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Purtov et al.

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[54] **SPRAY-TYPE HEAT EXCHANGER**

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[52] **U.S. Cl.** **261/103,** 261/67

[51] **Int. Cl.** **B01f 3/04**

[58] **Field of Search** 261/95, 97, 102, 103, 106, 261/67, 112

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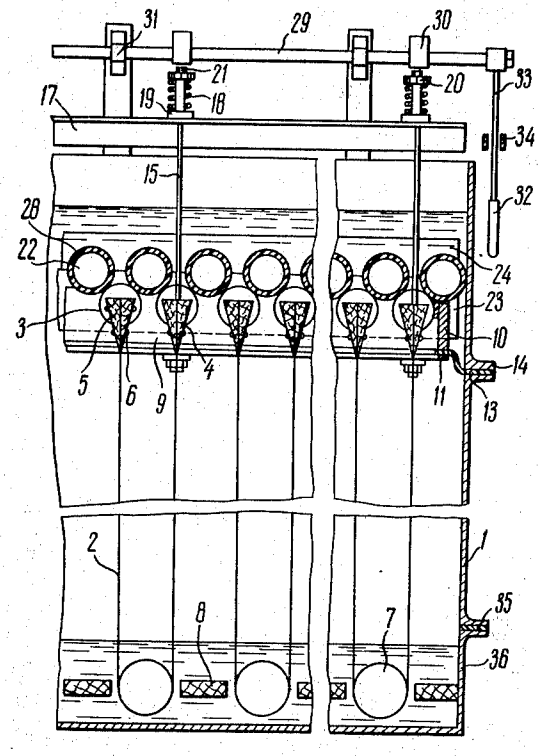
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[57] **ABSTRACT**

A heat exchanger is provided with a heat exchange assembly comprising separate sheets attached to supporting bars. The supporting bars are secured together and form a lattice suspended on spring-loaded rods, which makes it possible to adjust the size of gaps for passage of liquid. Alternative embodiments of means for securing the sheets of the heat exchange assembly to the rods are described.

