April 14, 1953 C. S. SIMPELAAR 2,634,958

HEAT EXCHANGER

Filed Dec. 3, 1948 5 Sheets-Sheet 1

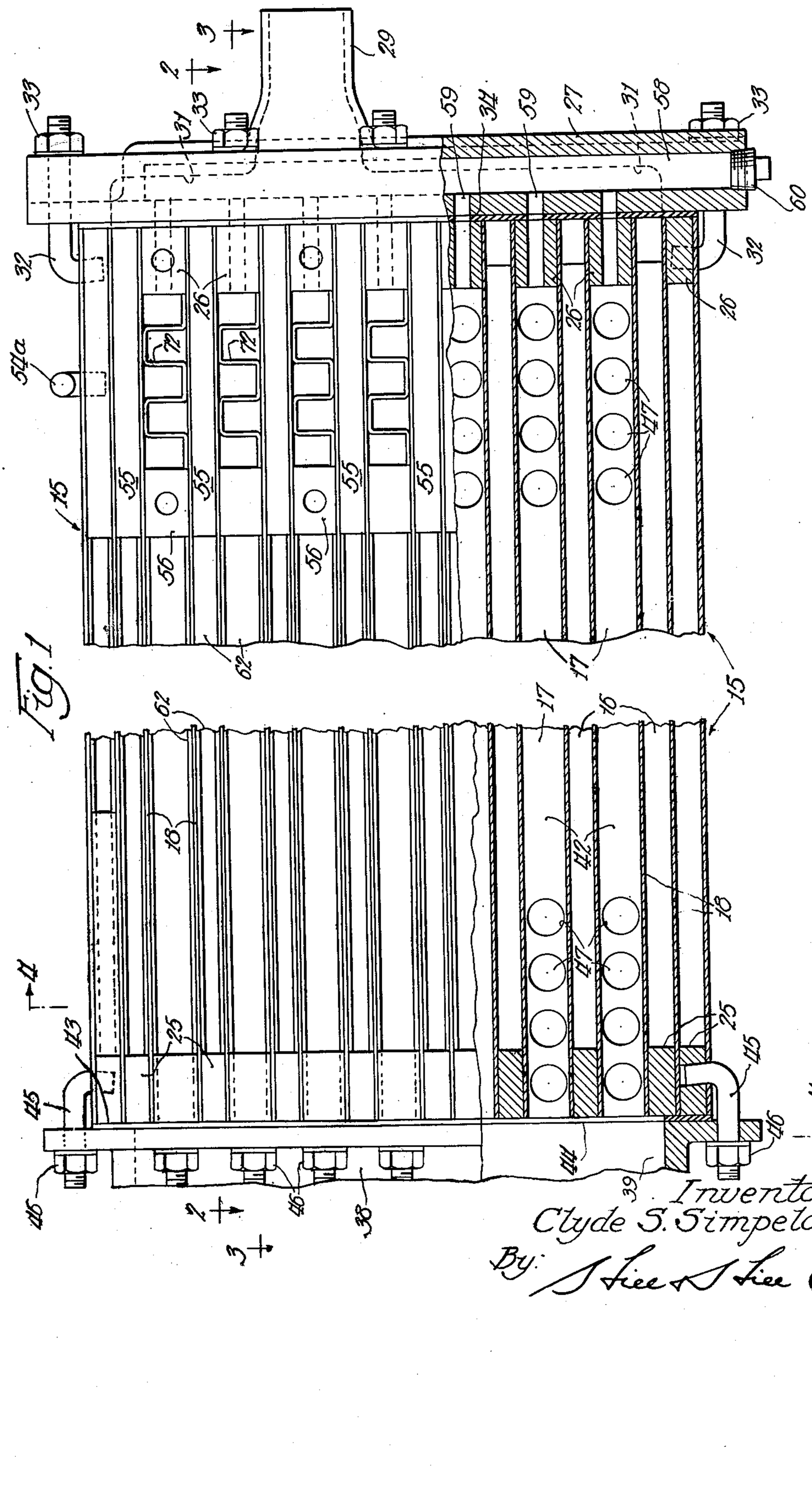

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Fig. 3

