March 21, 1933. S. M. BURTON 1,902,320

HEAT EXCHANGER

Filed Aug. 18, 1931 5 Sheets-Sheet 1

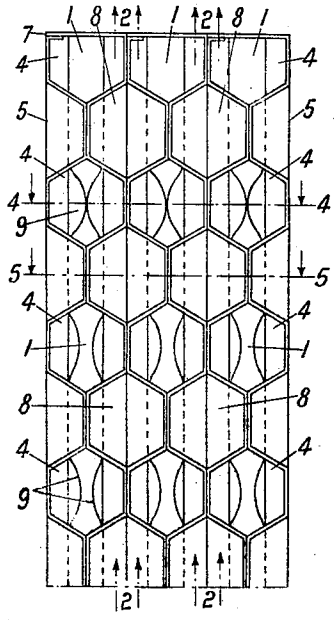


FIG. 1.

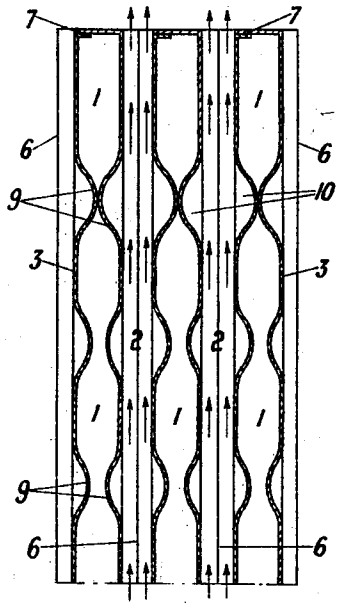


FIG. 6.

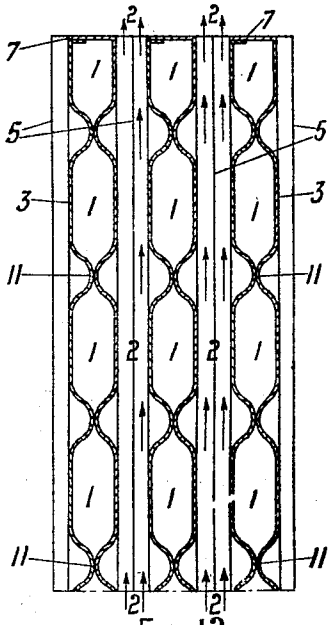


FIG. 12.

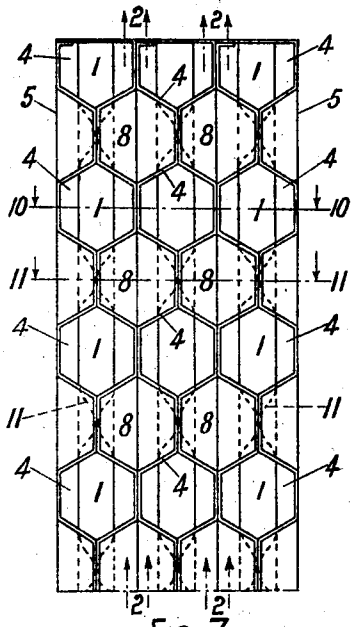


FIG. 7.

