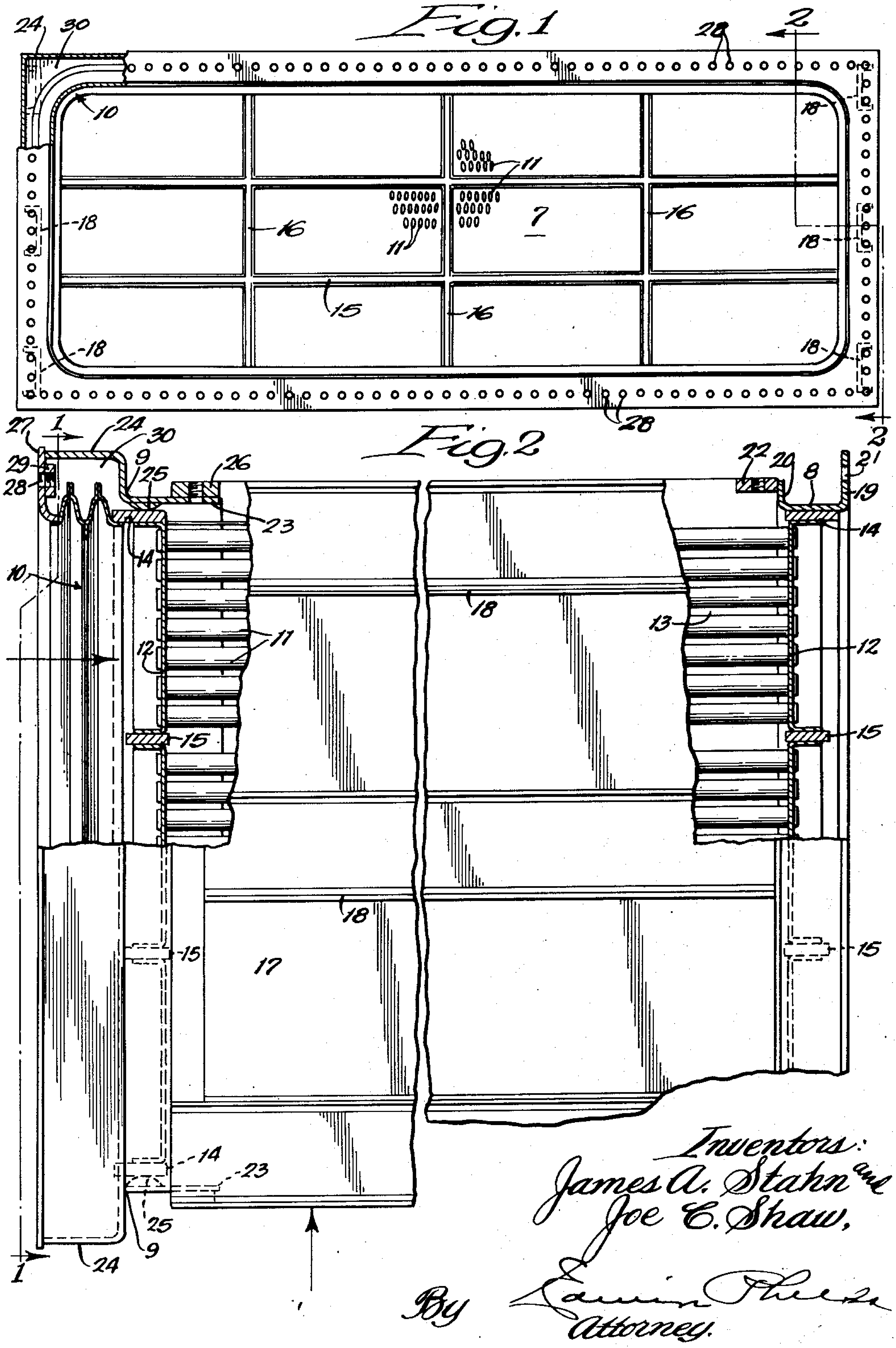
Sept. 29, 1953 J. A. STAHN ET AL 2,653,799