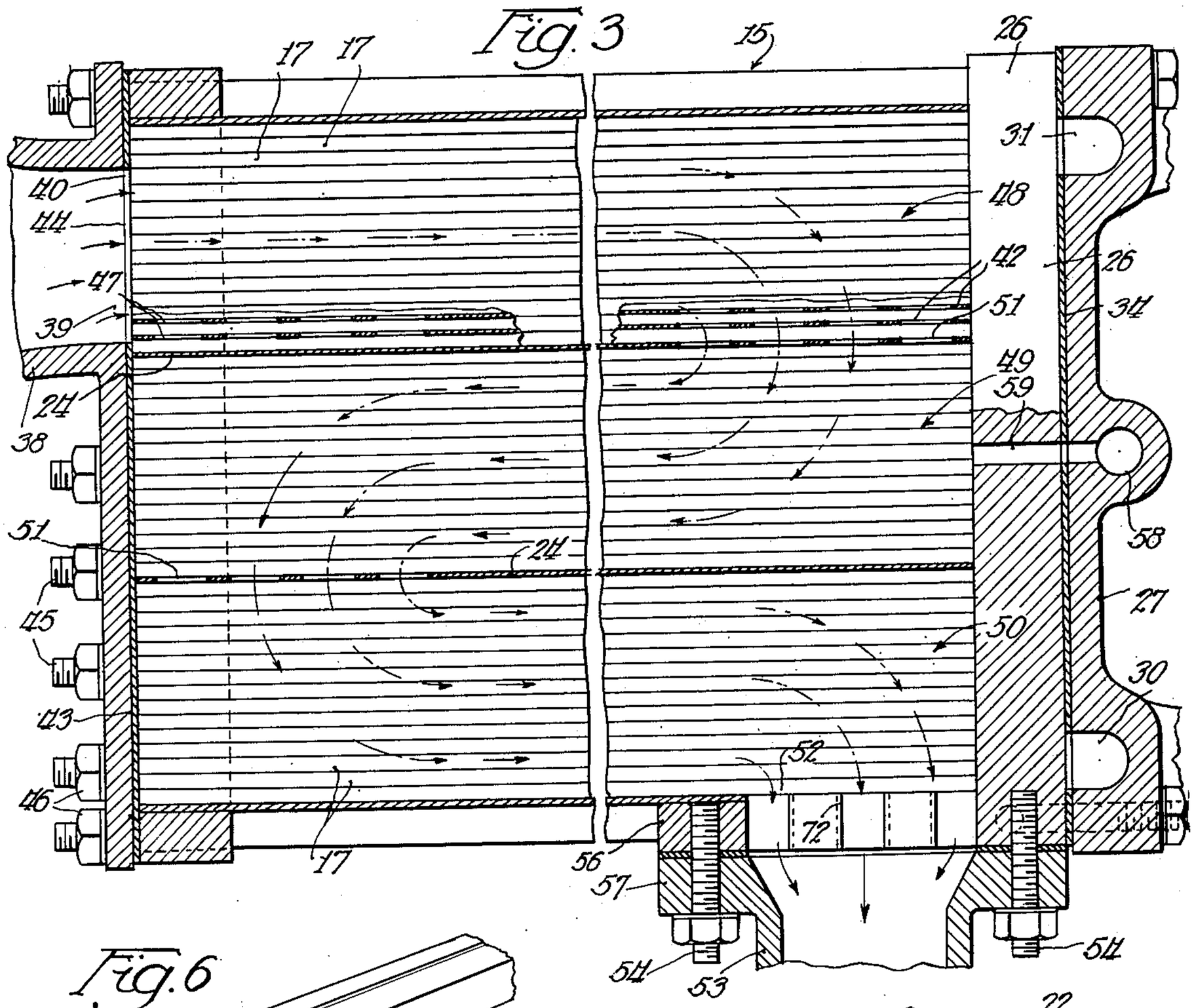

Fig. 6

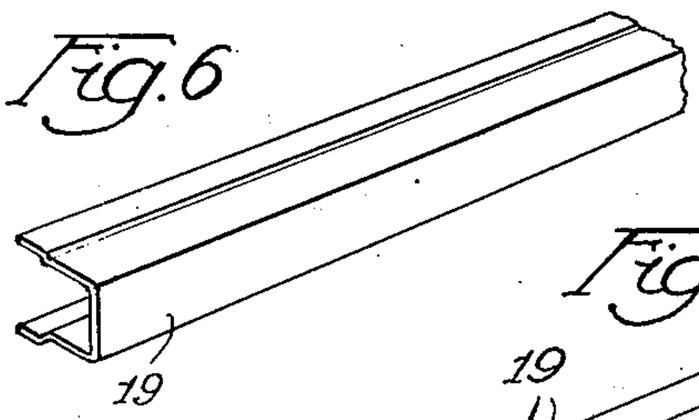

Fig. 5

Fig. 16

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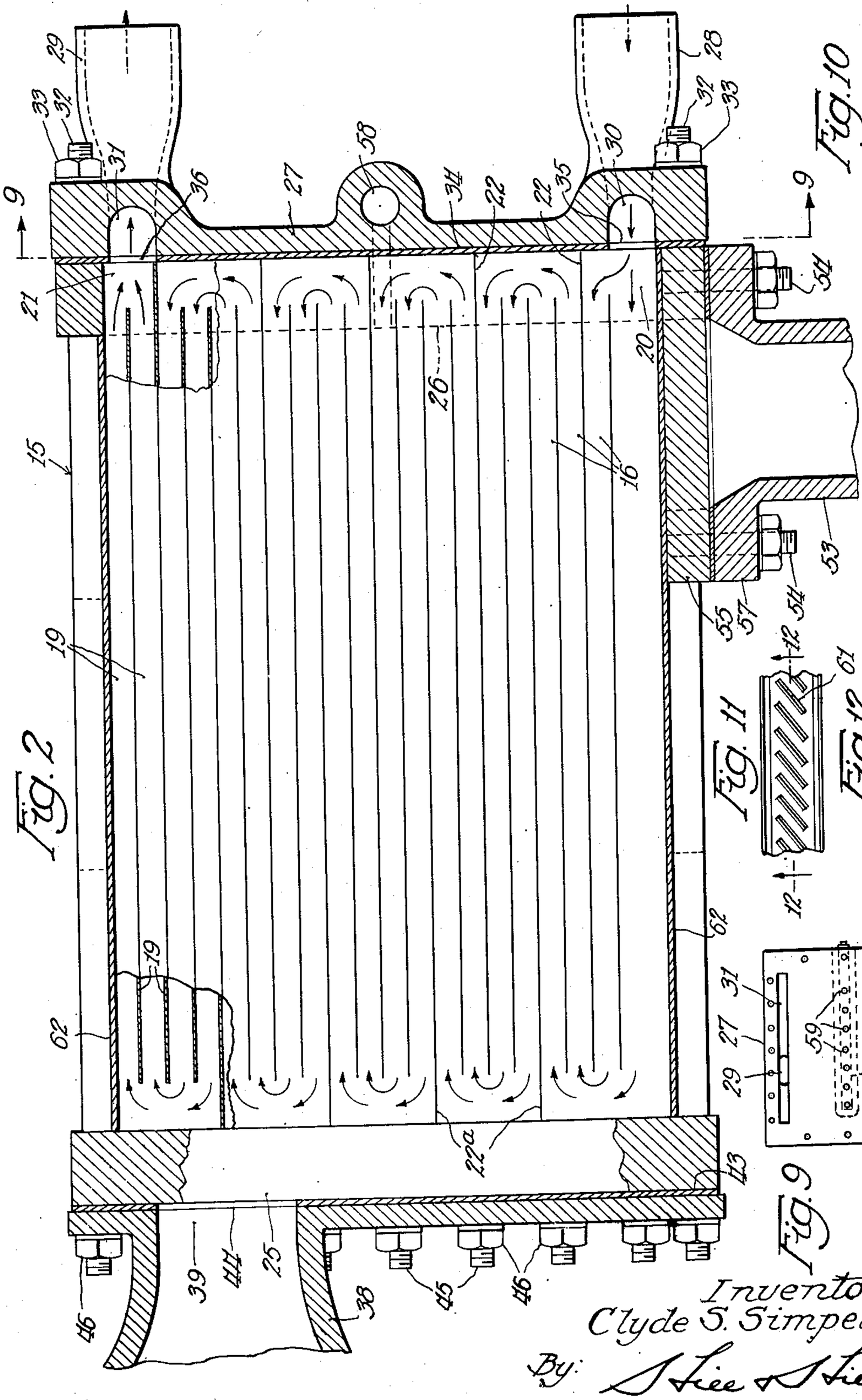

