

Aug. 20, 1935.

F. E. KEY

2,011,640

HEAT EXCHANGER

Filed April 15, 1935

2 Sheets-Sheet 1

Fig. 1.

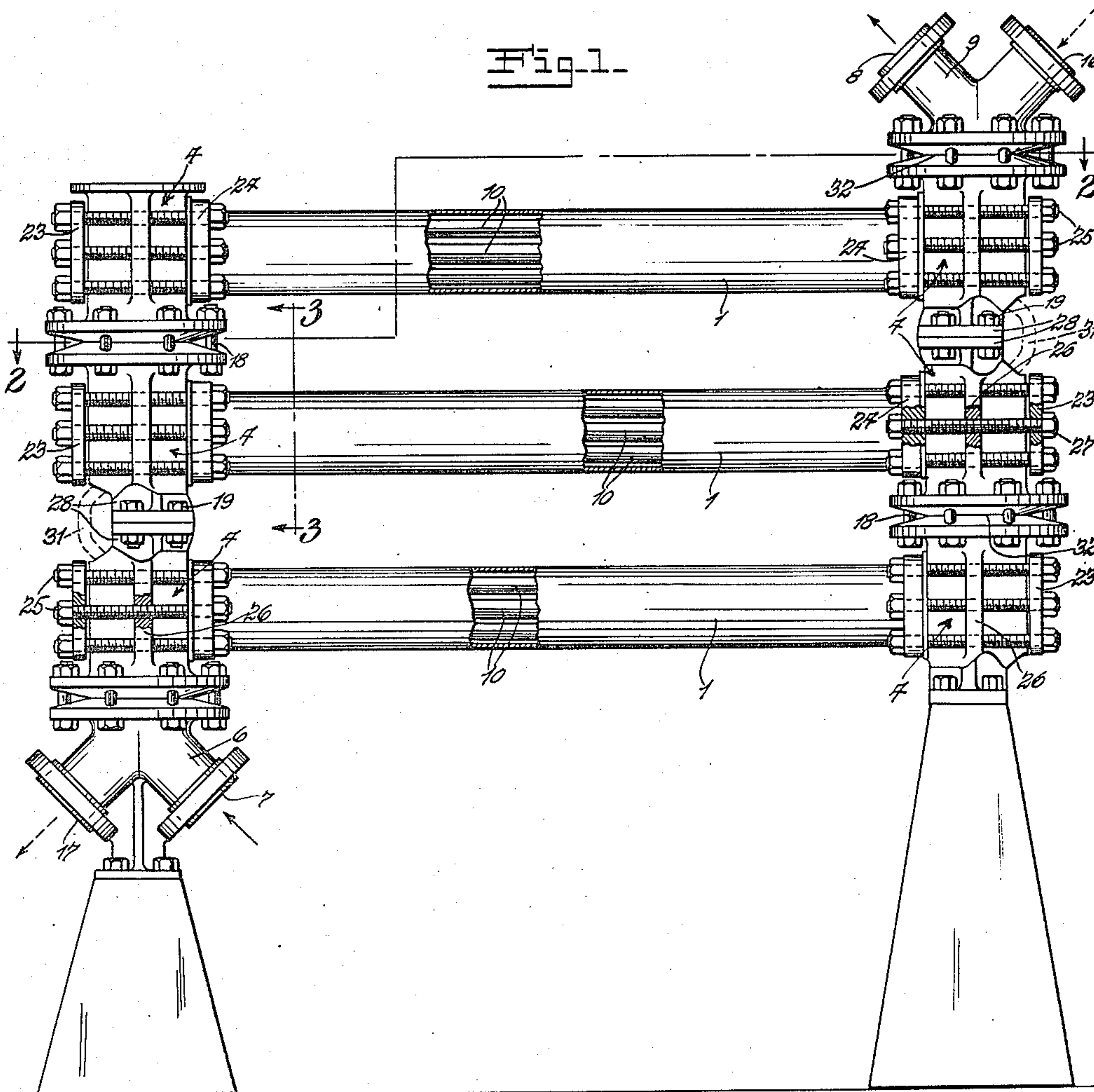
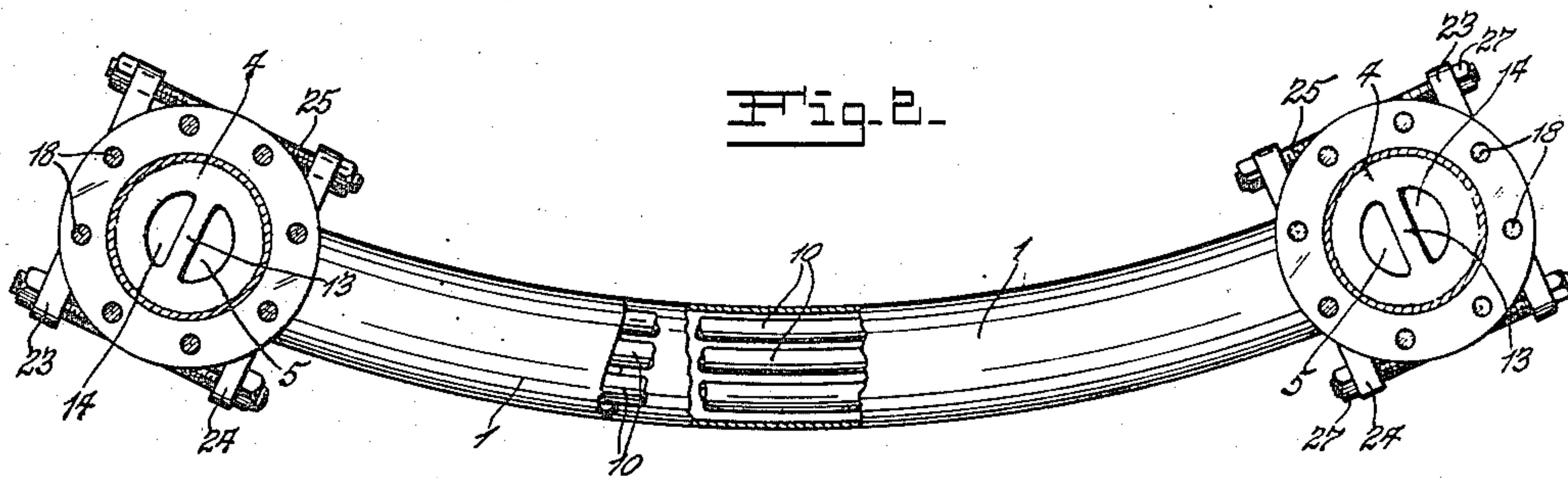