HEAT EXCHANGER

Filed Nov. 12, 1949 2 Sheets-Sheet 1

Fig. 1

Fig. 2



Sept. 29, 1953 | J. A. STAHN ET AL | 2,653,799

HEAT EXCHANGER

Filed Nov. 12, 1949 | 2 Sheets-Sheet 2

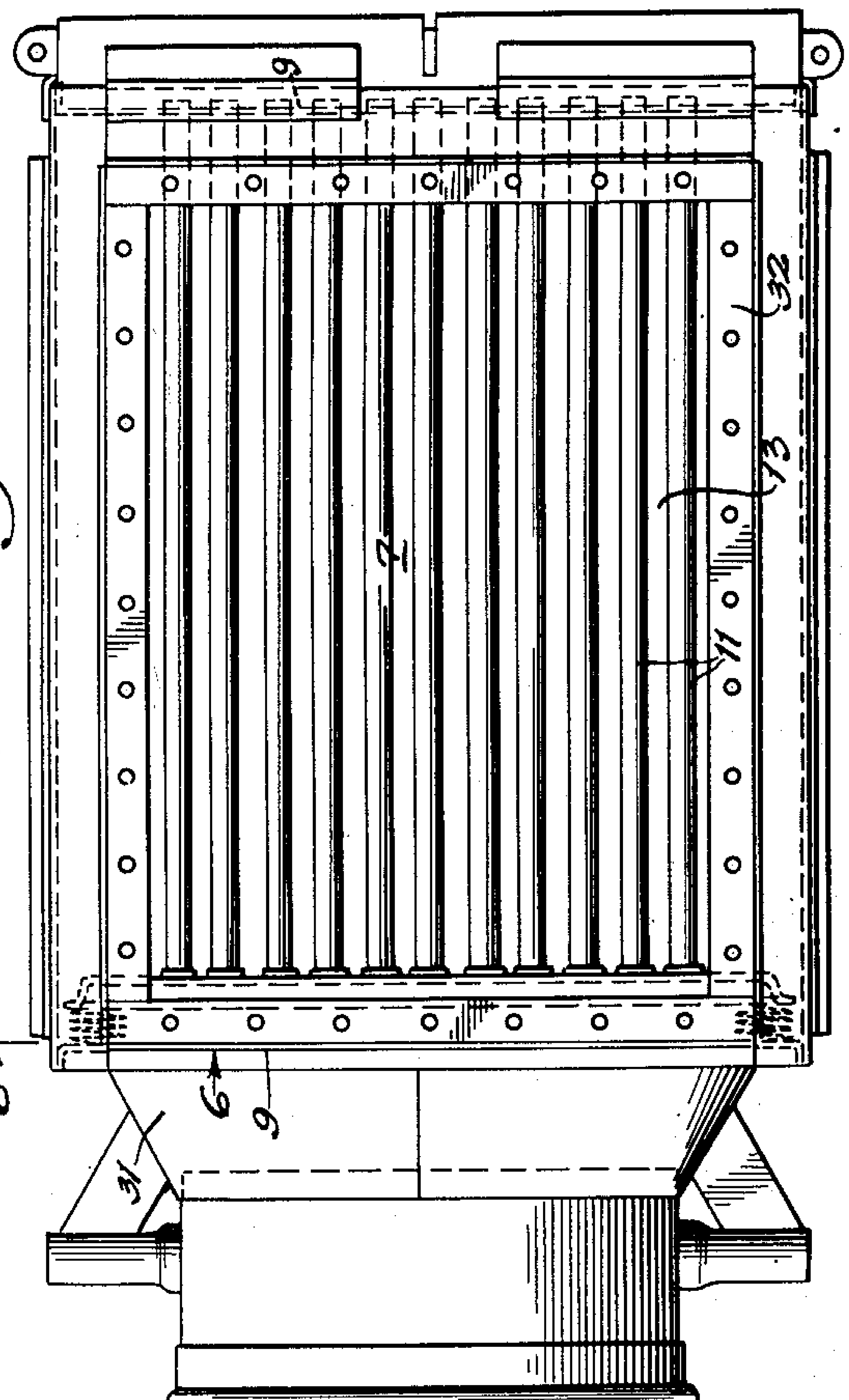


Fig. 4

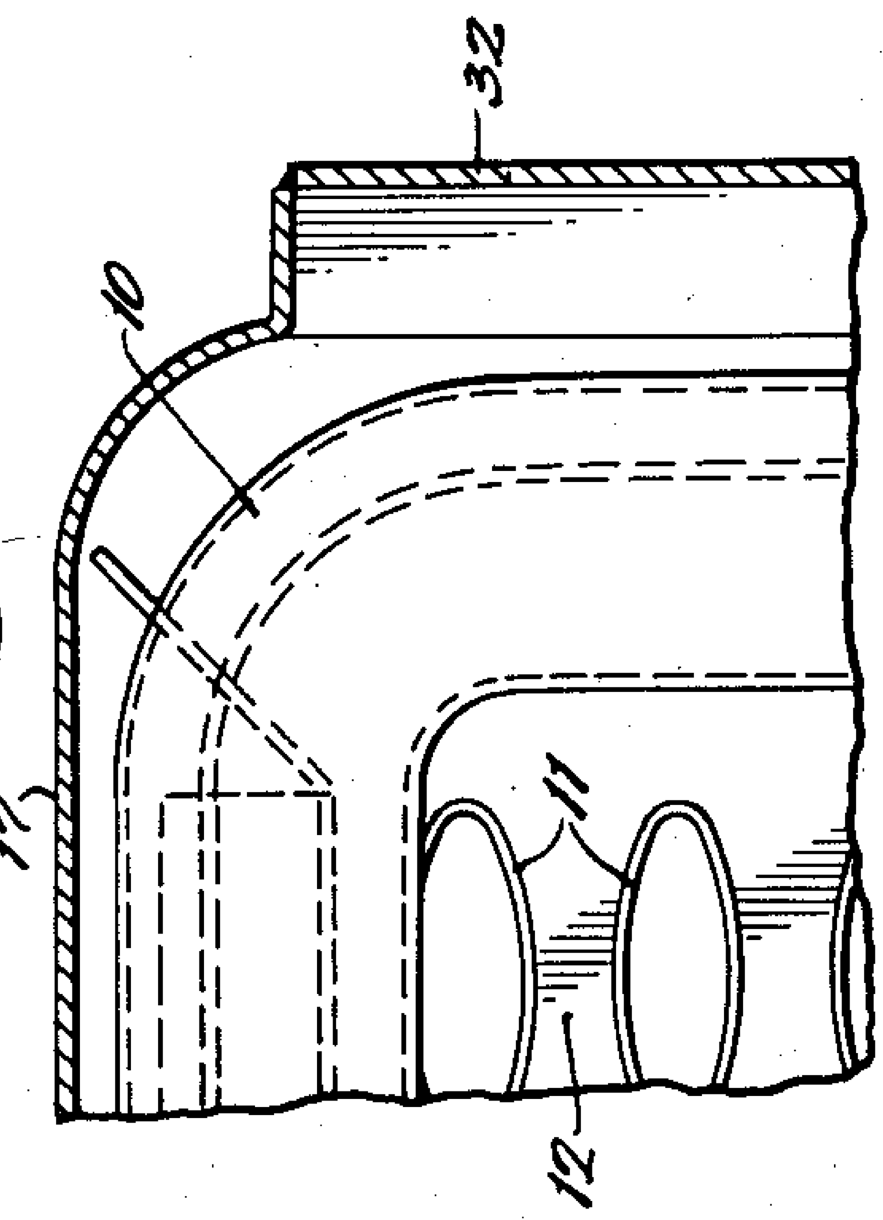


Fig. 6

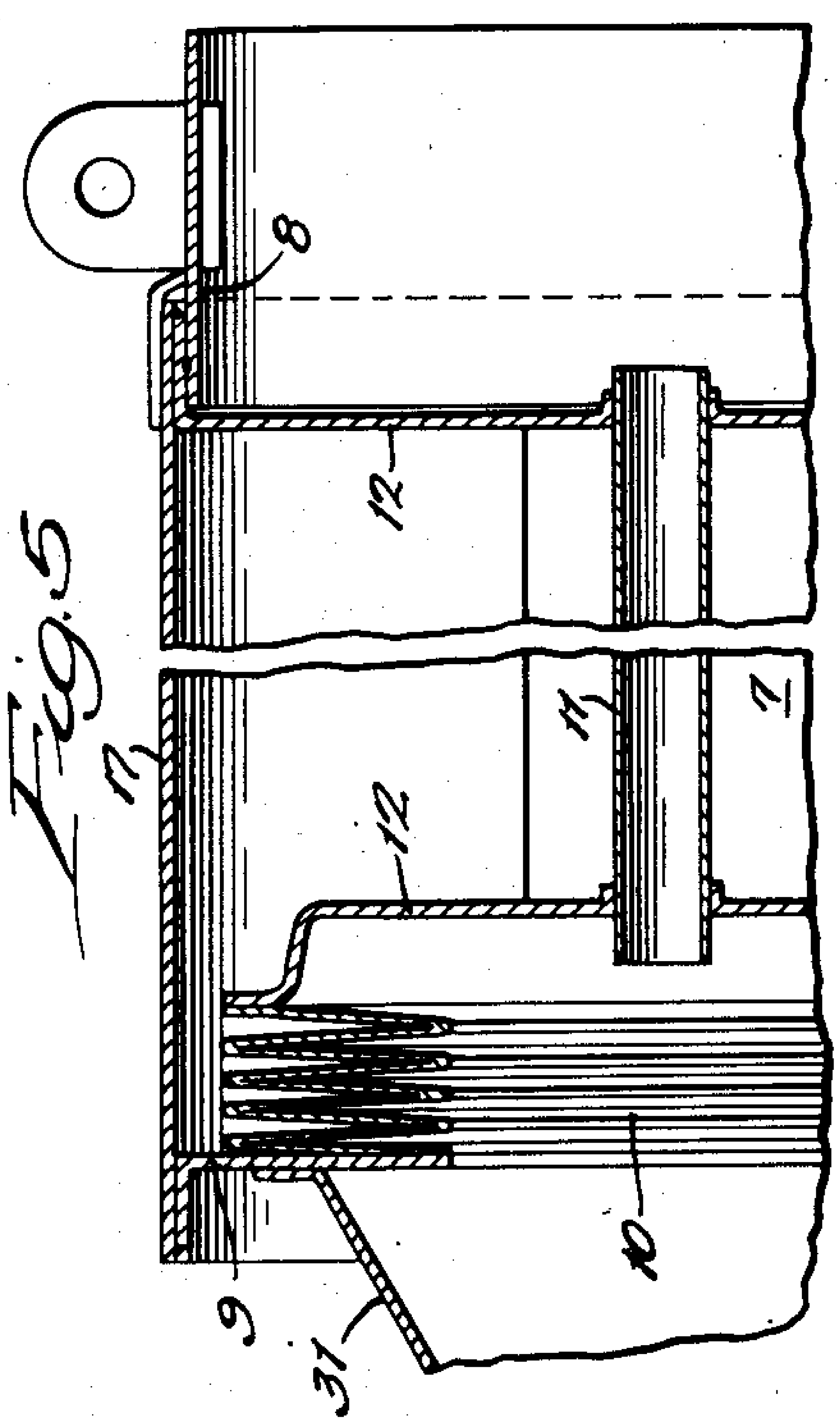


Fig. 5