10 Claims, 7 Drawing Figures



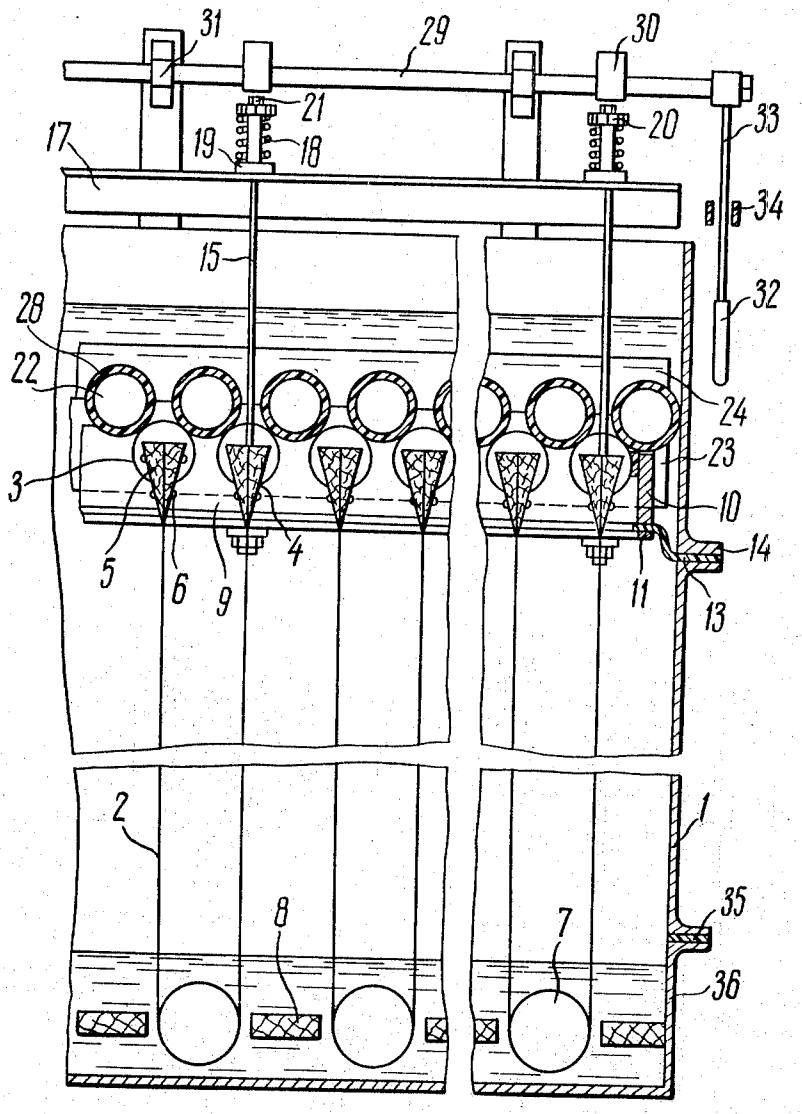

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FIG. 1

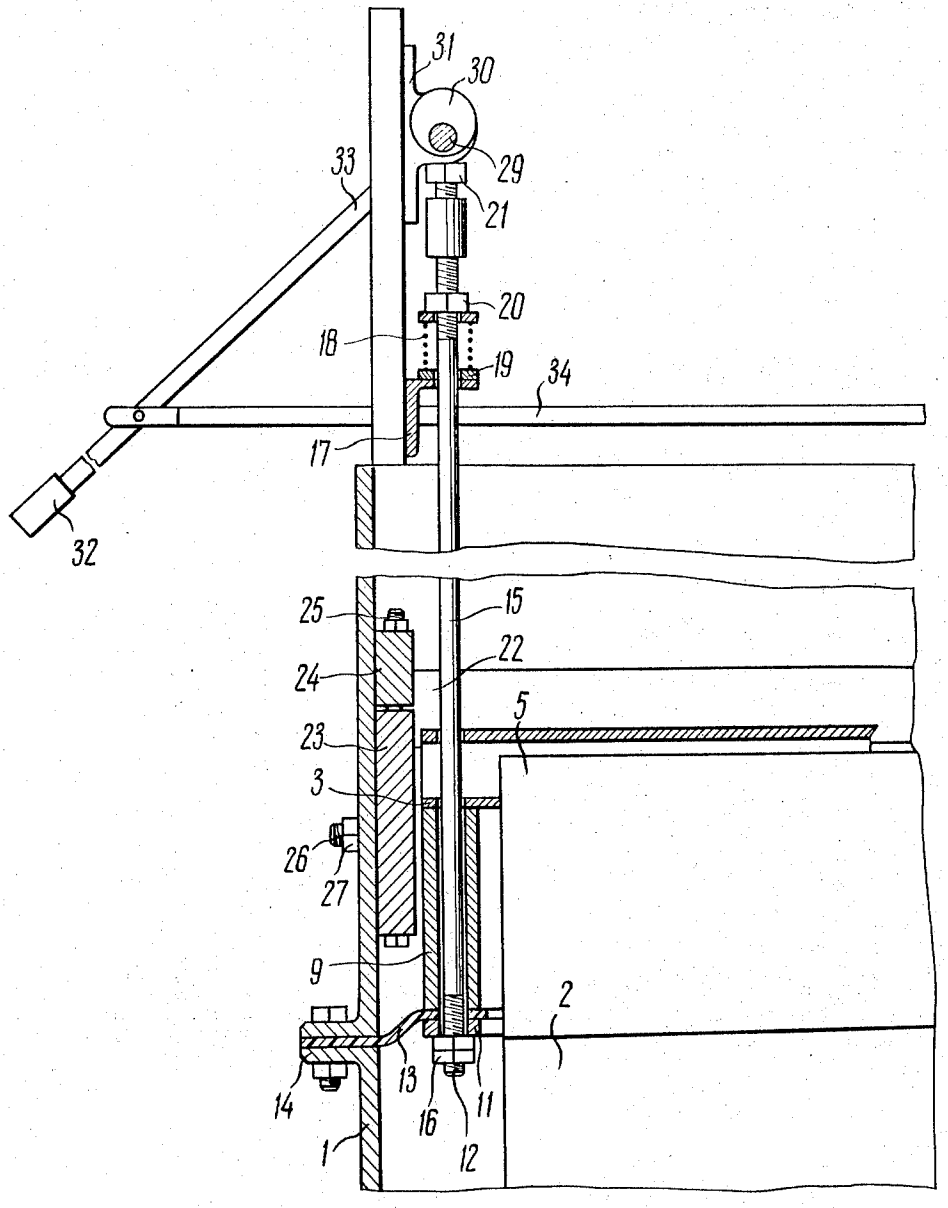

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FIG. 2

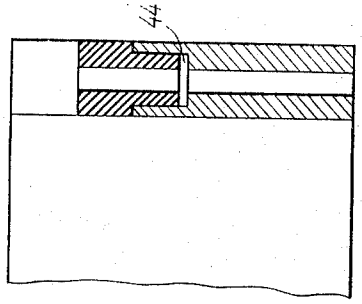


FIG. 4

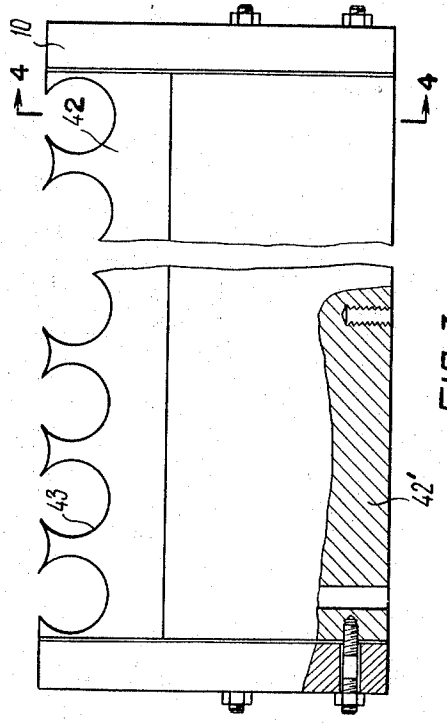


FIG. 3

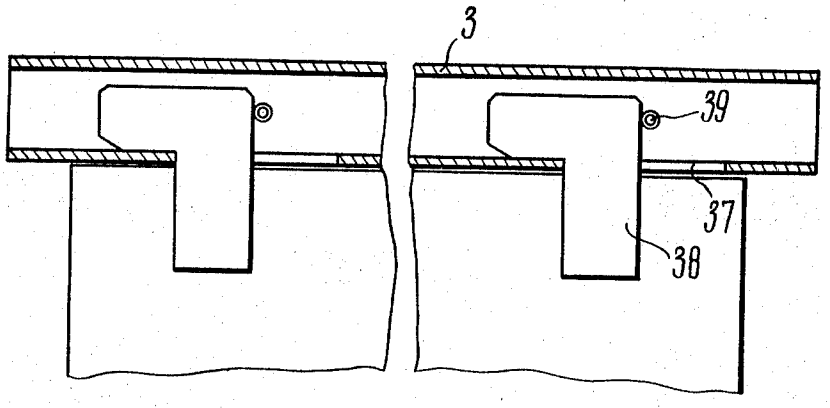


FIG. 5

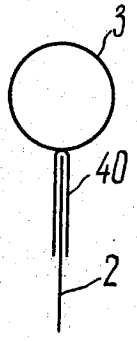


FIG. 6

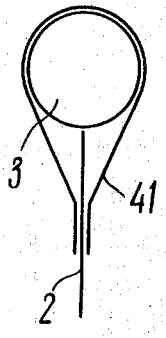


FIG. 7

SPRAY-TYPE HEAT EXCHANGER

This invention relates to gas-liquid contact apparatus and, more particularly, to contact-type heat exchangers in which gas flows across the latter.

This invention may be used in the chemical, oil refining and other industries in cases where cooling, e.g., of water, should be effected in the cooling system of an installation.