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HEAT EXCHANGER

Filed Aug. 18, 1931 5 Sheets-Sheet 2

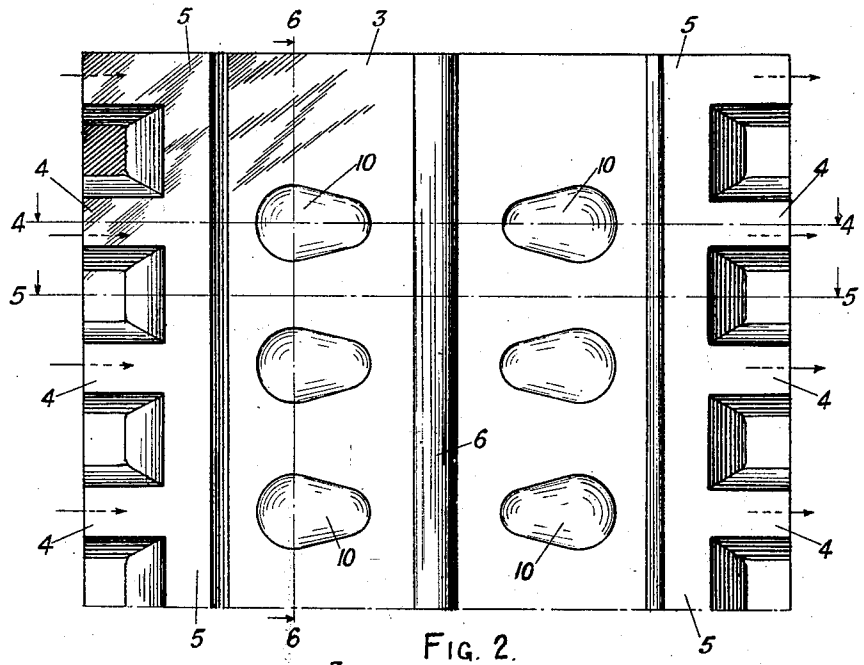


FIG. 2.

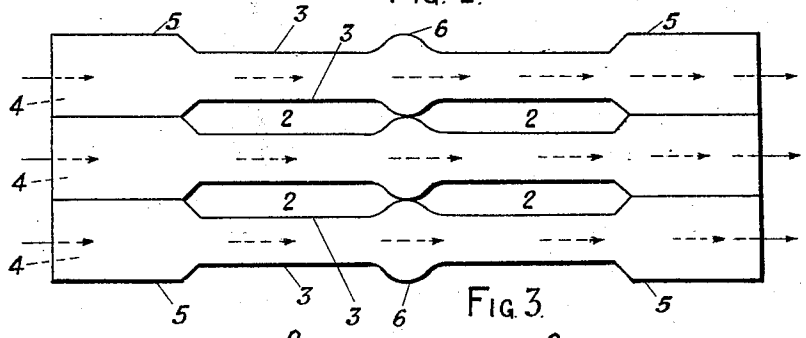


FIG. 3.

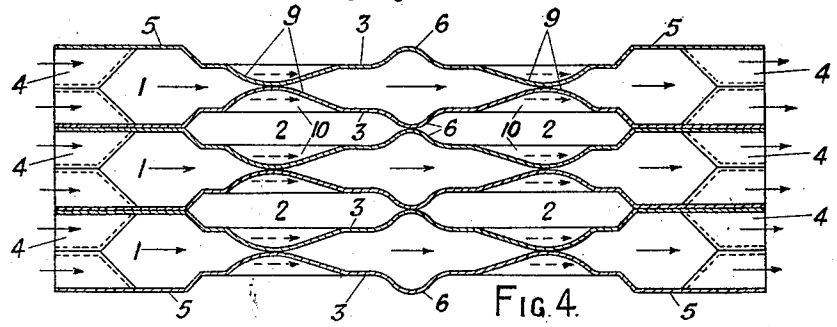


FIG. 4.

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HEAT EXCHANGER

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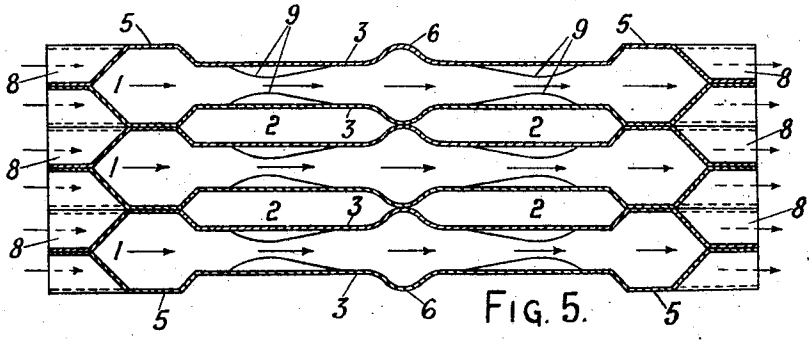


FIG. 5.