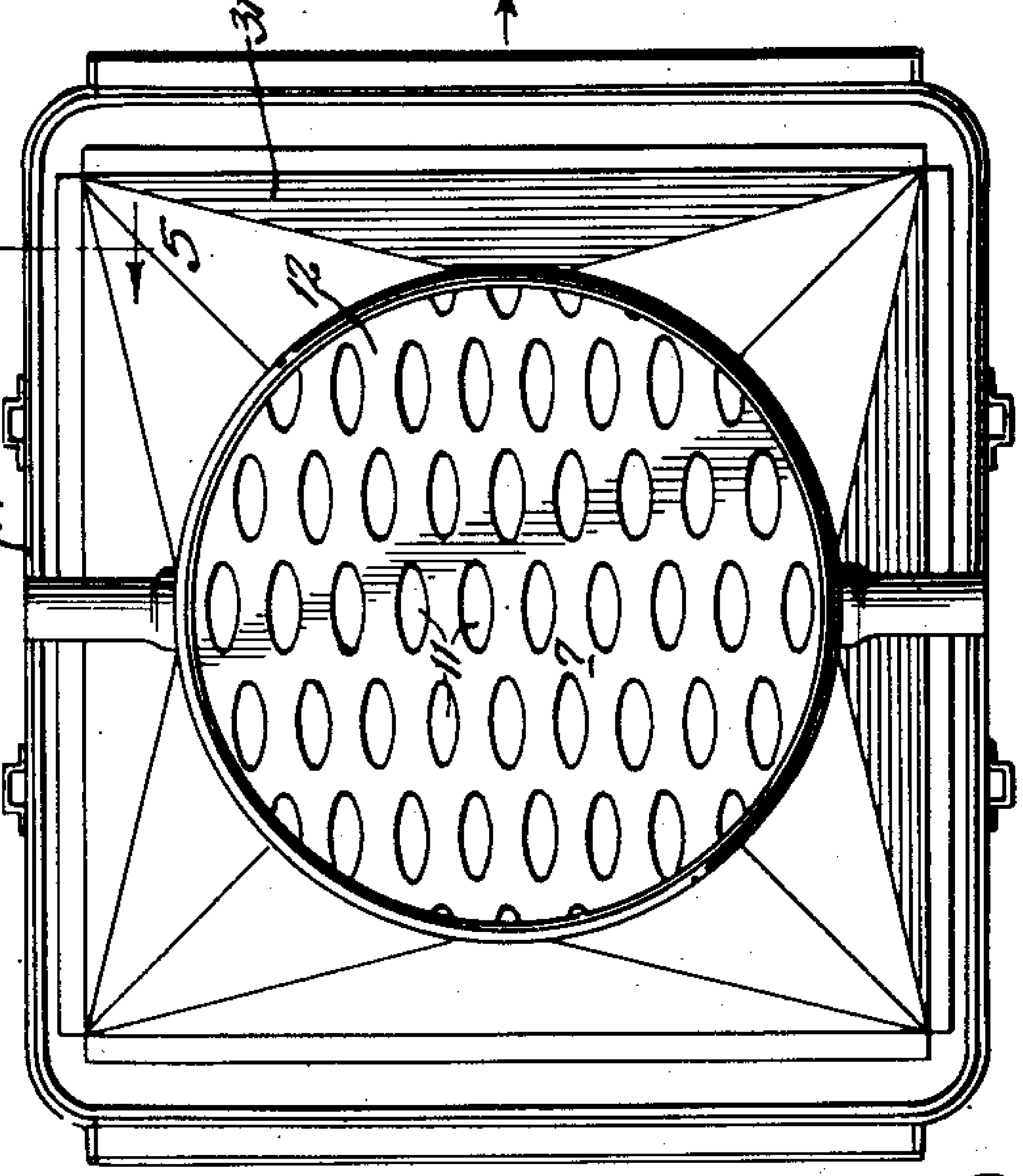


Fig. 3

Inventors:
James A. Stahn and
Joe C. Shaw,
By
Attorney.

Patented Sept. 29, 1953

2,653,799

UNITED STATES PATENT OFFICE

2,653,799

HEAT EXCHANGER

James A. Stahn and Joe C. Shaw, Racine, Wis., assignors to Young Radiator Company, Racine, Wis., a corporation of Wisconsin