Fig. 10

Fig. 2

Fig. 11

Fig. 12

Fig. 9

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Fig. 4

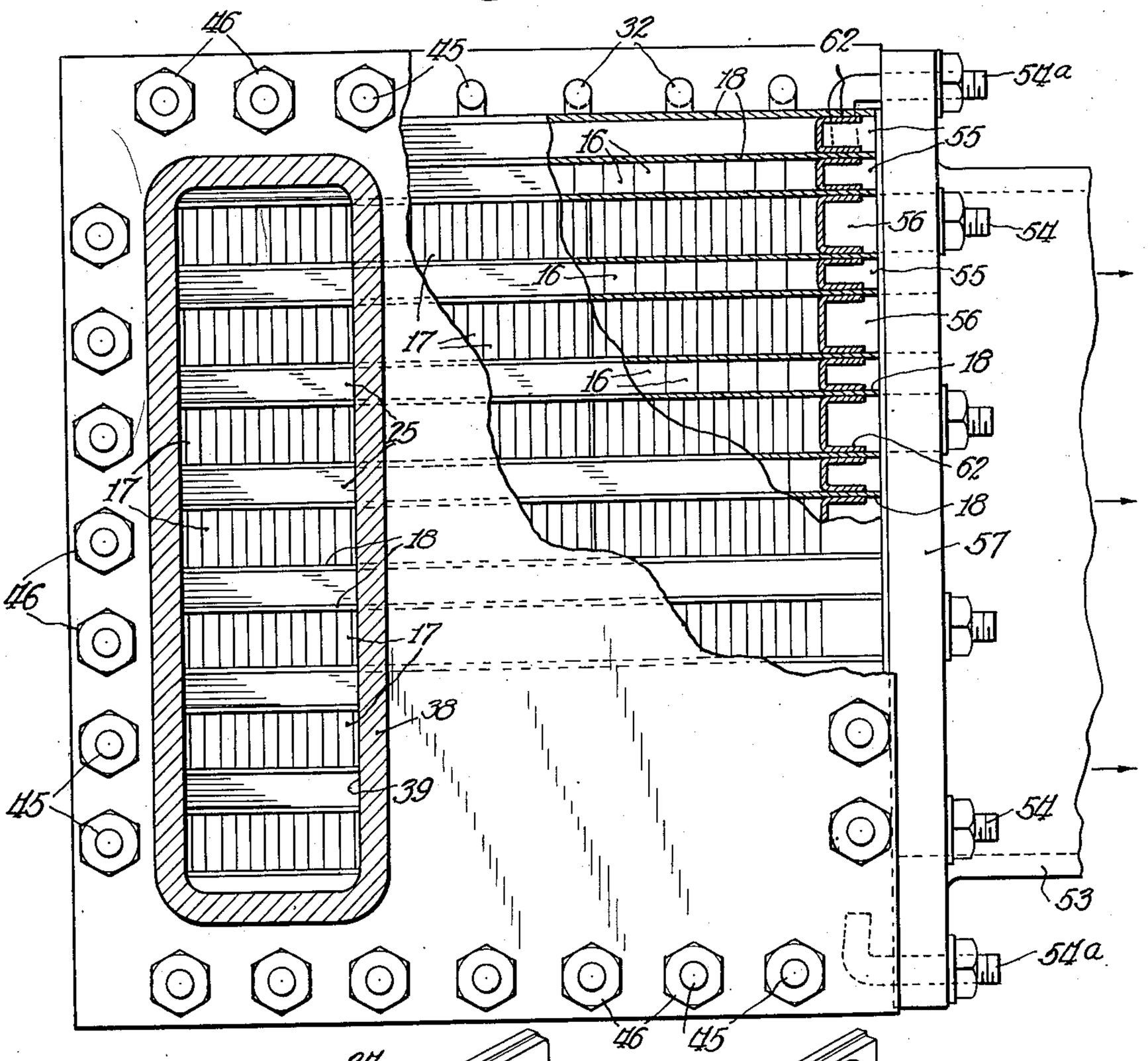

Fig. 7

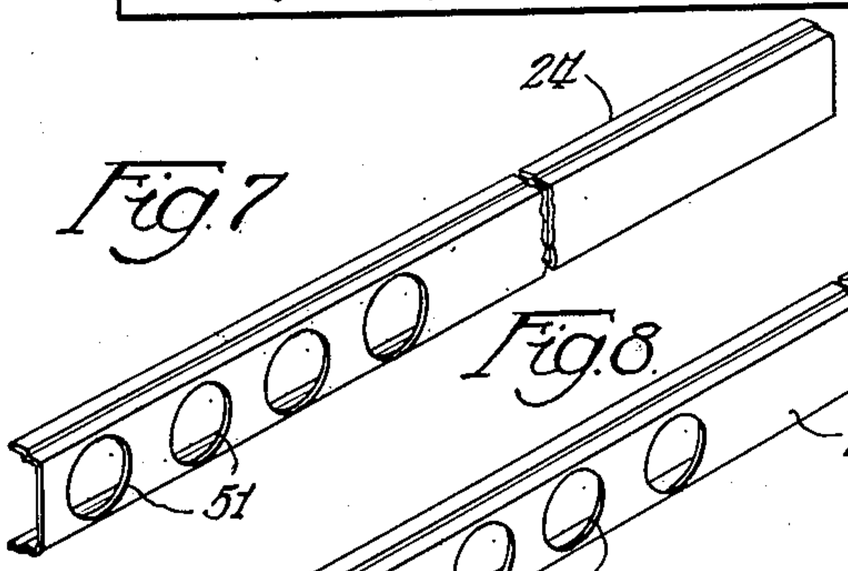

Fig. 8