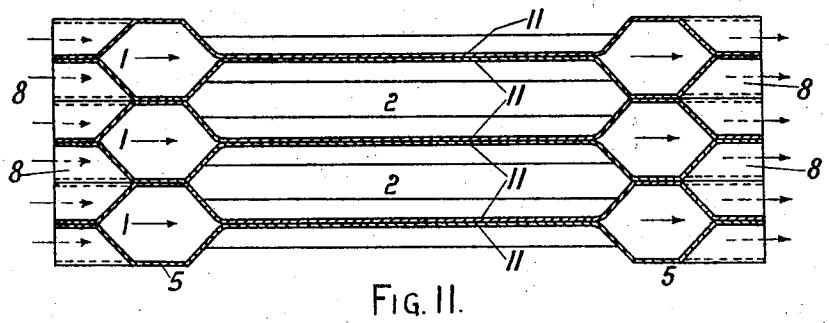


FIG. 11.

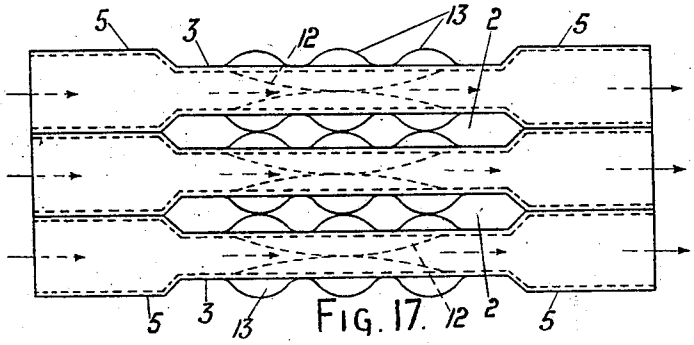


FIG. 17.

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HEAT EXCHANGER

Filed Aug. 18, 1931 5 Sheets-Sheet 4

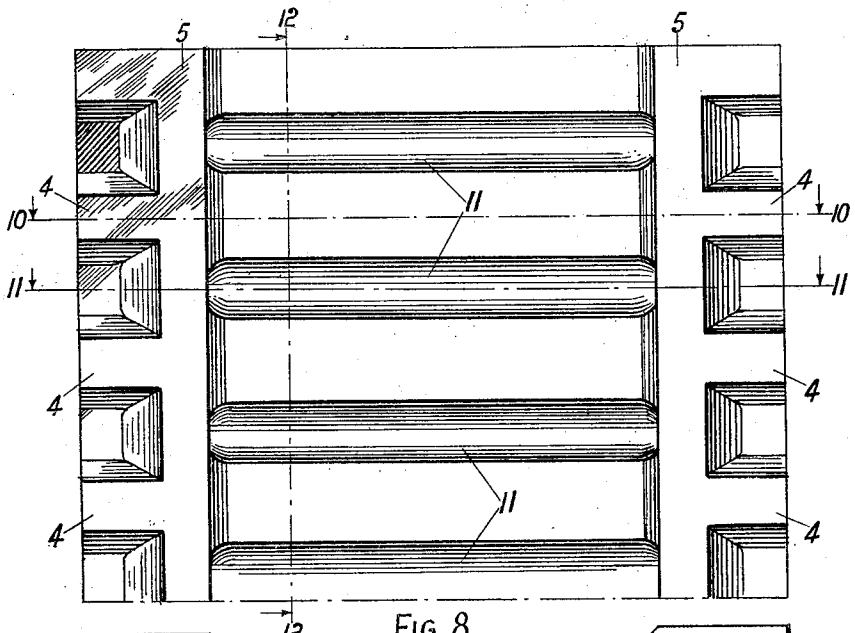


FIG. 8.