Application November 12, 1949, Serial No. 126,803

2 Claims. (Cl. 257—236)

1

The recent developments in heat-generating engines for powering large-sized land vehicles and air- and sea-craft has created a demand for regenerators or recuperators and exhaust gas heat-exchangers designed to use the high temperature exhaust from the engines for pre-heating an in-coming air-flow required for purposes incident to the effective operation of such vehicles and craft. Among the requirements for such pre-heated air-flow are the more efficient combustion of turbine fuel, cabin heating, and wing and carburetor de-icing. For certain types of engines the temperature of the exhaust gas may be as great as 1800 degrees Fahrenheit. Using such gases an attempt is made to raise the temperature of the in-coming air-flow to 300-500 degrees Fahrenheit. To be acceptable for some of the aforesaid purposes, a heat-exchanger must have an extensive amount of heat-exchange surface in order to effect the desired heat transfer. Such transfer of heat can best be obtained from equipment using the small, closely-spaced, thin, metal tubes or passages which generally have been employed in the production of heat-exchange units for the transfer of heat between the more moderate-temperature fluids. However, working with these higher temperatures presents the manufacturer of equipment with problems of thermal expansive and contractive forces not heretofore encountered in the production of heat-exchange equipment for moderate-temperature heating or cooling media.

The main objects of this invention, therefore, are to provide an improved form of heat-exchanger for use in exposing an in-coming air-flow to the heat of exhaust gases from a heat-generating engine for the purpose of pre-heating said air-flow to make it utilizable for special purposes incident to the operation of the engine and/or the vehicle or craft which the engine powers; to provide an improved expansion mounting for heat-exchangers of this type which will allow for the comparatively excessive expansion and contraction forces to which such an exchanger will be subjected; to provide an improved expansion mounting especially suitable for large sized heat-exchangers of the type known as regenerators and which are required for turbines powering railroad locomotives; and to provide an improved form of expansion-mounted heat-exchanger of this kind which is comparatively simple and economical to manufacture and which is highly efficient in use.

In the accompanying drawings two types of heat-exchangers embodying this invention are shown:

2

Fig. 1 is a front elevation of a heat-exchanger, embodying this invention, of the type generally known as a regenerator. One corner thereof is broken away to more clearly indicate the form of the bellows which provides a part of the expansion mounting for the core-unit;

Fig. 2 is an enlarged, partly-sectional, partly-elevational view of the regenerator, as viewed from the plane of the line 2—2 of Fig. 1, showing in detail the manner of connecting the core-unit to the mounting members, whereby the regenerator is interposed between transversely disposed conduit sections adapted to direct the flow of gases and air through the core labyrinth and tubes, respectively;

Fig. 3 is a front elevation of a smaller-size heat-exchanger of the type required for pre-heating an incoming air-flow for cabin heating and/or wing or carburetor de-icing;

Fig. 4 is a side elevation of the same;

Fig. 5 is an enlarged, fragmentary, cross-sectional detail taken on the line 5—5 of Fig. 3 showing the bellows construction which provides an expansion mounting for the core unit; and

Fig. 6 is an enlarged fragmentary detail taken on the line 6—6 of Fig. 4 showing the arcuate corner construction of the bellows.

A heat-exchanger embodying this invention and suitable for pre-heating air for any of the aforesaid purposes, comprises a core-unit 7 made up of one or more sections supported on mounting members 8 and 9, whereby it is interposed between the ends of transversely disposed conduit sections which direct the exhaust gases and the air-flow through the core-unit. Between the core-unit and at least one of the mounting members is arranged an air-sealed, expansion connection 10 which permits the relative shifting of the core-unit and mounting member to accommodate the excessive expansive and contractive forces to which said core-unit is subjected.

Each core-unit section comprises a battery or bundle of thin, metal tubes 11 arranged in parallel, spaced relationship spanning and bonded at their ends to header plates 12, so as to provide an air-flow labyrinth 13 around the tubes 11 between the header plates 12.

The core-unit 7 for the regenerator type of heat-exchanger has to be a rather massive structure because of the volume of gas and air that have to be handled. Thus, as shown in Figs. 1 and 2, the core-unit 7 is a fabrication of a plurality of these core-unit sections of rather considerable length. As indicated, the sections are arranged in rows and bonded together within embracing rectangular-members 14 between horizontal and vertical reinforcing cross-braces 15 and 16, thereby forming an elongated structure of rectangular cross-section.