Fig. 15

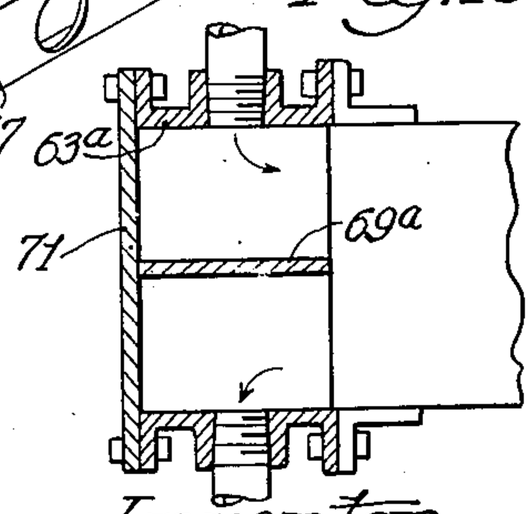

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Fig. 13

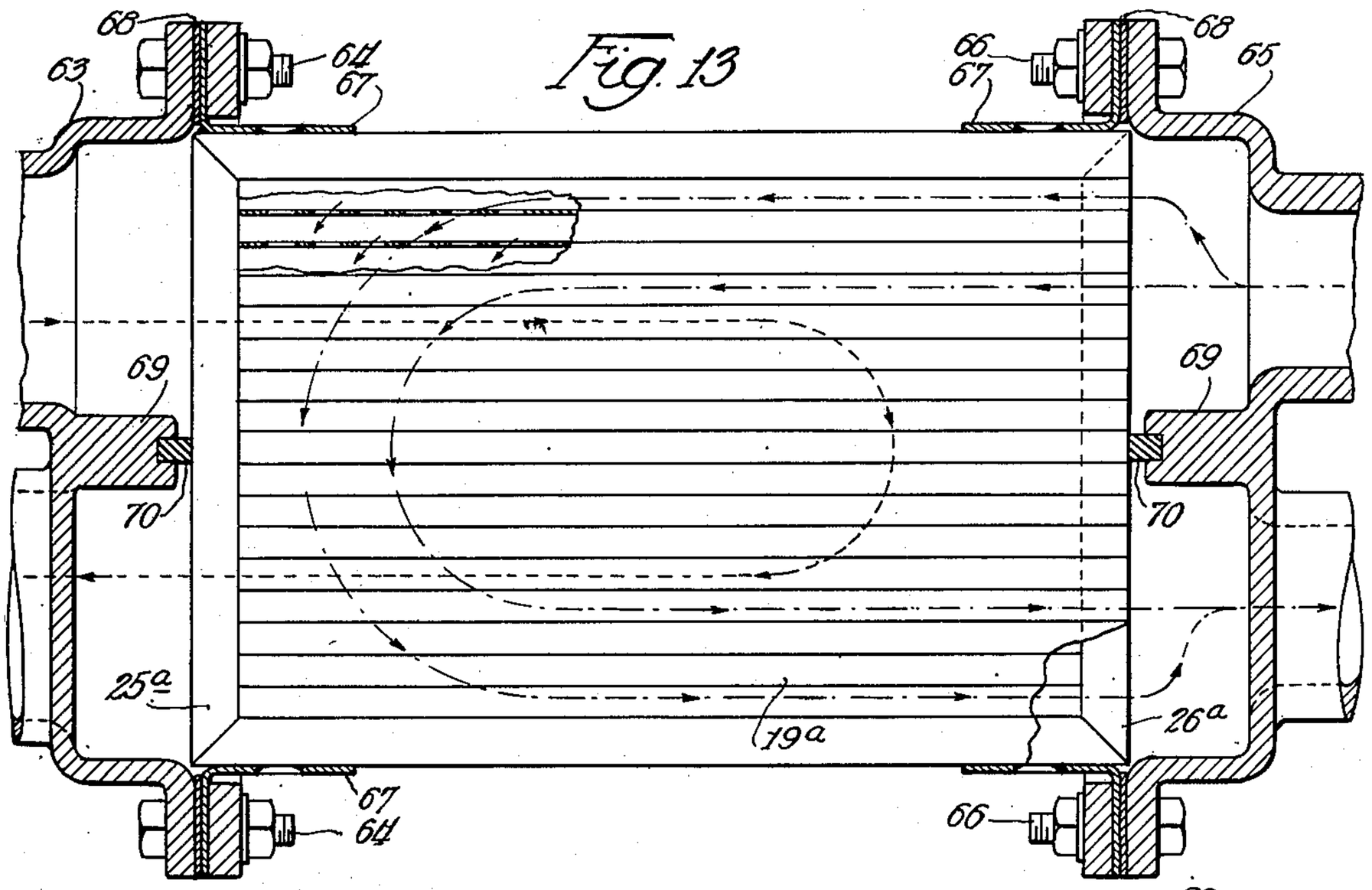
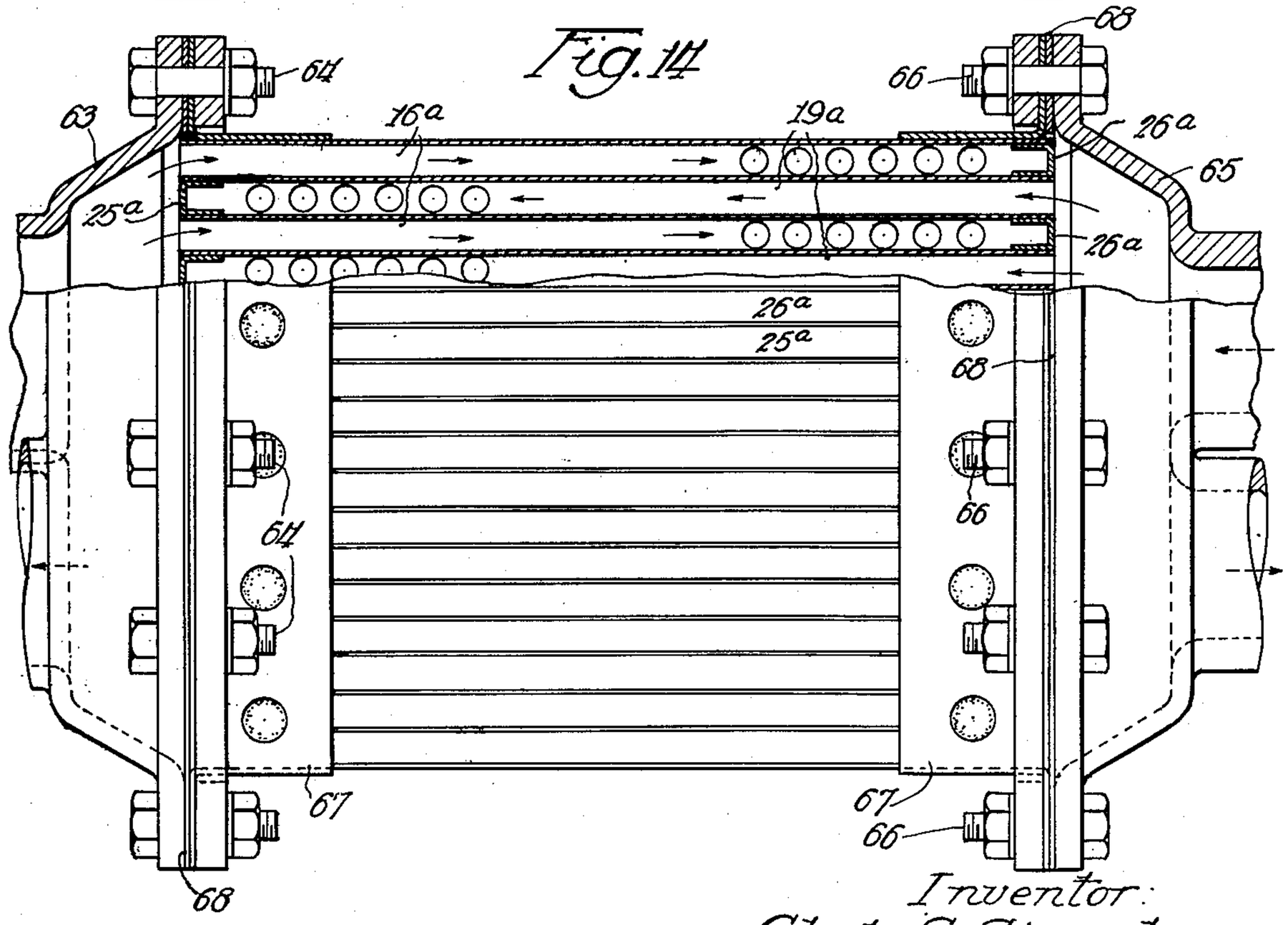


