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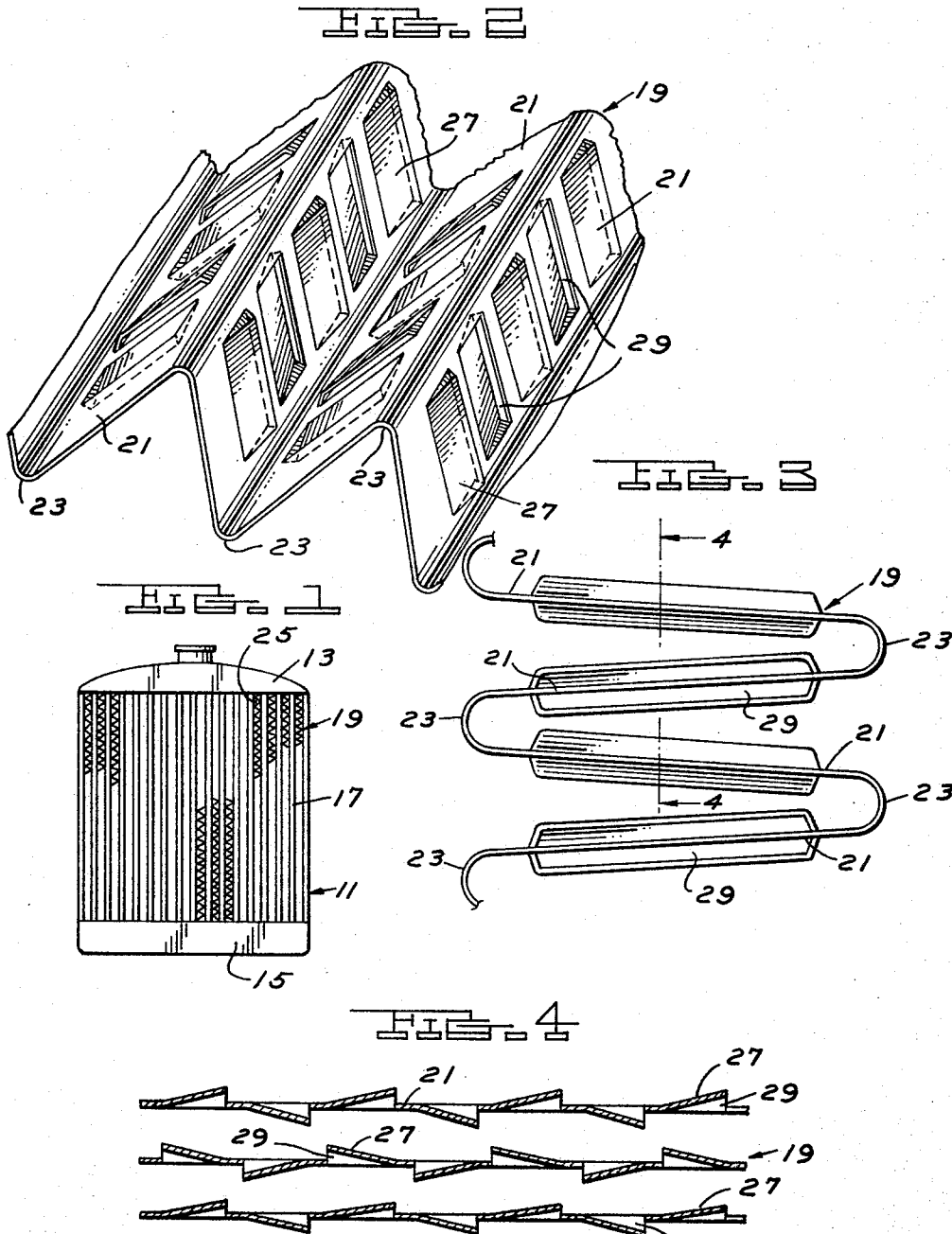
H. A. NICKOL ETAL