The core-unit 7, for the smaller type heat-exchanger, as shown in Figs. 3–6, may be a single section. The perimetrical portions of the header plates 12 are extended beyond the outer rows of tubes 11 a greater distance than with the regenerator type. Moreover, the header plate 12, wherewith the air-sealed expansion connection 10 is associated, is formed slightly different from the header plates employed in the core-unit sections for the regenerator-type of exchanger in that plate 12, for the smaller type heat exchanger, adjacent the perimeter is disposed transversely to the plane of the plate and then extended outwardly to provide an L-shaped border flange. The regenerator header plate 12 has merely a transverse flange.

The mounting members 8 and 9 for the two types of exchangers shown in the drawings differ materially in form. However, they have essentially the same function. In either modification, these mounting members are spanned and connected together on two sides by plates 17 (and in the case of the regenerator, channel bars 18) which constitute closures for the opposite sides of the labyrinth 13, and serve to channel the exhaust gases from the engine through the labyrinth.

For the regenerator-type of heat-exchanger, the mounting members 8 and 9, as herein shown, are respectively channel-form and Z-form. For the smaller-type of heat-exchanger the mounting members 8 and 9 are respectively a sleeve and a flanged open rectangle.

The channel-form mounting-member 8 has its outer flange 19 slightly wider than the inner flange 20. The base of the member 8 is bonded to the retaining member 14. The outer flange 19 is provided with a row of apertures 21 bordering the perimeter thereof. This permits the mounting member 8 to be attached to a similar flange on the end of a section of a conduit which directs the air-flow through the tubes 11 for heating by the gases passing through the labyrinth 13. The inner, vertical flange 20 on opposite sides of the core-unit 7 has bonded thereto a perforated bar 22, which provides for a connection of the regenerator to the opposed ends of sections of a conduit leading from the exhaust of an engine and to the atmosphere, respectively.

The Z-form mounting-member 9 is positioned with the inner leg 23 embracing the retaining member 14 and its outer leg 24 spaced circumferentially outward therefrom. The core-unit 7 is shiftably supported on the leg 23 by a rib or bead 25 constituting a part of the air-sealed expansion connection 10 for one end of the core-section, as will be explained more fully hereinafter. The leg 23 has secured to each of the opposite sides thereof a perforated plate or bar 26, which bars co-act with the bars 22 for attaching the exchanger to the exhaust gas conduit sections hereinbefore referred to.

A transversely-disposed ring plate 27 is bonded to the edge of the outer leg 24 of the mounting member 9. This is provided with perforations 28 and a reinforcing bar 29 for connection thereof to a section of the conduit which directs the in-coming air through the tubes 11, as hereinbefore indicated. Incidentally, the positioning of the plate 27 on the leg 24 of the mounting member 9 provides a chamber 30 perimetrically of

the adjacent header plate 12, wherein is located the bellows forming a part of the air-sealed expansion connection 10, to be more fully described hereinafter.

The sleeve mounting member 8, (for the modification shown in Figs. 3–6) telescopes with the flange on the adjacent header plate 12 and is bonded thereto (see Fig. 5). Suitable means are provided for attaching the sleeve to one end of a section of conduit for conveying air through the tubes 11.

The flanged mounting-member 9 is bonded to the side plates 17, and mounts a funnel 31, whereby the exchanger is connected to the end of a section of the aforesaid conduit which conveys air through the tubes 11 of the core-unit 7.

At opposite sides, the mounting-members 8 and 9 have perforated rectangular members 32 secured thereto, whereby the exchanger is attached to the ends of opposed sections of a conduit for directing the flow of exhaust gases through the core labyrinth 13.

The air-sealed expansion connection 10, as herein shown, comprises a bellows made up of a plurality of sheet metal stampings in the form of rectangular members bonded together along their perimeters. Two or more pairs of these opposed stampings have their opposite end stampings respectively secured to one end of the core-unit 7 and the contiguous mounting-member which, as herein shown, is the mounting-member 9.

For the regenerator-type exchanger, the end members for the bellows are secured to the binding member 14 and the inner perimeter of the ring plate 27 and provides an air-seal between the respective conduit passages through the tubes 11 and the labyrinth 13. Thus the weight of the core-unit 7 is borne directly by the mounting-member 9, the bead 25 affording the required relative shifting of the core-unit 7 with respect to the mounting-member.