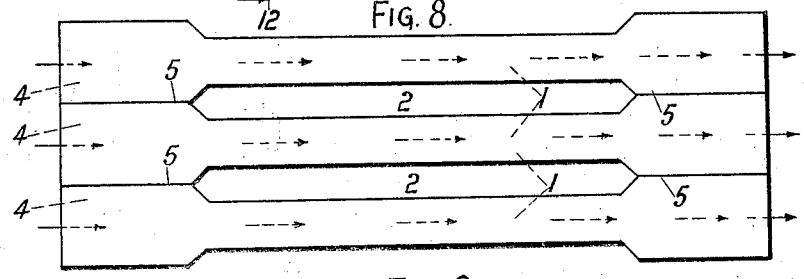


FIG. 9.

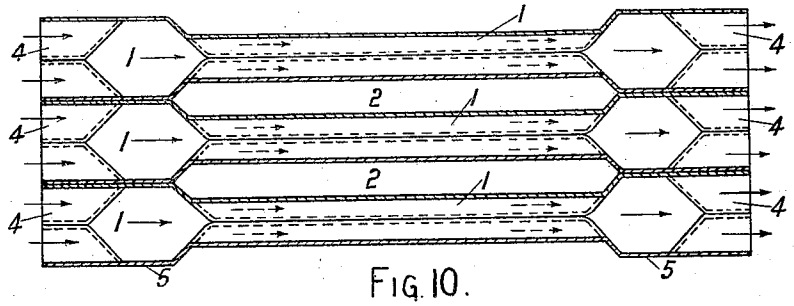


FIG. 10.

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HEAT EXCHANGER

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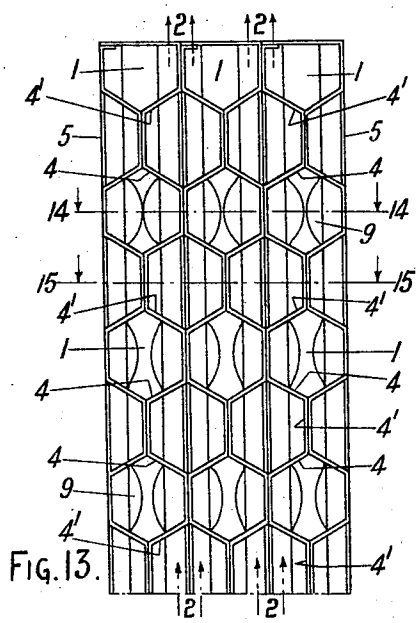


FIG. 13.

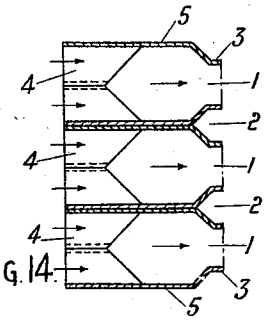


FIG. 14.

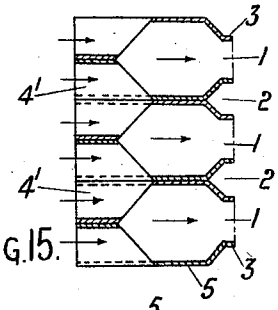


FIG. 15.