Known in the art are cross-flow heat exhangers comprising a housing with a vertical heat exchange assembly made of flat sheets suspended in said housing on horizontal supporting bars, an upper water distributing tank, an apparatus for air or gas supply, a header and water traps.

The main disadvantage of such heat exchangers consists in that they require a device for spraying the liquid to be cooled.

Also known in the art are heat exchangers comprising a housing accomodating a vertical heat exchange assembly attached to supporting bars forming a lattice, and intermediate bars which also form a lattice and are disposed between said supporting bars to define a gap for passage of liquid therethrough.

In such heat exchangers the heat exchange assembly essentially comprises a flexible film extending across the heat exchange chamber with descending and ascending turns, which film extends over the supporting bars rigidly secured in the housing and held at the bottom under tension by means of weights disposed in the water collecting tank.

Mounted between each two adjacent supporting bars with the film turns are intermediate bars provided with distributing wings, said intermediate bars defining gaps with the supporting bars. The size of the gap between the supporting bars and intermediate bars is adjusted by varying the deflection of the distributing wings, whereby the amount of the liquid to be cooled is controlled.

The arrangement of the heat exchange assembly of the heat exchanger is intended for employment of vertical sheets made of a flexible material only, such as plastic film. In this case the liquid is supplied to one side of the film only.

Furthermore, the adjustment of the gaps between tubes for directing the liquid to the film surface by means of the distributing wings is a labor-consuming operation necessitating interruption of the heat exchanger operation and partial dismantling thereof, which, however, does not ensure high accuracy of positioning of the bars and, consequently, a constant size of the gap therebetween.

A constant size of the gaps between the supporting and intermediate bars is an indispensable condition for uniform distribution of the liquid over the surfaces being sprayed.

Finally, due to the small size (0.3 – 0.5 mm) of the gaps for passage of the liquid between the bars, the gaps inevitably become clogged, which results in frequent discontinuation of the heat exchanger operation, necessary for washing the gaps.

It is an object of the present invention to provide a heat exchanger which has a heat exchanging surface twice as great as that of the prior art heat exchangers, this being achieved due to the fact that the liquid is supplied on both sides of the heat exchange assembly. Furthermore, the heat exchanger according to the present invention ensures uniform distribution and a constant

flow rate of the liquid, as well as washing of the gaps between the rods without discontinuing the operation of the heat exchanger.

The above object is accomplished by the provision of a spray-type heat exchanger comprising a vertically arranged sheet heat exchange assembly which is attached to supporting bars mounted on beams and forming a lattice, intermediate bars being disposed between said supporting bars to define a gap for passage of the liquid therethrough, said intermediate bars also forming a lattice.

According to the invention, the lattice formed by the intermediate bars is disposed above the lattice formed by the supporting bars, one of the lattices being fixed in the housing of the heat exchanger, while the other one is suspended on spring-loaded rods for adjustment of the size of the gap between the supporting and intermediate bars, the heat exchange assembly of the heat exchanger being made of separate sheets attached to the supporting bars.

This embodiment of the heat exchanger makes it possible to adjust the gaps between the intermediate and supporting bars without discontinuing the operation of the heat exchanger and dismantling the latter.

The use of the heat exchange assembly fashioned as separate sheets permits obtaining a two-fold increase in the efficiency of the heat exchanger since the liquid is supplied to both sides of the sheets.

The intermediate bars are preferably provided with a flexible porous envelope, for instance, a sponge rubber envelope. This envelope allows a more accurate maintanence of a constant size of the gap along the whole length of the bars, thereby ensuring a more uniform liquid supply to the surface of the heat exchange assembly.

In accordance with one of the embodiments of the invention, the heat exchanger may be provided with rolls arranged above the upper ends of the suspension rods carrying the bar lattices, said rolls being provided with eccentrics adapted to displace the rods to increase the gaps between the supporting and intermediate bars until a necessary gap for washing thereof is obtained.

