing wherein:

FIG. 1 is an exploded view, partially in section, of a heat exchanger which embodies the principles of the invention;

FIG. 2 is a view of the heat exchanger of FIG. 1 along the line 2—2 of FIG. 1; and

FIG. 3 is a view of the heat exchanger of FIG. 1 along the line 3—3 of FIG. 1.

While the heat exchanger shown comprises two headers separated by one block, it should be appreciated that the heat exchanger of the invention is not so limited and one way of varying the total heat transfer surface area of a heat exchanger embodying the principles of the invention is to provide a plurality of blocks in line instead of one, or no blocks at all since a considerable amount of heat transfer occurs in the headers themselves. This may be

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done, of course, at the time the heat exchanger is originally assembled or at any later time.

Referring now to the drawing, and particularly FIG. 1, the heat exchanger shown comprises in combination two impervious graphite headers 10 and 12, separated by an impervious graphite block 14. Both the headers 10 and 12, and the block 14 which originally were monolithic blocks of impervious graphite, have all been provided with a plurality of corresponding drilled passageways 18, the axes of which are all parallel. In addition, in the preferred embodiment, the faces of the headers 10 and 12 and the faces of the center block 14 are all provided with horizontal machined grooves 19 which extend across the faces between each row of horizontal passageways 18.

It should be understood that the words horizontal and vertical as used herein and in the appended claims refers to the heat exchanger as illustrated in the drawing. The heat exchanger of the invention may, of course, be installed where desired in any position, i.e., on its side, on one end, etc.

In a complete unit pressure plates 20 and 22 are provided at opposite ends of the heat exchanger. The plates 20 and 22 are tied together with a plurality of tie rods 24 which pass through apertures 26 provided in the plates 20 and 22, and secured by nuts 28. The pressure plates 20 and 22 respectively are provided with apertures 30 and 32 for the inlets 34 and 36 of headers 10 and 12 and apertures 38 and 40 for the outlets 42 and 44 of the headers 10 and 12.

In order to protect the graphite headers, properly apertured pressure pads 46 and 48 are positioned between the pressure plates 20 and 22 and the headers 10 and 12. Gaskets 50 and 52, having apertures 54 which exactly correspond to the passageways 18, are provided between block 14 and the headers 10 and 12. In the event of faulty gasket sealing due to insufficient pressure on the gasket or a faulty gasket surface, the grooves 19 will prevent interpassage exchange of fluids by channelling the fluids to the periphery of the heat exchanger. In addition, the escape of the fluid at a particular groove 19 will act as a "tell-tale" to where the leakage is occurring with the heat exchanger. Threaded studs 56 may be provided on the pressure plates 20 and 22 for ease of connecting the heat exchanger into appropriate fluid lines.

As shown in FIGS. 2 and 3, the headers 10 and 12 are provided with a plurality of drilled conduits which taken together conduct the fluids designated as A and B in FIG. 1 from the inlets in the headers into alternate rows of drilled passageways 18 and collect the fluids A and B from the alternate rows of passageways 18 and channel them, as the case may be, into either a plurality of passes through the passageways 18 in the headers 10 and 12 and the block 14, or into the outlets 42 and 44. In the particular heat exchanger illustrated, fluid A is allowed to make a single pass through the entire exchanger and fluid B makes a total of three passes through the entire exchanger.

Prior to a discussion of the path which each fluid A and B takes through the illustrated exchanger, a more detailed discussion of the headers 10 and 12 is believed to be in order. Headers 10 and 12 are identical and interchangeable, the headers at opposite ends merely being positioned at the time of assembly out of phase to one another by 180° in relation to the vertical axis. Accordingly, the discussion will be limited to one of the headers, namely 10. In the practice of the invention all headers which are adapted so that both the fluids make an odd number of passes through the entire exchanger, i.e., one, three, five, etc., or any combination thereof, are interchangeable with one another as are headers 10 and 12. If an even number of passes is desired for one or more of the fluids, the headers are not interchangeable since the fluid or fluids

that make an even number of passes will enter and exit the heat exchanger through the same header.

In header 10, a drilled dead end main conduit 58 shown in FIG. 2, is provided in communication with the inlet 34 for fluid A. The external opening of conduit 58 is closed with a plug 60. Conduit 58 is intersected by a plurality of feeder conduits 62 which correspond to one-half the number of total horizontal rows of passageways 18 which are provided and which conduct fluid A into every other row of passageways 18 by means of a selected number of branch conduits which intersect the feeder conduits 62. Of course, one branch conduit 64 could connect the feeder conduit 62 with all the passageways 18 in a given row. The openings through which conduits 62 and 64 were drilled are closed with plugs 66 and 68 respectively.

The conduits necessary for the three pass system, and which are in connection with every alternate row of passageways 18 is shown in FIG. 3. A selected proportion of the drilled passageways 18 in these rows dead end at a dead end branch conduit 70 which in turn is intersected by still another selected proportion of passageways 18. The remaining proportion of drilled passageways 18 in each of the rows which carry fluid B finally dead end at another branch conduit 70a which is in turn in communication with collector (feeder) conduit 72, which connects with the outlet 42. Branch conduits 70 and 70a are closed at the drilled end with plugs 74 and 74a.