Fig. 14



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Patented Apr. 14, 1953 2,634,958

UNITED STATES PATENT OFFICE

2,634,958

HEAT EXCHANGER

Clyde S. Simpelaar, Racine, Wis., assignor to Modine Manufacturing Company, Racine, Wis., a corporation of Wisconsin

Application December 3, 1948, Serial No. 63,259

15 Claims. (Cl. 257—245)

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This invention relates to heat exchangers of the channel shaped fin type structure as applied to heat exchangers used for liquid to gas service such as intercoolers and aftercoolers, for compressors or superchargers.

The fins used in this heat exchanger are preferably of the nested channel shaped type. These fins may be of the plain strip design, or they may be provided with corrugations or contoured bottoms or transversely slit bottoms.

One of the objects of this invention is to provide a heat exchanger in which access to both the liquid and gas passes may be had for inspection and cleaning purposes.

Another object is to provide a plenum section as part of the fin structure to provide multipass flow within each individual pass of the heat exchanger with certain plane ended fins providing the baffles.

Another object is to provide a heat exchanger with effective use of the plenum sections as heat transfer surface.

Another object is to provide a heat exchanger fabricated primarly from relatively inexpensive strip, plate or bar structure.

Another object is to provide a liquid inlet and outlet fitting at one end of the structure, and a gas fitting at the other end of the structure, which fittings are detachably secured thereto so that when removed, the open ends of the passes are exposed for the purposes of inspection and cleaning.

With these and other objects and advantages in view, this invention consists in the several novel features hereinafter fully set forth and more particularly defined in the appended claims.

The invention is clearly illustrated in the drawings accompanying this specification, in which;

Fig. 1 is a view of a heat exchanger embodying a simple form of the present invention, the view being partly in side elevation and partly in vertical longitudinal section.

Fig. 2 is a horizontal section, taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a horizontal section taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is a view partly in end elevation with certain parts broken out, and partly vertical cross section taken substantially along the line 4—4 of Fig. 1.

Fig. 5 is a fragmental perspective view illustrating a portion of the core structure of the heat exchanger.

Fig. 6 is a fragmental perspective view of one of the channel shaped fin members which form the liquid passes.

Fig. 7 is a fragmental perspective view of one of the fin members which provides a baffle.

Fig. 8 is a fragmental perspective view of one of the other fin members for the gas passes.

Fig. 9 is a cross section taken on the line 9—9 of Fig. 2.

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Fig. 10 is a fragmental side elevation of a modified form of fin.

Fig. 11 is a fragmental side elevation of a second modified form of the same.

Fig. 12 is a longitudinal section taken on the line 12—12 of Fig. 11.

Fig. 13 is a view partly in plan and partly in horizontal section of a modified form of heat exchanger as applied to an oil cooler.

Fig. 14 is a view partly in side elevation and partly in vertically longitudinal section of a heat exchanger seen in Fig. 13.

Fig. 15 is a fragmental horizontal section of a modified form of the heat exchanger seen in Figs. 13 and 14, and

Fig. 16 is an end elevational view of a plurality of nested fin members.

Referring to said drawings which are somewhat diagrammatical and not intended as working drawings, and referring first to Figs. 1 to 9 inclusive, which illustrate the preferred embodiment of the invention, the reference character 15 designates the core structure of the heat exchanger desirably comprising alternately disposed slabs of liquid passes 16, and slabs of gas passes 17, separated by metal separation sheets 18.

The slabs of liquid passes 16 are preferably composed of channel shaped fin members 19, nested together or interlocked as illustrated in Fig. 16, and arranged in groups as seen in Figs. 2 and 5, having an inlet end 20 and an outlet end 21. One fin member of each group is made longer at one end as at 22, and provides a baffle, and another fin member of each group is made longer at the other end as at 22*a* to provide another baffle. The other fin members instead of being shorter than those providing the baffles may be of the same lengths as the baffle fin members, and formed with holes in their bottom walls as shown in connection with the gas fin member 24 in Fig. 7 to permit the liquid to cross flow into the next adjacent group whereby a circuitous path is taken by the liquid from the inlet end of the liquid passes to the outlet end thereof.

Cross bars 25 (see Figs. 2 and 5) disposed at the ends of the liquid passes opposite the inlet and outlet ends close all of said ends, and bars 26 disposed at the opposite end of the core structure close off the adjacent ends of the gas passes. Fig. 4 shows the cross bars 25 closing the adjacent ends of the liquid passes.

At the outer sides of the several passes are channel members 62 (see Fig. 4) which extend between the separation sheets 18 and provide side closures for the several passes. The fin members, bars and channel members 62 are bonded together to provide a core structure after which the end faces of the core are machined to provide smooth faces against which certain gaskets are placed as will be hereinafter set forth.

Bolted or otherwise detachably secured to the

liquid inlet end of the core structure is a fitting **27** (see Figs. 2 and 3), here shown as formed of a single rectangular plate having a liquid inlet **28** and a liquid outlet **29** cast integral therewith, and arranged to be connected to piping. The liquid inlet leads to a channel **30** which opens to the inlet end **20** of the liquid passes, and the liquid outlet **21** leads to a channel **31** which opens from the outlet end of the liquid passes.

The liquid inlet and outlet fitting **27** is here shown as detachably secured to the core structure by hook bolts **32**, (see also Fig. 1) which are hooked into the cross bars **26** and extend through the fitting and have nuts **33** on their threaded ends bearing against the outer face of the fitting. A gasket **34** is interposed between the fitting and core structure, and is formed with holes for the hook-bolts, and with a slot **35** which establishes communication between the liquid inlet channel **30** and inlet end of the liquid passes and said gasket is formed with a slot **36** which establishes communication between the channel **31** and outlet end of the liquid passes.