Fig. 2.



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Fig. 3.

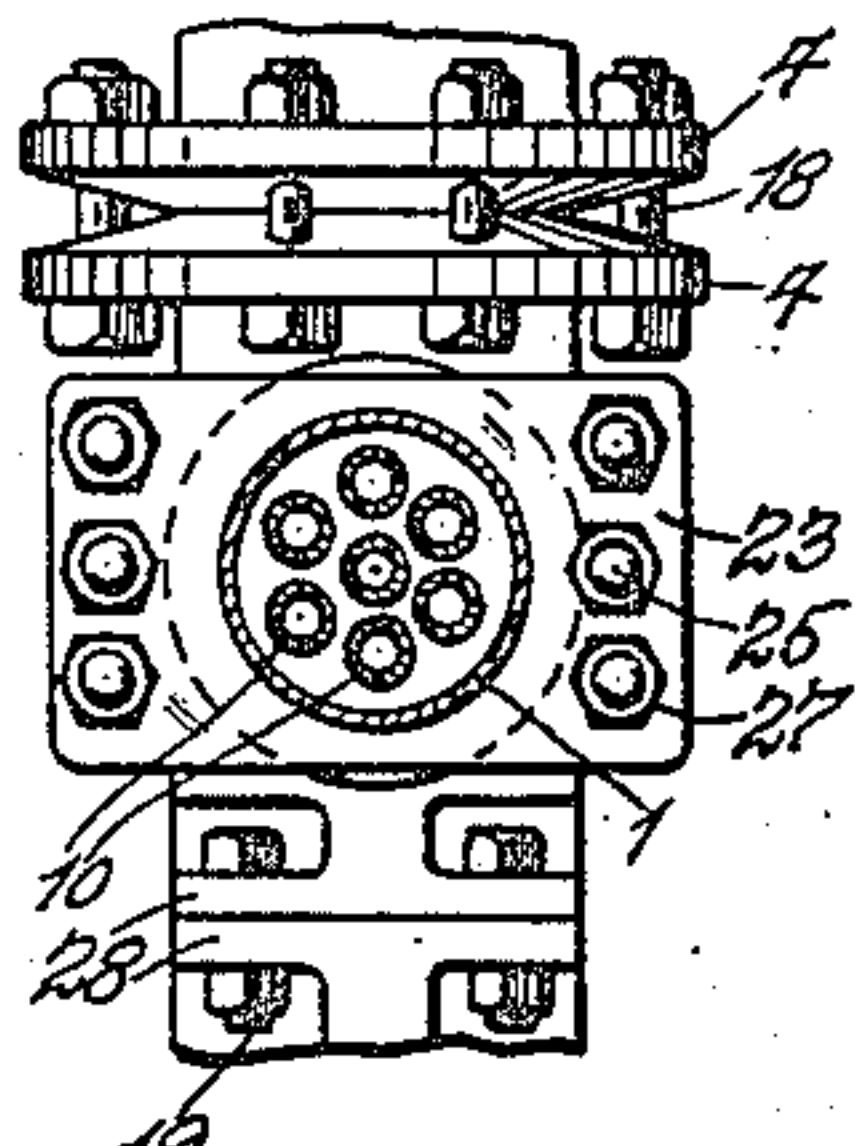


Fig. 5.

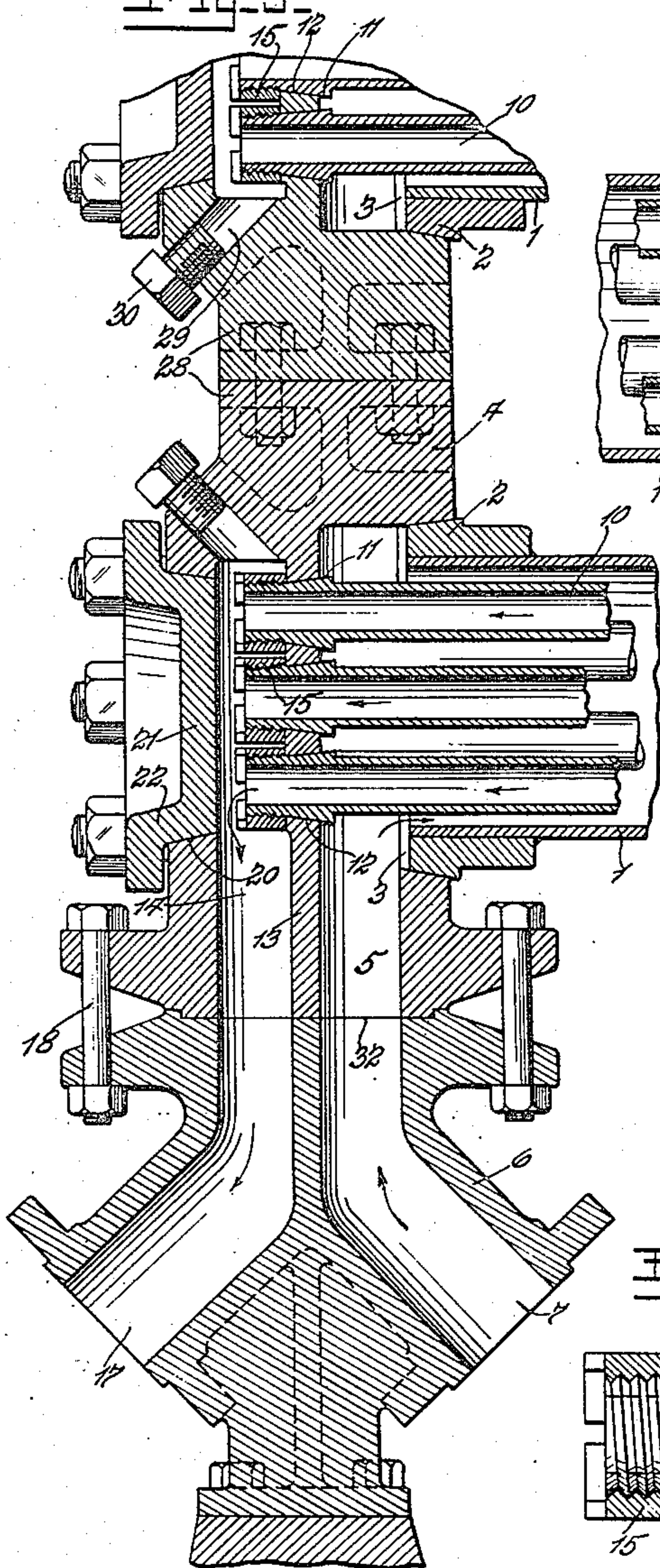


Fig. 4.