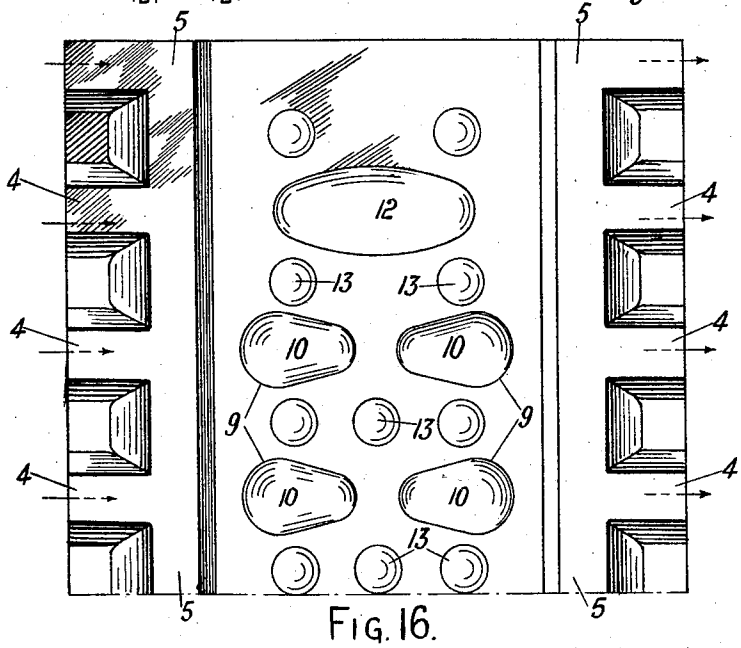


FIG. 16.

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Patented Mar. 21, 1933

1,902,320

UNITED STATES PATENT OFFICE

STUART MELVILL BURTON, OF BURNHAM, ENGLAND

HEAT EXCHANGER

Application filed August 18, 1931, Serial No. 557,819, and in Great Britain August 18, 1930.

This invention relates to improvements in or relating to heat exchangers, for example radiators or liquid coolers particularly applicable to motor vehicles.

For the purpose of the following description, in the interest of brevity, the cool fluid which is heated in its passage through the heat exchanger will be referred to as "air" and the hot fluid which gives up heat to the cool fluid will be referred to as "water", it being understood that the heat exchanger may serve for the exchange of heat between other fluids at different temperatures.

The type of heat exchanger to which the invention relates is built up from a plurality of pairs of metallic sheets, each such pair of sheets constituting a unit presenting an air passage or passages between the sheets, the units being so assembled as to present a waterway between each pair of adjacent units.

In a radiator for a motor vehicle, for example, the sheets are disposed vertically, edgewise to the direction of travel of the vehicle with the air passages extending from the front to the rear.

In constructing a radiator or the like according to the invention the sheets are pressed or rolled so as to form a series of corrugations of semi-hexagonal section along their front and rear edges and immediately adjacent to each such series of corrugations is formed a strip-like elevation extending parallel to the edges from the top to the bottom of the sheet. One or more additional strip-like elevations, depending on the dimensions of the radiator in the direction of the air flow therethrough, similar and parallel to the aforesaid elevations, may be formed at intervals between the front and rear elevations.

One such sheet is applied to the other sheet forming a unit therewith, with the corrugations in register, so that the depressions of the corrugations of each sheet contact with the depressions of the corrugations of the associated sheet, the two sheets being thereby spaced to provide an air passage, the corrugations forming the boundaries of series of nozzles of hexagonal section opening into and discharging from the air passage. When a plurality of such units are assembled, the strip-like elevations on the adjacent sheets of adjacent units are in contact with one another, whereby the adjacent units are spaced apart to afford waterways therebetween, said waterways being closed at the front and rear by brazing or welding or soldering or otherwise interconnecting the units.

The front and rear faces of the radiator each present a plurality of hexagonal cells disposed in staggered relation with the nozzles aforesaid. The inner ends of these cells may be imperforate, or, if desired, in order to reduce the wind-resisting area presented by the radiator, the inner ends of certain or all of the cells may be perforated, in which event the cells form additional air nozzles opening into and discharging from the air passages.

Adjacent to the strip-like elevations there are preferably formed rows of depressions in line with the nozzles, so that the air flowing through the air passages may be diffused therein. There may also be provided in alternating relation with said depressions segmental elevations which project into the water passages so as to break up the water flow therethrough.