At the end of the core structure opposite the one to which the liquid inlet and outlet fitting is attached, is a gas inlet fitting **38** having an inlet opening **39** opening to the inlet end **40** of the several slabs of gas passes **17**. A gas gasket **43** is interposed between the gas inlet fitting and the end of the core structure, and said gasket is formed with bolt holes and with an opening **44** for establishing communication between the gas inlet fitting and the inlet end **40** of the gas passes. Hook bolts **45** are hooked into the bars **25**, and extend through the bolt holes in the gasket and gas inlet fitting, and have nuts **46** on their threads ends for tightening the fitting against the gasket.

The gas passes are formed by nested together channel shaped fin members **42**, one of which is shown in detail in Fig. 8. The gas fin members extend between the gasket **43** and the bars **26**, and their open ends are blocked off by said bars **26**. The fin members **42** are provided with holes **47** adjacent their ends for cross flow of the gas.

The gas passes may be divided into groups **48**, **49** and **50**, (see Fig. 3) separated into such groups by fin members **24**, one of which is seen in detail in Fig. 7. The fin members **24** are each provided with holes **51** adjacent one end only, the remainder of the fin members **24** being imperforate, preventing the gas from passing from one group to the other except through the holes **51**. The holes in one fin member **24** are disposed at one end thereof, and the holes in the other fin member **24** are disposed at the opposite end thereof, whereby the gas is caused to circulate through a circuitous path through the gas passes from the inlet end **40** to the outlet end **52**. It is to be understood that the gas flows in the same direction in the several passes of any group.

A gas outlet fitting **53** is secured to the core structure at the outlet end **52** of the gas passes (see Figs. 2 and 3) as by bolts and nuts **54**, **54***a*. To provide a solid connection between the gas outlet fitting and the core structure, reinforcement bars **55** and blocks **56** are bonded to the core structure, and the bolts **54** may be rigidly anchored in said bars **55** and blocks **56** end extend through a bolting flange **57** formed on the gas outlet fitting. Certain of the bolts **54** may be anchored in the cross bars **26**, and the bolts **54***a* may be in the form of hook bolts anchored in reinforcement bars **55**. Corrguated reinforcement strips **72** (see Figs. 1, 3 and 5) may be provided between the separation sheets **18** at the discharge end of the gas passes.

In the liquid inlet and outlet fitting **27** is formed a drainage channel **58** closed by a plug **60** (see Fig. 1), and connected to the gas passes by ducts **59** (see also Fig. 9). By suspending the heat exchanger from the end containing the gas inlet fitting **38** and unscrewing a plug **60** any liquid which may have collected in the gas passes may be drained out through the channel **58**.

The gas fin member may be imperforate between the holes **47**, or their bottom walls may be corrugated as shown at **60** in Fig. 10, or they may be provided with diagonal slits **61**, with downturned lips as shown in Fig. 11. The bottoms of the gas fins may be otherwise contoured to obtain greater surface area.

In the modified form of the invention illustrated in Figs. 13 and 14 which is shown as applied to an oil cooler, the water passes are shown at **16***a* and the oil passes at **19***a*. These passes are formed of nested together channel shaped fin members as in the preferred form and extend from end to end of the core structure, the water and oil passes being arranged alternately. Channel shaped bars **25***a*, close the ends of the oil passes at one end, bars **26***a* close the ends of the water passes at the other end of the core structure. A water inlet and outlet fitting **63** is removably secured to one end of the core structure as by bolts and nuts **64**, and an oil inlet and outlet fitting **65** is removably secured to the other end of the core structure by bolts and nuts **66**. Angle shaped bands **67** are bonded to the core structure and the bolts extend through bolting flanges of the fittings and through said angle shaped bands. Gaskets **68** may be interposed between the flanges of the fittings and the angle shaped bands to provide leak-proof joints.

The water inlet and outlet fitting **63** and the oil inlet and outlet fitting **65** are each provided with a partition **69**, in which is secured a bearing strip **70** that bears against the core structure and respectively divide the water and oil inlet and outlet fittings **63** and **65** into inlet and outlet chambers. The fin members are provided with holes adjacent their ends but in oppositely disposed relation so that the incoming water may cross flow through the water passes, and discharge through the water outlet chamber. The same arrangement is provided in the oil inlet and outlet fittings, whereby the oil enters the oil passes through one chamber and discharges from the oil passes through the other chamber.

In the modified form of oil cooler shown in Fig. 15, each inlet and outlet fitting **63***a* is provided with a partition **69***a*, and a separate head **71**, bolted to the fitting **63***a* is provided which may be removed from the fitting without disturbing the gas connections.

From the above it is apparent that I have provided a heat exchanger, having inlet and outlet fittings removably secured to a core structure having liquid and gas passes through which may be exposed for inspection and cleaning by removing the fittings.

Having thus described my invention, it will be apparent that various immaterial modifications may be made therein without departing from the spirit or scope of my invention; hence I do not wish to be understood as limiting myself to the exact form, construction, arrangement and combination of parts herein shown and described or uses mentioned.

What I claim as new and desire to secure by Letters Patent is:

1. In a heat exchanger the combination of a core structure comprising alternately disposed slabs of liquid passes and slabs of gas passes arranged for substantially counterflow heat exchange, the passes being formed by channel shaped fin members, the bottom walls of the fin members which form the gas passes having perforations adjacent their ends forming a plenum chamber to provide cross flow from one pass to the next adjacent one, metal separation sheets, one between adjacent slabs of passes, each slab being closed at one end and open at the other end, with the closed ends of the adjacent slab being positioned at opposite ends of the core structure, a liquid inlet and outlet fitting detachably secured to the end of said core structure upon which the liquid passes open, and in communication with the liquid passes, a gas inlet fitting detachably secured to said core structure at the opposite end thereof upon which the gas passes open, and in communication with the gas passes, a gas outlet fitting detachably secured to a side of the core structure, in communication with said gas passes and gaskets one interposed between each fitting and the core structure, and said gas passes arranged for access thereto for inspection and cleaning upon removal of the gas inlet fitting.

2. In a heat exchanger the combination of a core structure comprising alternately disposed slabs of liquid passes and slabs of gas passes, the passes being formed by channel shaped fin members, the bottom walls of the fin members which form the gas passes having perforations adjacent their ends to provide for cross flow from one pass to the next adjacent one, a baffle dividing said gas passes into groups, said baffle having perforations adjacent one end for the passage of gas from one group to the next adjacent group, metal separation sheets separating adjacent slabs of passes, a liquid inlet and outlet fitting detachably secured to one end of said core structure in communication with one end of liquid passes, a gas inlet fitting detachably secured to said core structure at the opposite end thereof and in communication with the gas passes, a gas outlet fitting detachably secured to the core structure in communication with said gas passes, and gaskets one interposed between each fitting the core structure.