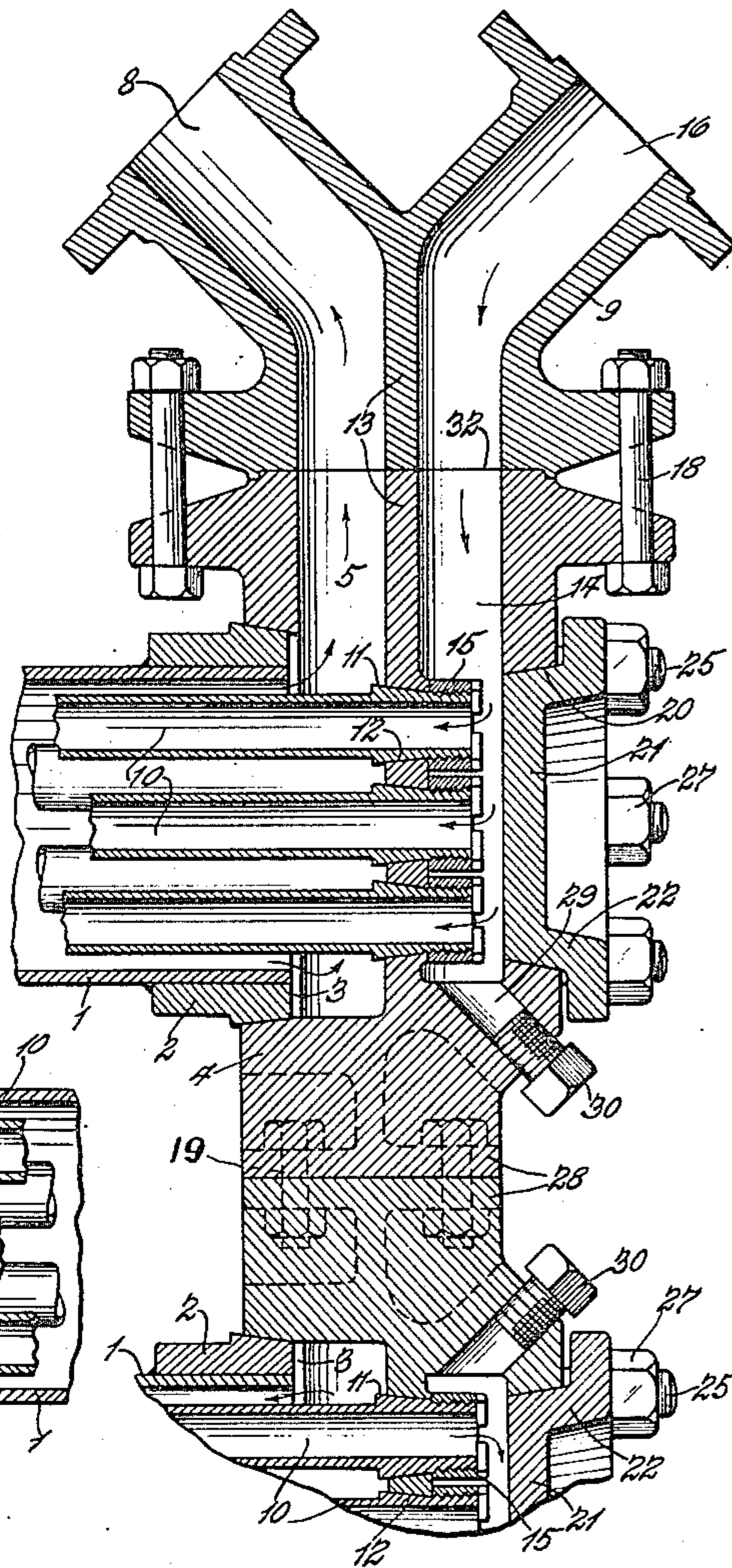


Fig. 7.