3,265,127

HEAT EXCHANGE ELEMENT

Filed Oct. 21, 1963

2 Sheets-Sheet 1



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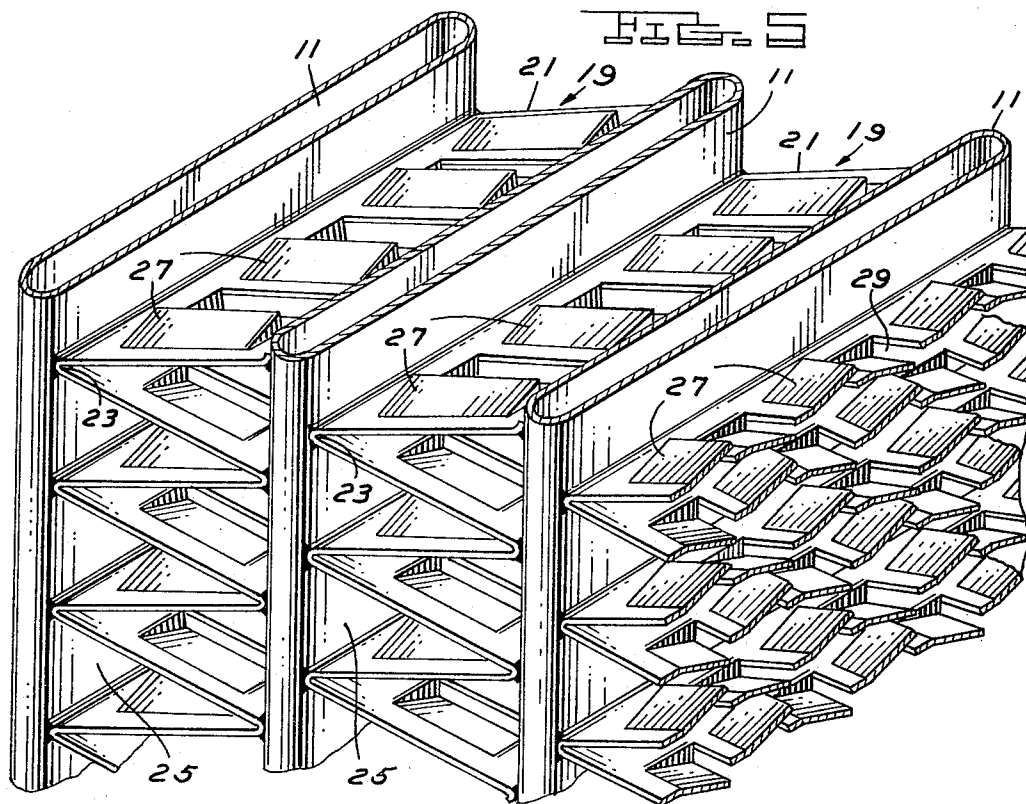
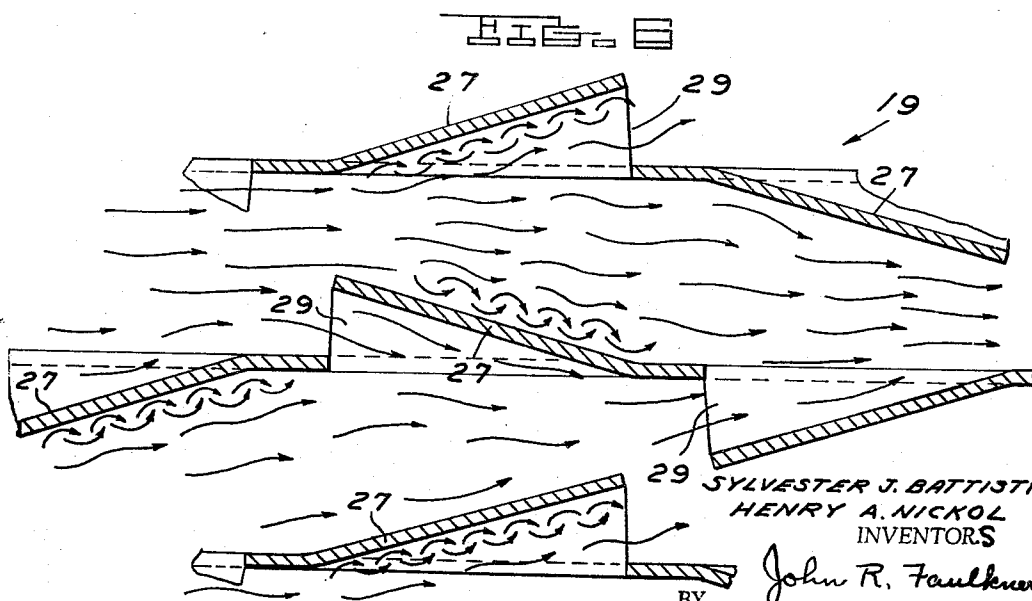
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HEAT EXCHANGE ELEMENT

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7 Claims. (Cl. 165—152)

This invention relates to heat exchange devices and particularly to a novel heat exchange element which forms an integral part of a fin assembly or spacer strip for use in a device wherein heat exchange is effected between fluids, as, for example, in automobile radiators and heaters. More particularly, this invention relates to a louvered heat exchange fin wherein adjacent louvers extend from opposite sides of the otherwise essentially planar body.