3. In a heat exchanger the combination of a core structure comprising alternately disposed slabs of liquid passes and slabs of gas passes, the passes being formed by channel shaped fin members, the bottom walls of the fin members which form the gas passes having perforations adjacent their ends to provide for cross flow from one pass to the next adjacent one, baffles dividing said passes into groups, said baffles each having perforations adjacent one end for the passage of gas to a next adjacent group, the perforations of one baffle being disposed adjacent one end of the core structure, and the perforation of the other baffle being disposed adjacent the opposite end of the core structure, metal separation sheets, one between each adjacent slab of passes, a liquid inlet and outlet fitting detachably secured to one end of said structure in communication with the liquid passes, a gas inlet fitting detachably secured to said core structure at the opposite end thereof, and in communication with the gas passes, a gas outlet fitting detachably secured to the core structure in communication with said gas passes, and gaskets one interposed between each fitting and the core structure.

4. In a heat exchanger the combination of an elongated hollow fluid pass, a plurality of fin elements having their respective side edges secured to oppositely disposed side walls of said pass, said fin elements longitudinally extending substantially from one end of said pass to the other to divide said pass into a plurality of longitudinally extending fluid passageways, said fin elements having apertures therein adjacent each end thereof providing communication between the passageways with at least one of said fin elements being solid at one end to provide a baffle operative to form a circuitous fluid path through said pass, and means adjacent each end of the fluid path so formed for providing a fluid inlet and outlet for said pass.

5. In a heat exchanger the combination of a core structure comprising several alternately disposed slabs of fluid passes comprising slabs of liquid passes and slabs of gas passes in heat exchange relationhip formed by nested together channel-shaped fin elements and separated by metal sheets, the nested together channel-shaped fin elements comprising each slab of fluid passes forming a plurality of continuously straight, substantially parallel fluid passages, plenum chambers formed at each end of said slabs of fluid passes, the bottom wall of the nested together channel-shaped fin elements which form certain of the slabs of fluid passes having perforations adjacent an end thereof forming a plenum chamber to provide cross flow from one passage to the next adjacent one, cross bars adapted for closing one end of each slab of the liquid passes, the opposite ends thereof being open throughout their length, and other cross bars adapted for closing the opposite ends of each slab of the gas passes, the opposite ends thereof being open throughout their length, a liquid inlet and outlet fitting detachably secured to one end of the core structure of the open ends of and in communication with the liquid passes, said fitting having a drain passage therein communicating with said gas passes, a gas inlet fitting detachably secured to said core structure at the opposite end thereof and in communication with the open ends of the gas passes, a gas outlet fitting detachably secured to the core structure in communication with said gas passes, and gaskets, one interposed between each fitting and the core structure.

6. In a heat exchanger the combination of a core structure comprising alternately disposed slabs of fluid passes including slabs of liquid passes and slabs of gas passes arranged for substantially counterflow heat transfer and separated by metal sheets, the passes being formed by nested together, channel-shaped fins, plenum chambers formed at each of said slabs of fluid passes, the bottom wall of the nested together channel-shaped fins which forms certain of the slabs of fluid passes having perforations adjacent one end thereof forming a plenum chamber to provide cross flow from one pass to the next adjacent one, and the liquid passes being arranged in groups with baffles separating the groups at alternate ends, whereby the liquid circulates through a circuitous path from an inlet end to an outlet end, said sheets and fins being bonded together to form an integral structure, a liquid inlet and outlet fitting connected to a complementary end of the core structure having an inlet channel communicating with the inlet ends of the liquid passes, and having an outlet channel communicating with the outlet ends of the liquid passes, a gas inlet fitting connected to a complementary end

of the core structure and having an inlet opening communicating with the slabs of gas passes, a gas outlet fitting connected to the core structure at the outlet end of the gas passes complementally formed to the gas outlet fitting and gaskets interposed between the several fittings and core structure, and said liquid passes and said gas passes arranged for access thereto for inspection and cleaning upon removal of said air inlet fitting and said liquid inlet and outlet fitting.

7. In a heat exchanger the combination of a core structure comprising alternately disposed slabs of fluid passes including slabs of liquid passes and slabs of gas passes separated by metal sheets and arranged for substantially counterflow heat transfer, the slabs of fluid passes being formed by nested together channel-shaped fins providing a plurality of substantially parallel fluid passages, the bottom wall of the nested together channel-shaped fins which form the slabs of gas passes having perforations adjacent each end thereof forming plenum chambers to provide cross flow from one passage to the next adjacent one, and the liquid passes being arranged in groups with baffles separating the groups at alternate ends, whereby the liquid circulates through a circuitous path from an inlet end to an outlet end, cross bars for closing one corresponding end of each slab of the liquid passes and other cross bars for closing the opposite corresponding end of each slab of the gas passes, a liquid inlet and outlet fitting connected to a complementally formed end of the core structure at the open ends of said liquid passes, and having an inlet channel communicating with the inlet ends of the liquid passes, and having an outlet channel communicating with the outlet ends of the liquid passes, a gas inlet fitting detachably secured to the opposite end of the core structure and having an inlet opening communicating with the slabs of gas passes, a gas outlet fitting connected to the core structure at the outlet end of the gas passes, and gaskets interposed between the several fittings and the core structure, and said liquid passes and said gas passes arranged for access thereto for inspection and cleaning.

3. In a heat exchanger the combination of a core structure comprising alternately disposed slabs of liquid passes and slabs of gas passes separated by metal sheets, said liquid and gas passes arranged for access thereto for inspecting and cleaning, the slabs of liquid and gas passes being formed by nested together channel-shaped fins providing a plurality of continuously straight, substantially parallel fluid passages, cross bars for closing one corresponding end of each slab of the liquid passes and other cross bars for closing the opposite corresponding end of each slab of the gas passes, a liquid inlet and outlet fitting disposed on the end of said core structure at the open ends of said liquid passes in communication with the liquid passes, a gas inlet fitting disposed at the opposite end of the structure in communication with the gas passes, a gas outlet fitting secured to a side of the core structure in communication with said gas passes, hook bolts anchored in certain of said bars and extending through the liquid inlet fitting and gas inlet fitting with nuts on their threaded ends bearing against the outer face of the fittings, said nuts when unscrewed permitting removal of said fittings, whereby the passes may be inspected and cleaned.