It will be understood by those skilled in the art, that the heat exchanger of the invention may at the time of manufacture be provided with an equal or unequal number of passes for each fluid and these passes for each fluid may range from one to a number which is dependent on the number of parallel passageways which may safely be drilled in the block and headers while maintaining sufficient strength between the passageways to resist the pressure of the fluids passing therethrough. The illustrated selection of twelve horizontal and eighteen vertical passageways is purely arbitrary as is the selection of four passageways for each pass in the three pass system. If desired, using the block illustrated as the standard, each header could be so drilled with conduits as outlined here in order to give one hundred and eight passes for each fluid. Furthermore, the passageways need not be in vertical rows or of equal diameter as illustrated, the only requirement being that the axes of all the passageways which are primarily involved in heat transfer are parallel. Likewise, the conduits may be so provided that the two fluids are diverted into an unequally divided number of rows of passageways. The unique conduit system shown in FIGS. 2 and 3 and which may be varied as outlined above permits parallel flow of the fluids virtually up to the outlets of the heat exchanger.

In order to further aid in an understanding of the invention, the course of fluid A and fluid B in counter flow relation will be followed through the illustrated heat exchanger.

Fluid A makes one pass through the system and it enters the heat exchanger through inlet 34 and flows into conduit 58 which preferably is tapered toward the bottom. The fluid A is fed into alternate rows of passageways 18 by means of the corresponding feeder conduits 62 and branch conduits 64. Once the fluid A has passed through the entire length of the passageways it is collected and exited through outlet 44 in header 12 in exactly the inverse order in which it entered the passageways 18 in header 10.

Fluid B makes three passes through the system and it enters the heat exchanger through inlet 36 and flows through the header 12 into passageways 18 exactly in the inverse order as will be discussed with its exit from header 10. Fluid B first enters header 10 through a proportion of the passageways 18 and empties into branch conduit 70 from whence it flows back through the next proportion of passageways 18 into header 12 where it

is similarly turned around and returned to header 10 through the remaining proportion of passageways 18 into branch conduit 70a. All the fluid B exiting from such branch conduit 72 in each alternate row of passageways is collected in collector (or feeder) conduit 72 which empties into outlet 42.

It will be appreciated that both fluids which are introduced into the heat exchanger of the invention are in contact only with impervious graphite. Thus, the heat exchangers are eminently suited for heat transfer between two corrosive liquids, between a corrosive liquid and a corrosive gas, as well as heating or cooling a corrosive solution with steam or water.

What is claimed is:

1. A heat exchanger for two fluids which comprises in combination two headers fabricated from monolithic blocks of impervious graphite, said headers being provided with a plurality of rows of horizontal drilled passageways all of whose axes are parallel to one another, said headers being so adapted that each of said fluids pass through separate horizontal rows of parallel passageways.

2. The heat exchanger of claim 1 wherein each of said fluids pass through alternate rows of said horizontal rows of parallel passageways.

3. The heat exchanger of claim 2 wherein said plurality of drilled passageways are also arranged in vertical rows and all of said passageways are uniform in size.

4. The heat exchanger of claim 3 wherein the facing surfaces of said headers are provided with grooves which extend across said faces between said horizontal rows of passageways and a gasket is provided between said headers, said gasket having a plurality of holes which correspond to said passageways in said headers.

5. A heat exchanger having an inlet and an outlet each for two fluids which comprises in combination two headers fabricated from monolithic blocks of impervious graphite, said headers being provided with a plurality of rows of horizontal drilled passageways all of whose axes are parallel to one another; alternate rows of said horizontal passageways being for one of said two fluids and being in communication with each other by means of conduits which connect all the passageways in said alternate rows to vertical conduits which are in communication with said inlet and said outlet for each one of said fluids, in order that adjacent rows of said horizontal rows will contain different fluids.

6. The heat exchanger of claim 5 wherein said plurality of drilled passageways are also arranged in vertical rows and said passageways are uniform in size.

7. The heat exchanger of claim 6 wherein the facing surfaces of said headers are provided with grooves which extend across said faces between said horizontal rows of passageways and a gasket is provided between said headers, said gasket having a plurality of holes which correspond to said passageways in said headers.

8. The heat exchanger of claim 7 wherein each of said fluids enters one of said headers and exits from the other of said headers.

9. The heat exchanger of claim 8 wherein at least one monolithic block of impervious graphite provided with a plurality of vertical and horizontal rows of drilled passageways all of whose axes are parallel and which correspond to said vertical and horizontal rows of drilled passageways in said headers, is disposed between said headers.

10. The heat exchanger of claim 9 wherein the faces of said block are provided with grooves which extend across said faces between said horizontal rows of passageways and a gasket is provided between each of said headers and said block, said gaskets having a plurality of holes which correspond to said passageways in said headers and said block.

11. The heat exchanger of claim 8 wherein said conduits which connect said alternate rows of passageways

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to said inlet and outlet for at least one of said fluids are so disposed in relation to said passageway that at least one of said fluids makes multiple passes through said heat exchanger.

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