According to another embodiment of the invention, the supporting bars are made hollow and provided with longitudinal slots made in the lower portion thereof, while the edge of the sheet is provided with wedge-shaped straps secured to each other and introduced into these slots.

According to a further embodiment of the invention, the supporting bars are made hollow and are provided with rectangular slots equally spaced along the axis, while the sheet edge is provided with L-shaped straps inserted in said slots.

In still another embodiment of the invention, the sheets of the heat exchange assembly are secured by means of clamps attached to the lower portion of the supporting bar and equally spaced therealong.

In accordance with another embodiment of the invention, sheets of the heat exchange assembly are secured by means of collars mounted on the bars, with the sheets of the heat exchange assembly being fixed between the arms of said collars.

The above-described embodiments for securing the heat exchange assembly offer economies in manufacture and ensure the liquid supply to both sides of the sheets of the heat exchange assembly.

These and other objects of the invention will become more apparent from the following description of embodiments thereof given with reference to the accompanying drawings, in which:

FIG. 1 is a partial cross-sectional view of a spray-type heat exchanger;

FIG. 2 shows details of means for securing the supporting and intermediate bars in a partial section taken along the axes of the bars;

FIG. 3 is an elevational view partly broken away and in section of a beam for securing the supporting bars;

FIG. 4 is a cross-sectional view taken along line 4-4 in FIG. 3 of the beam for securing the supporting bars;

FIG. 5 is an embodiment of means for securing a sheet of the heat exchange assembly to a supporting bar;

FIG. 6 is another embodiment of means for securing a sheet of the heat exchange assembly to a supporting bar; and

FIG. 7 is a further embodiment of means for securing a sheet of the heat exchange assembly to the supporting bar.

A spray-type heat exchanger comprises a housing 1 accomodating a vertically arranged heat exchange assembly composed of sheets 2 which are secured to supporting bars 3. In this embodiment of the invention, the supporting bars 3 are essentially tubes having a longitudinal slot 4 provided at the lower portion thereof adapted for securing the sheets 2 of the heat exchange assembly. The heat exchange assembly may be composed either of flat or corrugated metal sheets, or of a plastic film or woven fabrics.

In the illustrated embodiment in FIG. 1, the sheets 2 of the heat exchange assembly are made of plastic film. The two opposite edges of the film are provided with wedge-shaped straps 5 disposed on the both sides of the sheet 2 and secured to each other by means of rivets 6 to secure the film to the supporting bars 3. In this case the straps 5 are made of wood. The resulting wedge formed from straps 5 is inserted in a slot 4. All the remaining sheets 2 of the heat exchange assembly are secured in the same manner. Since the sheets 2 which are suspended at both ends from a loop, weights 7 are used for tensioning thereof. Spacers 8 are placed between the weights 7 to fix the spacing between the sheets 2 of the heat exchange assembly. In case the heat exchange assembly is made of rigid metal sheets, the weights 7 can be dispensed with, but the spacers 8 are still provided between the sheets 2 of the heat exchange assembly.

The supporting bars 3 are received in recesses provided in cross beams 9 whose ends are joined by means of longitudinal beams 10 to form a frame for the supporting bars 3. A flexible membrane 13 is attached to the lower surface of said frame along the periphery thereof by means of strips 11 and studs 12, the membrane being placed between flanges 14 of the heat exchanger housing 1. The membrane 13 serves to seal gaps between the housing 1 of the heat exchanger and the frame of the lattice formed by the supporting bars 3.

In this case the lattice formed by the supporting bars is made movable. This is achieved due to the fact that rods 15 fixed by nuts 16 are passed through openings provided in the cross beams 9. The rods 15 are essentially bars of a round cross section, and they pass through a beam 17 which is rigidly secured in the heat exchanger housing 1. Each of the ends of the rods 15, extending above the beam 17 is provided with a spring 18 mounted thereon, one end of said spring abutting a washer 19 engaging the beam 17, while the other end of the spring rests on a nut 20 fixing the rod 15. Furthermore, an adjusting bolt 21 is screwed onto the end face of each rod, said bolt being adapted to adjust the length of the rod 15 when the lattice of the supporting bars 3 is being suspended.