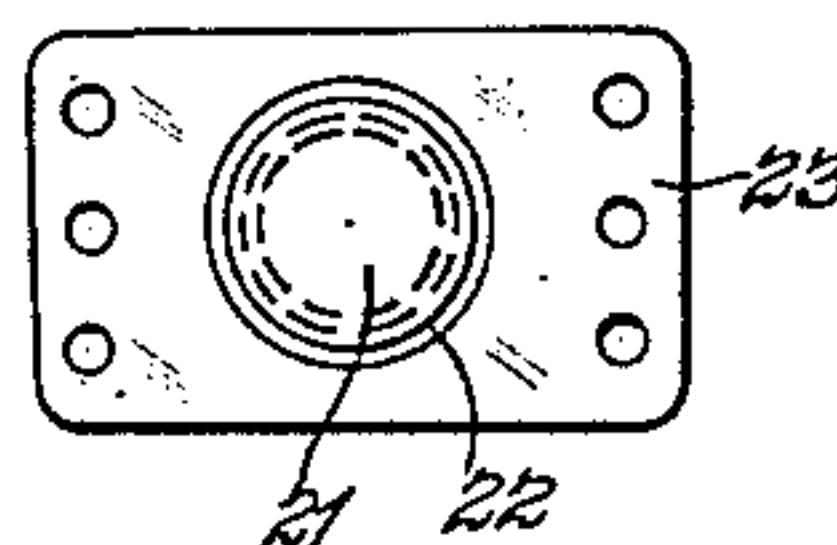
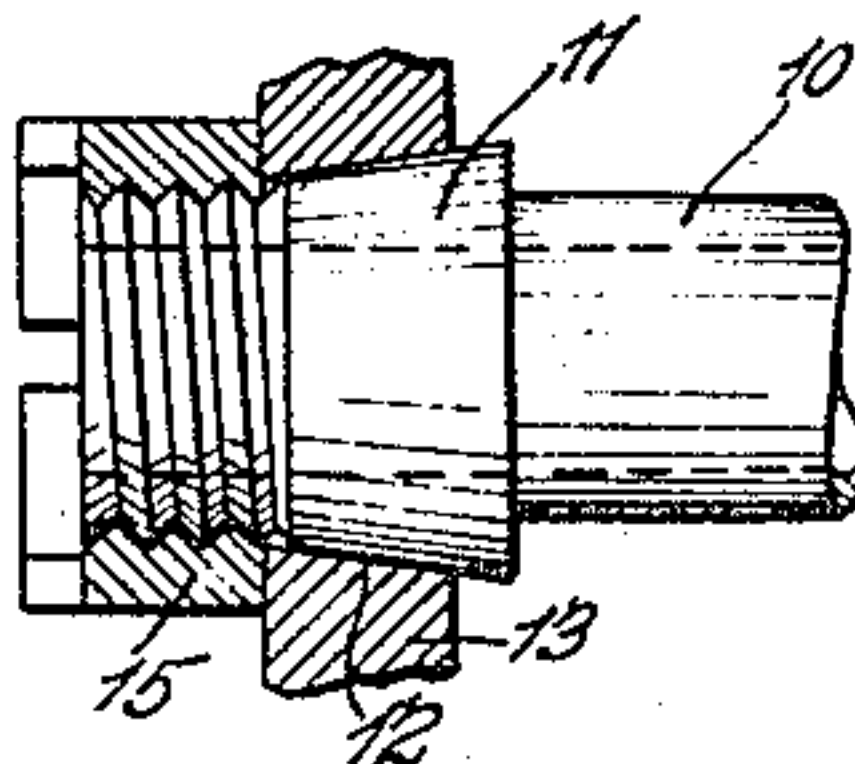


Fig. 6.



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UNITED STATES PATENT OFFICE

2,011,640

HEAT EXCHANGER

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Application April 15, 1935, Serial No. 16,366

12 Claims. (Cl. 257—234)

This invention relates to heat exchangers, and has special reference to an apparatus to be used as a medium of exchanging heat between two fluids.

6 An object of the invention is to provide an apparatus for use in exchanging heat between two fluids, or two gases, or a gas and a fluid, and including a curved outer tube of relatively large diameter and one or more curved inner tubes of
10 relatively small diameter extending through the outer tube, the curvature of said tubes being to compensate for unequal expansion and contraction between the inner tube or tubes and the outer tube. This curvature takes up variations
15 in the relative lengths of the inner and outer tubes resulting from temperature changes.