For purposes of illustration, the fin of this invention is hereinafter described in relation to its use as a part of the main cooling system of an engine.

Although details of construction may vary, an engine cooling radiator ordinarily includes an inlet tank and an outlet tank for suitable connection with the water jacket of the engine, and a core or heat dissipating unit interposed between the two tanks for the travel of water in thin streams from one tank to the other through a number of spaced passageways or water tubes of suitable heat exchange material. Between each pair of these water conduits flows an air stream to take up or absorb heat carried by the water. A heat exchange and spacer element comprising a thin strip of suitable metal or alloy, e.g., copper, brass, etc., is interposed between the water tubes and folded back and forth so as to divide the air passageway into a multiplicity of air cells of substantially equal dimensions. The portion extending between folds or major corrugations may be referred to as a "heat exchange fin," a "fin proper" or merely a "fin." The material extending between each of two adjacent fins may be referred to as a "connecting member," it being understood that the fin strip is of unitary construction.

It is one object of this invention to provide an improved fin structure for use in a heat exchange device as hereinafter described which will increase the heat absorption of an air stream passing through such device by increasing the turbulence level of the air flow there-through.

It is another object of this invention to provide an improved heat exchange structure wherein adjacent fins each have louvers aligned so as to provide an air passageway therebetween of alternating diverging and converging sections.

Other objects and advantages of this invention will be obvious to those skilled in the art from the following description and the accompanying drawings wherein:

FIGURE 1 is a partially completed front view of an automobile radiator illustrating one use for the fin assembly of this invention;

FIGURE 2 is a perspective view of a portion of a fin assembly or spacer strip constructed in accordance with the present invention;

FIGURE 3 is a front elevational view of the fin structure shown in FIGURE 2;

FIGURE 4 is a semidiagrammatic transverse section

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taken approximately on line 4—4 of FIGURE 3 showing the alignment of alternating louvers in relation to the planar base of the fin of which they form a part and in relation to the corresponding louvers of adjacent fins;

FIGURE 5 is a fragmentary perspective view of a portion of an automobile radiator employing the fin strip of this invention and illustrating the alternation of converging and diverging sections within the air passageways formed by the fin strips and the adjacent water tubes; and

FIGURE 6 is a representative flow diagram illustrating the flow of air through and between adjacent air passageways formed with the fin strip of this invention.

Referring now to the drawings, the radiator assembly, as will be readily understood, includes a heat dissipating unit of core 11 having at opposite ends a top tank or inlet header 13 and a bottom tank or outlet header 15, adapted for connection, respectively, with the discharge and intake conduits of a cylinder block cooling jacket. For the flow of cooling medium from one tank to the other, the core is made up of a number of fluid passageways or water tubes 17 spaced apart by fin strips or heat exchange spacer strips 19. The fin strip shown in the drawing is of folded or corrugated outline providing a series of fins 21 between the folds or connecting members 23. The strips 19 therefore extend between each pair of water tubes 17 and divide the space into a plurality of relatively small air cells, passageways or conduits 25. Ordinarily, the opposite edges or front and rear faces of the core assembly are dipped first in a flux and then in molten solder to set the margins or ends of the walls of the water tubes where necessary and to join the fin strips to the walls.

Attention is now directed to the novel design of the fin proper and specifically to FIGURES 2, 4, 5 and 6 of the drawing. Fin 21 comprises a planar base or body having a plurality of transversely aligned louvers 27 which may be formed by slitting the planar base and turning the metal abutting one major side of the opening out of the base plane. The slits or windows 29 place adjacent passageways in fluid communication with each other and preferably are substantially equidistant from each other, the edge opposite the corresponding louver being substantially perpendicular to the longitudinal axis of the fin proper and substantially parallel to the longitudinal axis of the fin strip. On a given fin, alternate louvers are turned from the base plane in opposite directions. The order of louver alignment on adjacent fins is reversed.