The supporting bars 3 are spaced from one another at a distance smaller than their diameters. Intermediate bars 22 are located above the supporting bars 3 in such a manner as to ensure engagement with them along the whole length. These intermediate bars 22 are locked between two beams 23 and 24 which are clamped by bolts 25. Thus, the intermediate bars 22 form a lattice rigidly fixed in the heat exchanger housing by means of studs 26 and nuts 27.

To ensure uniform supply of the liquid to the heat exchange assembly, it is necessary to provide uniform gaps between the supporting bars 3 and intermediate bars 22. The size of these gaps should be from 0.3 to 0.5 mm, depending on a preset efficiency of the heat exchanger. As the surface of the bars is generally rather rough, in this specific embodiment of the invention, the intermediate bars 22 are covered with an elastic porous envelope 28 made, for instance, from sponge rubber. This envelope makes it possible to maintain constant the size of the gaps between the bars 3 and 22 when the liquid is flowing.

Generally, any liquid contains mechanical impurities which in the course of time lead to clogging of the gaps between the bars 3 and 22. Therefore, the gaps should be periodically washed. For this reason, rolls 29 provided with eccentrics 30 rigidly fixed thereto are mounted above the upper ends of the rods 15. The rolls 29 are mounted in supports 31. During the rotation of the roll, the eccentrics 30 act on the end faces of the rods 15, and the whole movable lattice of the supporting bars 3 is moved downwards, whereby the size of the gaps between the supporting bars and the intermediate bars is increased up to $1.5 \div 2$ mm. The liquid passing through the increased gaps removes deposited mechanical impurities. The periodicity of washing depends on the quality of the liquid used and on the preset efficiency of the heat exchanger.

The rolls 29 are actuated by means of a handle 32 through a lever 33. One lever 33 is located at each of the opposite ends of the bars 3 and the levers are interconnected by a link 34.

A tank 36 adapted to collect the liquid is attached to the lower part of the housing 1 by means of flanges 35, the weights 7 and the spacers 8 being lodged in this tank. Perforated chutes (not shown) are provided above the bars 3 and 22 in the upper part of the heat exchanger housing 1 to supply water.

The invention contemplates several embodiments of means for securing the sheets 2 of the heat exchange assembly to the supporting bars 3. The bar 3 (FIG. 5) is essentially a tube with equally spaced rectangular longitudinal slots 37 cut in its wall. L-shaped laminar strips 38 are secured at the same spaces to the edge of the sheet in such a manner that the free portion of the strip 38 is inserted into the slot 37, whereafter the sheet 2 is moved in the left-hand direction (as viewed in the

Figure) to the extreme position and is fixed by means of a pin **39** to preclude its displacement in the opposite direction.

In accordance with another embodiment of the invention, equally spaced clamps **40** (FIG. **6**) are welded to the bar **3** along the axis thereof, the sheet **2** being inserted into these clamps **40** and secured therein.

According to still another embodiment of the invention, a plurality of collars **41** (FIG. **7**) are mounted on the supporting bar **3,** the number of the collars being determined by the size and weight of the sheet **2.** The latter is inserted into spaces between the arms of the collars **41** and secured therebetween.

The spray-type heat exchanger operates as following.

Liquid is fed into the chutes located in the upper part of the housing **1** wherefrom it flows down through the perforations to spray the sheets of the heat exchange assembly. Prior to the beginning of the operation, the springs **18** are adjusted so as to ensure an intimate contact between the bars **3** and **22,** as a result of which the liquid is accumulated in the upper part of the housing **1.** As the level of the liquid rises, the load acting on the bars **3** and **22,** and consequently, on the springs **18** increases. Upon achievement of the liquid level preset by adjustment of the springs **18,** the lattice of the supporting bars **3** suspended on the rods **15** start moving downwards to define gaps between the supporting and intermediate bars. The liquid flows down through these gaps in the form of a continuous film along the external surface of the sheets **2** of the heat exchange assembly where it comes into contact with a gas blown in a direction normal to the direction of the liquid flow. Thus, the process of heat and mass-exchange takes place on the surface of the sheets **2.**

The cooled liquid flows down from the sheets **2** of the heat exchange assembly into the liquid-collecting tank **36,** wherefrom it is constantly removed to be used for technological purposes.