Another object of the invention is to provide an improved apparatus for use in exchanging heat between two fluids and comprising a number of tubular units, in combination with improved fittings attached to the ends of the tubes forming the units to control the flow of the fluids through the respective tubes.

Another object of the invention is to provide
25 an apparatus of the character mentioned wherein the fitting units may be open to afford access to the inner tube or tubes, or may be detached from the ends of the respective tubes to afford access to all of the tubes, said units being easily
30 reassembled in connection with the tubes.

Other objects will appear from the following description, reference being made to the annexed drawings, in which—

Fig. 1 is a side elevation, with parts in section, of a heat exchanger made in accordance with the present invention.

Fig. 2 is a plan view of certain of the parts on the line 2—2 of Fig. 1.

Fig. 3 is a sectional view on the line 3—3 of Fig. 1.

Fig. 4 is an enlarged sectional view of one of the unit fittings at one end of the assembly and the tubes communicating therewith.

Fig. 5 is a similar sectional view of the opposite end unit fitting.

Fig. 6 is an enlarged detail view showing the construction whereby the ends of the inner tubes are attached to the fittings.

Fig. 7 is a view showing the inner side of one of the removable closure plates attached to the unit fittings.

As shown, each outer tube 1 is curved in a horizontal plane and has a tapered joint-forming collar 2 rigidly attached to each end thereof and forming an hermetic joint therewith. The ends

of the collars 2 and the ends of the tubes 1 are in the same plane (Fig. 5). The peripheries of the tapered portions of the collars 2 are smoothly ground and fit into tapered holes 3 in the respective fitting units 4. The ends of the tubes 1 open into cold fluid passages 5 in the respective fitting units 4. An inlet and outlet fitting 6 is attached to the fitting 4 at one end of the apparatus, and has a cold fluid inlet passage 7 through which cold fluid enters the adjacent fitting unit 4 and thence passes through the attached tube 1, and thence through the connected fittings 4 at the opposite end of the tube 1, and so on, to a cold fluid outlet passage 8 in a combined inlet and outlet fitting 9 attached to the fitting unit 4 at the opposite end of the apparatus.

The inner tubes 10 extend through the tubes 1 and are curved in accordance with the curvature of said tubes 1, and are supported in spaced relationship with respect to each other and said tubes 1, so that the tubes 10 do not contact with each other nor with the tubes 1 through which they extend. Tapered shoulders 11 are formed on the tubes 10 near the ends thereof and fit into tapered holes 12 in the partition walls 13 in the fitting units 4 which separate the fluid passages 5 from the hot fluid or hot gas passages 14. The ends of the tubes 10 beyond the tapered shoulders 11 are threaded, and castellated nuts 15 are screwed thereon and against the partition 13, thereby holding the tubes 10 in rigid relationship with respect to each other and the tubes 1 and with respect to the fitting units 4. The ends of the tubes 10 open into the passages 14. The combined inlet and outlet fitting 9 has an inlet passage 16 (Fig. 4) opening into the passage 14 in the end fitting unit 4, and the fitting unit 4 at the opposite end of the apparatus opens into an outlet passage 17 (Fig. 5) in the combined inlet and outlet fitting 6.

The ends of the fitting units 4 through which the passages 5 and 14 open, are rigidly attached together by removable and replaceable bolts 18, and the closed ends are rigidly attached together by removable and replaceable bolts 19.

Each fitting unit 4 has an opening 20 (Figs. 4 and 5) opposite the ends of the tubes 10. A closure plate 21 is provided for each opening 20. Each closure plate has a tapered portion 22 forming an hermetic joint with the tapered wall of the opening 20. The plates 21 have laterally extended portions 23, and the collars 2 have similar laterally extended portions 24 (Figs. 1 and 2). Bolts 25 are screwed through threaded

holes in flanges 26 formed integral with the respective fitting units 4, and the ends of said bolts extend through unthreaded holes in the flanges 23 and in the flanges 24, nuts 27 being
 5 screwed on the ends of the respective bolts 25. Since the bolts 25 are in threaded engagement with the flanges 26, it is easily possible to remove the nuts 27 from the outer ends of the bolts and remove the plate 21, affording access to the
 10 interior of the tubes 10 through the hole 20 in order that said tubes 10 may be easily cleaned or otherwise conditioned.