In the accompanying drawings Figs. 1—6 illustrate a heat exchanger in the form of a radiator constructed in accordance with the invention, Fig. 1 being a fragmentary front elevation, Fig. 2 a fragmentary side elevation, Fig. 3 a plan view, Fig. 4 a horizontal section on the lines 4—4 of Figs. 1 and 2, Fig. 5 a horizontal section on the lines 5—5 of Figs. 1 and 2, and Fig. 6 a transverse section on the line 6—6 of Fig. 2. Figs 7–12 show a modified construction, Fig. 7 being a fragmentary front elevation, Fig. 8 a fragmentary side elevation, Fig. 9 a plan view, Fig. 10 a horizontal section on the lines 10—10 of Figs. 7 and 8, Fig. 11 a horizontal section on the lines 11—11 of Figs. 7 and 8, and Fig. 12 a transverse section on the line 12—12 of Fig. 8. Figs. 13–15 are views showing a further modification, Fig. 13 being a view corresponding to Fig. 1, Fig. 14 a fragmentary section on the line 14—14 of Fig.

13, and Fig. 15 a fragmentary section on the line 15—15 of Fig. 13. Figs. 16 and 17 are views corresponding to Figs. 2 and 3 showing yet another modification.

Similar parts are denoted by similar reference characters in the several views.

Referring to Figs. 1–6, the radiator construction shown comprises an assembly of units presenting horizontal flow air passages 1 alternating with vertical flow waterways 2, the air passages 1 being afforded within the units, and the waterways 2 being afforded between adjacent units.

Each unit comprises a pair of registering metallic sheets 3 which are pressed or rolled so as to form a series of corrugations of semi-hexagonal section along the parallel longitudinal edges of the sheets. Each sheet is joggled along a line adjacent and parallel to each of said longitudinal edges to afford a strip-portion located in a plane parallel to the plane containing the central or body portion of the sheet, and offset from said last mentioned plane in a direction away from the other sheet of the unit. As will be seen, the depth of the corrugations exceeds the amount of offset of the strip portions 5 from the plane containing the body portion of the sheet. Formed midway of the width of each sheet 3 is a further vertical strip-like elevation 6. In forming a unit one sheet 3 is applied to another sheet 3 with the troughs of the corrugations of the two sheets of the unit in face to face contact, the central portions of the two sheets being thus spaced to provide the air passage 1 between said sheets, the ridges of the corrugations defining nozzles 4 of hexagonal section communicating with the air passage 1. The upper and lower boundaries of the air passage 1 are defined by overlapping and brazing or welding the horizontal upper and lower edges of the sheets as at 7. When a plurality of units are assembled, the offset strip portion 5 of adjacent sheets of adjacent units are in contact with one another whereby adjacent units are spaced apart to afford the waterways 2 therebetween, the waterways 2 being closed at the front and rear by brazing or welding or soldering or otherwise interconnecting the units. The elevations 6, as shown best in Figs. 3–5, extend into the waterways 2 and contact with the corresponding elevations on adjacent sheets of adjacent units along their full length.

It will be evident that, when the units are assembled, the radiator presents at front and rear a plurality of hexagonal cells 8 closed at their inner ends and disposed in staggered relation with the hexagonal nozzles 4, said cells being bounded by the corrugations of adjacent units.

Formed in each sheet 3, so as to be in horizontal alignment with the hexagonal air nozzles 4, are pear-shaped depressions 9 which serve to diffuse the air streams flowing through the air passages, the widest portions of said depressions being presented to the air nozzles. Due to the provision of the depressions 9 shallow pockets 10 are formed in the waterways 2 but these pockets do not act as traps to collect solid material in suspension in the water flowing therethrough. Certain of the depressions 9, say every fourth depression in each vertical row, are made deeper than the intermediate depressions, the deeper depressions contacting with the corresponding depressions in the other sheet of the same unit. The provision of the depressions 9 endows the sheets 3 with the capacity to recover after distortion due to internal strain set up in the waterways 2, the extra deep depressions ensuring that the sheets will recover even though slightly permanently distorted.