9. A heat exchanger comprising in combination a core structure, comprising alternately disposed slabs of liquid passes and slabs of gas passes arranged for substantially counterflow heat exchange, with metal separation sheets separating each slab of passes from the next adjacent one, said passes being formed by nested together channel-shaped fin members, all of said fin members extending in the same direction, the liquid passes being open at one end and closed at the other end, and the gas passes being open at said other end and closed at their other ends, and there being openings at the bottom walls adjacent an end of the fin members to form a plenum chamber to provide for cross flow of the gas, a liquid inlet and outlet fitting connected to the core structure at, and extending cross the open ends of the liquid passes and complementally formed to the inlet and outlet fitting, a gas inlet fitting connected to the complementally formed structure at, and extending across the open ends of the gas passes, and a gas outlet fitting connected to the core structure at the gas outlet thereof complementally formed to the gas outlet fitting whereby upon removal of the liquid inlet and outlet fitting and gas inlet fitting, the liquid and gas passes are adapted for cleaning and inspection.

10. A heat exchanger comprising in combination a core structure arranged for access thereto for inspection and cleaning, comprising alternately disposed slabs of liquid passes and slabs of gas passes arranged for substantially counterflow heat exchange, with metal separation sheets separating each slab of passes from the next adjacent one, said passes being formed by nested together channel-shaped fin members extending in parallel directions, the liquid passes being open at one end of the respective fin members forming such passes and closed at the other end, and the gas passes being open at the opposite end of the fin members forming such passes and closed at their ends adjacent the open ends of the liquid passes, and there being openings at the bottom walls adjacent the ends of certain of the fin members providing for cross flow of the gas, a baffle in each slab for dividing the liquid passes into groups and forming a plenum chamber to provide for cross flow, a perforated baffle in each slab for dividing the gas passes into groups and arranged to provide for cross flow of the gas, a liquid inlet and outlet fitting connected to the complementally formed core structure at the open ends of the liquid passes, a gas inlet fitting connected to the complementally formed structure at the open ends of the gas passes, and a gas outlet fitting connected to the core structure at the gas outlet thereof complementally formed to the gas outlet fitting.

11. In a heat exchanger, the combination of a core structure arranged for access thereto for inspection and cleaning and comprising alternately disposed slabs of liquid passes and slabs of gas passes, the passes arranged for substantially counterflow heat exchange and being formed by nested together channel-shaped fin members, the bottom walls of the fin members which form the gas passes having perforations adjacent their ends to provide cross flow from one pass to the next adjacent one, said fin members extending substantially in the same direction, metal separation sheets, one between adjacent slabs of passes, baffles in the several slabs of passes for directing the flow of liquid and gas in circuitous paths, each slab of gas passes

being open at one of the corresponding ends of said fin members, each slab of liquid passes being open at the opposite end thereof, a liquid inlet and outlet fitting connected to the end of said core structure at such open ends of, and in communication with the liquid passes, a gas fitting connected to said core structure at the opposite end thereof complementally formed to the gas fitting, and in communication with the adjacent open ends of the gas passes, a gas fitting connected to a side of the core structure complementally formed to the gas fitting and in communication with said gas passes, means for sealing the other end of each slab from the adjacent fitting thereat and gaskets one interposed between each fitting and the core structure.

12. In a heat exchanger, the combination of an elongated hollow fluid pass, a plurality of nested together channel-shaped fin elements having their respective side edges secured to oppositely disposed side walls of said pass, said fin elements longitudinally extending substantially from one end of said pass to the other to divide said pass into a plurality of longitudinally extending fluid passageways, said channel-shaped fin elements each having apertures formed in the bottom thereof adjacent each end of the pass forming a plenum chamber to provide communication between the respective passageways, and inlet and outlet fitting members adjacent each end of said pass for providing a fluid inlet and outlet therefor.

13. In a heat exchanger, a core structure comprising a plurality of slabs of nested, channel-shaped fin members forming longitudinally extending passages, the fin members forming said slabs arranged for substantially counterflow heat exchange and extending in parallel directions, with the ends of all fin members terminating at a pair of oppositely disposed ends of the core structure, frame members at one of said ends adapted for sealing certain of said slab ends thereat from the corresponding ends of adjacent slabs, additional frame members at the other of said ends also adapted for sealing the ends of the other slabs thereat from the adjacent ends of the first-mentioned slabs, the elements of said core structure being bonded together into an integral unit, each of said slabs being formed at its closed end with passages therein providing cross flow at such end, the passages providing cross flow being formed by apertures in the bottom wall in at least one end of the channel-shaped fin members forming the respective slabs and connections secured to said core structure forming a fluid inlet and a fluid outlet for each slab, one of said connections extending across one of said ends and communicating with the open slab ends thereat, and the other extending across the other of said ends and communicating with the open slab ends thereat, said last-mentioned connections including heater flanges connected to complementary casing flanges of the core structure, so as to permit detachment of one of such connections exposing the adjacent open slab ends thereat, and the detachment of the other of such connections exposing the adjacent open slab ends thereat, whereby upon detachment of the last-mentioned connections, the longitudinally extending passages are adapted for cleaning and inspection.

14. In a heat exchanger, a core structure arranged for access thereto for cleaning and inspection and comprising a plurality of spaced, substantially parallel sheets, a plurality of elongated nested together channel-shaped fin members positioned between each pair of adjacent sheets forming slabs of fin members, said fin members extending in parallel directions, with the ends of all fin members terminating at a pair of oppositely disposed ends of the core structure and forming a fluid pass between each pair of adjacent sheets, frame member at one of said ends adapted for sealing the ends of certain of said passes thereat from the corresponding ends of adjacent passes, additional frame members at the other of said oppositely disposed ends also adapted for sealing the ends of the other passes thereat from the adjacent ends of the first-mentioned passes, whereby said fluid passes formed are arranged in substantially counterflow heat exchange relationship, each of said passes being formed at its closed end with passages therein providing cross flow at such end, the passages providing cross flow being formed by apertures in the bottom wall in at least one end of the channel-shaped fin members forming the respective slabs and connections secured to said core structure forming a fluid inlet and a fluid outlet for each pass, one of said connections extending across one of said ends and communicating with the open pass ends thereat, and the other extending across the other of said ends and communicating with the open pass ends thereat, said last-mentioned connections including header flanges connected to complementary casing flanges of the core structure, so as to permit detachment of one of such connections exposing the adjacent open pass ends thereat, and the detachment of the other of such connections exposing the adjacent open pass ends thereat.

15. An elongated hollow fluid pass for a heat exchanger having inlet and outlet connections for the fluid circulating therethrough and comprising a plurality of channel-shaped fin elements having their side edges nested together, said fin elements longitudinally extending substantially from one end of said pass to the other to divide said pass into a plurality of longitudinally extending fluid passageways, and the bottom wall of said channel-shaped fin elements each having apertures therein adjacent each end of the pass adapted to form a plenum chamber at each end of the hollow fluid pass to provide communication between the respective passageways, and the plenum chambers adapted to be connected to the inlet and outlet connections of the heat exchanger.

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