For the small-type exchanger, the end members of the bellows are attached respectively to the perimeter of the header plate 12 and the mounting-member 9. Hence, in this type, the bellows directly carries the weight of that end of the core-unit 7. As will be apparent from Fig. 5 the relative form and arrangement of the mounting member 9 and the header plate 12 provide a chamber perimetrically of the header plate in which chamber is located the bellows constituting a part of the expansive connection 10.

At the corners of the mounting-members 8 and 9 there is, of necessity, an accumulation of stress. However, these mounting-members can be and are made of comparatively heavy material so that they can resist these strains without injury or distortion of said members.

The bellows material being necessarily thin metal could not absorb or resist the stress accumulations to which they might be directly subjected or which might be communicated to them from the respective mounting-members or the core-units, if they were made with square corners. Therefore, the otherwise rectangular members for the bellows are made of arcuate form at the corners, as clearly shown in the drawings. This permits the corner stresses to be more readily dissipated through the contiguous portions of the bellows, and free the bellows from the likelihood of corner fracture.

Variations and modifications in the details of structure and arrangement of the parts may be resorted to within the spirit and coverage of the appended claims.

We claim:

1. In a heat-exchanger of the class described, the combination of a heat-transfer core-unit comprising a battery of tubes arranged in spaced parallel relationship spanning and bonded at their ends to rectangularly shaped header plates so as to form an air-flow labyrinth around said tubes intermediate said plates, rectangularly shaped mounting members for interposing said core-unit between opposed ends of conduit sections adapted to direct heat-exchanging air flows through said tubes and said labyrinth, and a rectangularly shaped bellows connecting one of said header plates and one of said mounting-members to provide an air-sealed yielding-connection permitting a relative movement of said plate and member to accommodate the expansive and contractive forces to which said core-unit is subjected, said bellows having the perimetrical portions thereof adjacent the corners of said one header plate and mounting member materially arcuate-shaped so as to minimize the likelihood of fracture of said bellows adjacent said corners where stress is accumulated.

2. In a heat-exchanger for using the high-temperatured exhaust gases from an engine to preheat an incoming air flow, the combination of an elongated heat-transfer core-unit of rectangular cross-section fabricated from a plurality of separately-formed core-sections arranged in superimposed rows and each comprising a battery of tubes arranged in spaced parallel relationship spanning and bonded at their ends to header plates, rectangularly-shaped retaining members bonded to the peripheral portions of the header plates of the outer rows of core sections, a pair of rectangularly-shaped mounting members each embracing one of said

retaining members for interposing said core-unit between the opposed ends of conduit sections adapted to direct air flows through said labyrinth and said tubes, a rib formed on one of the aforesaid embracing members to provide a minimum-friction shifting contact between said members to permit relative movement of said members to accommodate the expansive and contractive forces to which said core-unit is subjected, and a rectangularly-shaped bellows forming an air-sealed yielding connection between the aforesaid embracing members, said bellows having the perimetrical portions adjacent the four corners of said core-unit rounded so as to lessen the probability of fracture produced by stress accumulations at these points.

JAMES A. STAHN.
JOE C. SHAW.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,489,932	Dickey	Apr. 8, 1924
1,594,199	Heineman	July 27, 1926
1,604,197	Rushmore	Oct. 26, 1926
1,724,351	Henderson et al.	Aug. 13, 1929
1,815,618	Graham	July 21, 1931
1,875,663	Sandstrom	Sept. 6, 1932
1,918,966	Harkness	July 18, 1933
1,921,988	Govers	Aug. 8, 1933
1,922,173	Pedersen	Aug. 15, 1933
2,232,936	Bimpson	Feb. 25, 1941
2,344,269	Saco, Jr.	Mar. 14, 1944
2,375,999	Miller	May 15, 1945
2,487,626	Wittman	Nov. 8, 1949

FOREIGN PATENTS

Number	Country	Date
100,671	Great Britain	June 22, 1916
591,699	Great Britain	Aug. 26, 1947