In the modified construction shown in Figs. 7–12, the pear-shaped depressions 9 and the elevations 6 shown in Figs. 1–6 are omitted, and there are formed in each sheet 3, intermediate the corrugations defining the air nozzles 4, transverse depressions or ribs 11 extending between the vertical strip-like elevations 5. When one plate is applied to another to form a unit, the depressions or ribs 11 on both plates register and contact along their length.

In the further modification shown in Figs. 13–15, in order to reduce the wind-resisting area presented by the radiator, the inner ends of the cells 8 (Figs. 1–12) are perforated, the cells thus forming additional air nozzles 4′ opening into and discharging from the air passages 1.

Figs. 16 and 17 show a narrow radiator block construction in which there are provided in each sheet 3 between the front and rear strip-like elevations 5 two rows of pear-shaped depressions 9 and at vertically spaced intervals oval shaped depressions 12 of greater length than the pear-shaped depressions 9 and so arranged that the oval shaped depressions 12 in one sheet register and contact with the oval shaped depressions 12 in the other sheet of the same unit. Provided also in each sheet 3 in alternating relation with the depressions 9, 12 are small segmental elevations 13 which, when the units are assembled, project into the water passages 2, the elevations 13 on adjacent sheets of adjacent units registering and engaging with one another within the water passages 2 and serving to stiffen the radiator structure and to break up the water flow.

The elevations 13 may be arranged in any suitable manner and may be provided in any of the other constructions shown.

The construction has many advantages. In the first place the contours of the sheets permit of great expansion of the waterways, which, consequently, can withstand consider-

able internal strains and are practically immune from bursting in the event of freezing of the water. The corrugation of the edges gives additional strength and rigidity to the block. The radiator is considerably lighter and is easier to repair than existing constructions of the same cooling capacity. The arrangement of nozzles opening into elongated passages in which are distributed stream-like protuberances formed by the depressions gives the air a swirling movement.

Although for the purpose of the foregoing description it is assumed that the sheets forming each unit are initially separate, it will be understood that the sheets may be formed by doubling or folding over longer sheets.

I claim:

1. A heat exchanger built up from a plurality of assembled units presenting internal passages for fluid at one temperature alternating with passages for fluid at another temperature between adjacent units, each unit comprising a pair of registering metallic sheets having parallel longitudinal edges, each sheet joggled along a line adjacent and parallel to each of said edges to afford a strip portion located in a plane parallel to the plane containing the central portion of the sheet and offset from said last mentioned plane in the direction away from the other sheet of the unit, each such strip portion being formed at each of said edges with a series of hexagonal corrugations of a depth exceeding the amount of offset of the strip portion from the plane containing the central portion of the sheet, the troughs of the corrugations of the two sheets of the unit being in face to face contact, so that the central portions of the two sheets are spaced apart to afford a passage between said sheets, the ridges of the corrugations defining nozzles communicating with said passage, the offset strip portions on adjacent sheets of adjacent units contacting with one another whereby adjacent units are spaced apart to afford a passage therebetween.

2. A heat exchanger according to claim 1 presenting on the end faces hexagonal cells disposed in staggered relation with the nozzles and bounded by the corrugations of adjacent units when the units are assembled, said cells being perforated at their inner ends.

3. A heat exchanger according to claim 1 in which at least one additional strip-like elevation is formed in each sheet between and parallel with the offset strip portions.

4. A heat exchanger according to claim 1 in which three are formed intermediate the offset strip portions of each sheet depressions and elevations, the depressions projecting into the passage between said sheet and the other sheet of the same unit, and the elevations projecting into the passage between said unit and an adjacent unit.

5. A heat exchanger according to claim 1 in which there is formed in each sheet at least one row of depressions, each in line with a nozzle and in register with a depression in the other sheet of the same unit.

6. A heat exchanger according to claim 1 in which there are formed in each sheet rows of depressions and a row of elevations arranged in alternating relation with the depressions, the elevations contacting with corresponding elevations in the adjacent sheet of an adjacent unit.

In testimony whereof I have signed my name to this specification.

STUART MELVILL BURTON.