The connecting portions 28, whereby the closed ends of the fitting units 4 are attached
 15 together (Figs. 4 and 5) may be provided with threaded holes 29 communicating with the passages 14. The holes 29 may be closed by removable and replaceable plugs 30, or they may be placed in communication with each other by
 20 tubes 31 (Fig. 1). The tubes 31 may be applied when the plugs 30 are removed. When any of the hot gases passing through the exchanger become liquefied, or when condensate accumulates, such liquid or condensate may be with-
 25 drawn from the lower portion of any unit having a hole 29 therein by removing the plug 30 from that hole. Or, by removing the plugs 30 and applying the tubes 31, the liquid or condensate will be short-circuited or by-passed to the fit-
 30 ting 6 and discharged therefrom through the outlet passage 17.

From the foregoing, it should be apparent that the cold fluid enters the fitting 6 and flows upwardly through the apparatus and out
 35 through the passage 8, while the hot gas or fluid enters the opposite end of the apparatus through the passage 16 in the inlet and outlet fitting 9 and flows downwardly to discharge through the outlet passage 17 at the lower end of the ap-
 40 paratus.

Leak-proof joints 32 are provided between the closed ends of the respective units where the passages 5 and 14 of one unit communicate with the passages of another unit.

This invention may be applied to a wide variety of uses, and possesses all of the advantages hereinbefore indicated and others which should be apparent from the foregoing description. The arrangement of the elements of the device
 50 may be varied as widely as the scope of equivalents will permit without departure from the nature and principle of the invention.

I claim:—

1. A heat exchanger comprising two fitting
 55 units each having two non-communicating passages therein, a curved outer tube having each end opening into one of said passages in one of said respective fitting units and forming there-
 60 with an hermetic joint, a curved inner tube extending through said curved outer tube and beyond the ends thereof and opening into the other one of said passages in one of said respec-
 65 tive fitting units, and means securing the ends of said inner tube in hermetic and rigid engagement with said fitting units.

2. A heat exchanger comprising two fitting
 70 units each having two non-communicating passages therein, a curved outer tube having each end opening into one of said passages in one of said respective fitting units and forming there-
 75 with an hermetic joint, a curved inner tube extending through said curved outer tube and beyond the ends thereof and opening into the other one of said passages in one of said respective fit-
 75 ting units, means securing the ends of said inner

tube in hermetic and rigid engagement with said fitting units, each of said fitting units having an opening through the wall thereof beyond the ends of said inner tube, a closure for said open-
 5 ing, and detachable means securing said closure in said opening to form a leak-proof joint.

3. A heat exchanger for fluids comprising a pair of fitting units each having two non-commu-
 10 nicating passages therein separated by an intervening wall, a curved outer tube having each end opening into one of said passages in one of said respective fitting units and forming therewith an hermetic joint, a curved inner tube extending
 15 through said curved outer tube and beyond the ends thereof and opening into the other one of said passages in one of said respective fitting units, and means mounted on the ends of said inner tube and cooperating with said partition to hold said inner tube in rigid relationship with
 20 respect to said fittings and with respect to said curved outer tube.

4. A heat exchanger for fluids comprising a pair of fitting units each having two non-com-
 25 municating passages therein separated by an intervening wall, a curved outer tube having each end opening into one of said passages in one of said respective fitting units and forming there-
 30 with an hermetic joint, a curved inner tube extending through said curved outer tube and beyond the ends thereof and opening into the other one of said passages in one of said respective fit-
 35 ting units, means mounted on the ends of said inner tube and cooperating with said partition to hold said inner tube in rigid relationship with respect to said fittings and with respect to said
 40 curved outer tube, each of said fitting units having an opening therein opposite the adjacent end of said inner tube, a closure for said opening, and means engaging said closure and said outer tube holding said parts in rigid relationship.

5. A heat exchanger for fluids comprising a pair of fitting units each having two non-com-
 45 municating passages therein separated by an intervening wall, a curved outer tube having each end opening into one of said passages in one of said respective fitting units and forming there-
 50 with an hermetic joint, a curved inner tube extending through said curved outer tube and beyond the ends thereof and opening into the other one of said passages in one of said respective fit-
 55 ting units, means mounted on the ends of said inner tube and cooperating with said partition to hold said inner tube in rigid relationship with respect to said fittings and with respect to said
 60 curved outer tube, each of said fitting units having an opening therein opposite the adjacent end of said inner tube, a closure for said opening, and detachable holders supported by said fitting units, respectively, holding said closures in position and also holding said outer tube in rigid con-
 65 nection with said fitting units.