During operation of the heat exchanger there may take place clogging of the gaps between the supporting and intermediate bars **3** and **22,** in which case the liquid level above them rises. In order to remove the accumulated deposits, the rolls **29** with the eccentrics **30** are rotated with the aid of the handle **32** and the lever **33.** In so doing, both rolls **29** are rotated, the eccentrics **30** are urged against the end faces of the rods **15** to compress the springs **18,** and the whole lattice of the supporting bars **3** is lowered to increase the size of the gaps between the rods **3** and **22.** The liquid then flows through these gaps and washes them.

According to the invention, there is provided a modified form of the beam **9** adapted to secure the supporting bars **3** (FIG. **3**). The modified beam **9** is a composite member and comprises upper and lower parts **42** and **42'**. The upper part **42** of the beam **9** is made of a resilient material, such as rubber and is provided with sockets **43** to accommodate the bars **3.** The lower part **42'** of the beam **9** is made of a metal and is provided with a slot **44** in which the upper part **42** of the beam is snug fitted.

The spray-type heat exchanger according to the invention has a heat exchange surface which is twice as great as that of prior-art heat exchangers, while the adjustment of the gaps to allow the liquid to flow therethrough, as well as washing thereof, permits to dispensing with interruptions of the operation of the heat exchanger or dismantling thereof.

We claim:

1. A spray-type heat exchanger comprising a housing; mutually parallel supporting bars equally spaced in said housing, said bars forming a lattice; longitudinal and transverse beams disposed in said housing and securing said support bars together; a sheet heat exchange assembly vertically arranged in said housing and including sheets, each sheet being attached to a respective support bar; intermediate bars disposed above said supporting bars in said housing in such a manner as to define gaps between said supporting bars and said intermediate bars to ensure liquid flow therethrough; beams rigidly fixed inside said housing and supporting said intermediate bars; and spring-loaded rods rigidly fixed in said housing and supporting said lattice of supporting bars in suspended relation to provide for adjustment of the gap between said supporting bars and said intermediate bars.

2. A heat exchanger according to claim **1,** wherein the intermediate bars each include a porous envelope to ensure uniform gaps between said intermediate bars and said supporting bars.

3. A heat exchanger according to claim **1,** comprising rolls with eccentrics disposed above the upper ends of the rods carrying the lattice of the supporting bars, said rolls and said eccentrics being positioned to move the rods to increase the size of gaps between the intermediate and supporting bars up to a value necessary for washing said gaps.

4. A heat exchanger according to claim **2,** wherein the supporting bars are hollow and provided with longitudinal slots on the lower surface thereof, the ends of the sheets of the heat exchange assembly including two wedge-shaped interconnected straps disposed on both sides of each sheet, said straps being inserted into said slots.

5. A heat exchanger according to claim **2,** wherein said supporting bars are hollow and are provided with rectangular slots equally spaced along the axis of the bar, the edge of each sheet including L-shaped laminar straps inserted into said slots.

6. A heat exchanger according to claim **2,** wherein the lower end of the supporting bar includes clamps equally spaced along the axis of the bar to receive a sheet of the heat exchange assembly.

7. A heat exchanger according to claim **2,** wherein said supporting bar includes collars having arms, each sheet of the heat exchange assembly being secured under the bar between said arms.

8. A heat exchanger according to claim **1** wherein said beams are composite members including upper and lower connected parts, said supporting bars being supported by said upper parts, said upper parts being constructed of a resilient material.

9. A heat exchanger according to claim **1** comprising externally actuated means acting on said spring-loaded rods to adjust the gap between the supporting bars and said intermediate bars.

10. A heat exchanger according to claim **1** comprising means secured to said longitudinal and transverse beams and to said housing to partition the housing outside the supporting bars.

* * * * *