6. A heat exchanger comprising a series of fit-
 70 ting units each having two non-communicating passages therein, means connecting vertical series of said units in alternating relationship in which the passages in certain of the units in each series communicate with the passages in one adjacent unit and do not communicate with the passages in another adjacent unit, outer curved tubes hav-
 75 ing their ends opening into certain of said passages in respective ones of said fitting units and forming hermetic leak-proof joints, curved inner tubes extending through said respective curved outer tubes and beyond the ends thereof and opening into the other passages in said re-
 75

spective fitting units, and means for holding said fitting units and all of said tubes in rigid relationship.

7. A heat exchanger comprising a series of fitting units each having two non-communicating passages therein, means connecting vertical series of said units in alternating relationship in which the passages in certain of the units in each series communicate with the passages in one adjacent unit and do not communicate with the passages in another adjacent unit, outer curved tubes having their ends opening into certain of said passages in respective ones of said fitting units and forming hermetic leak-proof joints, curved inner tubes extending through said respective curved outer tubes and beyond the ends thereof and opening into the other passages in said respective fitting units, each of said fitting units having an opening beyond the end of the adjacent inner tube, closures for said openings, and devices connecting said closures with said fittings and with said outer tubes and holding said parts in rigid relationship.

8. A heat exchanger comprising a series of fitting units each having two non-communicating passages therein, means connecting vertical series of said units in alternating relationship in which the passages in certain of the units in each series communicate with the passages in one adjacent unit and do not communicate with the passages in another adjacent unit, outer curved tubes having their ends opening into certain of said passages in respective ones of said fitting units and forming hermetic leak-proof joints, curved inner tubes extending through said respective curved outer tubes and beyond the ends thereof and opening into the other passages in said respective fitting units, each of said fitting units having an opening beyond the end of the adjacent inner tube, closures for said openings, and devices connecting said closures with said fittings and with said outer tubes and holding said outer tubes in rigid relationship with respect to said fittings and being releasable in part to permit said closures to be removed while holding said outer tubes and said fitting units in rigid relationship.

9. A heat exchanger comprising a pair of fitting units each having two non-communicating passages therein, a curved outer tube having each end opening into one of said passages in one of said respective fitting units, a curved inner tube extending through said curved outer tube and

beyond the ends thereof and opening into the other one of said passages in said respective fitting units, each of said fitting units having an opening for access to said inner tube, a closure for said opening, and elements attaching said closure and said outer tube to said respective fitting units.

10. A heat exchanger comprising a pair of fitting units each having two non-communicating passages therein, a curved outer tube having each end opening into one of said passages in one of said respective fitting units, a curved inner tube extending through said curved outer tube and beyond the ends thereof and opening into the other one of said passages in said respective fitting units, each of said fitting units having an opening for access to said inner tube, a closure for said opening, and bolts attached to said fitting units and to said closure and said outer tube and holding said parts in relatively rigid relationship.

11. A heat exchanger comprising series of fitting units and curved outer tubes communicating therewith and forming a continuous tortuous passage, in combination with a curved inner tube extending through each of said outer tubes and opening into said fitting units, partitions in said fitting units, respectively, forming passages communicating with said outer tubes and with said inner tubes respectively, elements rigidly attaching said outer tubes to said fitting units, devices in said fitting units holding said inner tubes in rigid relationship, and means for admitting cold fluid into said outer tubes and hot fluids or gases into said inner tubes and discharging the same therefrom.

12. A heat exchanger comprising series of fitting units and curved outer tubes communicating therewith and forming a continuous tortuous passage, in combination with a curved inner tube extending through each of said outer tubes and opening into said fitting units, partitions in said fitting units, respectively, forming passages communicating with said outer tubes and with said inner tubes respectively, elements rigidly attaching said outer tubes to said fitting units, devices in said fitting units holding said inner tubes in rigid relationship, means for admitting cold fluid into said outer tubes and hot fluids or gases into said inner tubes and discharging the same therefrom, and optional means for providing by-passes between said respective fitting units

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