Two adjacent fins form two sides of an air passageway which is completed by one of the water tubes and the connecting element between such fins. This passageway is substantially triangular in cross section with such section taken on or along a line parallel to the longitudinal axis of the fin strip. The alternation of louver alignment on each fin with a reverse alignment on the fin forming the opposing wall of the passageway provides a passageway that is alternately converging and diverging in width. Since this alternation continues with each succeeding fin within the fin strip, a row of passageways are provided wherein the converging sections of a given passageway are in line with the diverging sections of the adjacent passageways. This arrangement provides a maximum number of converging and diverging passageways with any given number of louvers per

fin. This arrangement of louvers stimulates turbulence by wake flow from the converging louver and wall effect of the diverging louver. The alternately constricted and expanded air passages together with the inner communication between such passages provide a high level of turbulence with alternation of positive and negative pressure gradients within each passageway, such alternation being reversed in adjacent passageways.

The term "level of turbulence" as employed herein is interchangeable with "intensity of turbulence" and refers to the root mean square of the instantaneous velocity fluctuation divided by the mean velocity.

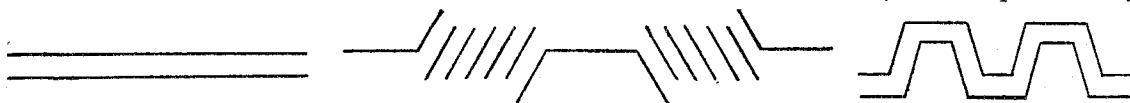
Example

Fins designed in accordance with this invention were tested with a variety of conventional radiator fin designs to evaluate their effectiveness for creating turbulence in an air stream.

The tests were carried out in a low turbulence wind tunnel, i.e., background turbulence of about 0.28% throughout the several tests.

A hot wire anemometer is an instrument by which the velocities in a moving fluid are determined by the cooling effect of the stream on a thin electrically heated element positioned therein. In these tests the sensing element was of platinum and had an average diameter of 0.00015 inch. The anemometer includes a probe to hold the sensing element in the fluid stream, a controlled source for electrically heating the sensing element, precision equipment for measuring D.C. electrical values, e.g., a precision galvanometer or bridge circuit, an amplifier and a recording device for measuring A.C. electrical signals, e.g., an oscilloscope or root mean square meter, and a second air channel for correlation studies. The filament size permits sensitive measurement of fluctuations in the flow pattern. These measurements were electrically recorded. In the first test readings were taken at a number of different depths within the air passageway. This procedure was duplicated as were all other procedures for each succeeding test.

One of the control fins tested employed planar fins without louvers and is hereinafter termed "Fin A." A second control fin employed planar fins with terminal louvers extending outward from one side of the base plane, a center portion supporting louvers turned from the base plane in a direction opposite the terminal louvers and intermediate louvers on either side of the center portion each of which are pivoted from the planar body so that each extended through the base plane to protrude on the two opposite sides thereof. This fin is hereinafter termed "Fin B." A third control fin was a species of the common serpentine or "bump" fin wherein the width of the winding air passageways are essentially constant. This fin is hereinafter termed "Fin C." The control fins provided passageways illustrated by the following profiles:



Fin A

The turbulence intensity provided by the best of the controls was less than one fifth of that provided by the fin of this invention.

From the foregoing it will be evident that the counter-louvered fins of this invention provide a high level of turbulence when interposed in an air stream and thus permit high utilization of the air stream for heat exchange.

We claim:

1. A heat exchange and spacer element for use in a passageway between and in heat exchange relationship with conduits of a heat exchange device, said element comprising a corrugated metal strip having a plurality of slitted fins separated by connecting members and being constructed and arranged to divide said passageway into

a plurality of smaller intercommunicating air passageways of substantially equal dimensions, said fins consisting of a substantially planar base having a plurality of slits therein extending through and in transverse relationship to the longitudinal axis of said fins with each end thereof terminating within said planar base and a plurality of louvers turned out of the base plane adjacent said slits in a manner such that alternate louvers extend from said base plane on opposite sides thereof, the directional alternation of the louvers of each fin being in reverse order with respect to the alternation of the louvers of the fins adjacent thereto thereby providing said air passageways with alternately converging and diverging sections.

2. A heat exchange and spacer element for use in a passageway between and in heat exchange relationship with conduits of a heat exchange device, said element comprising a folded metal strip having a plurality of slitted fins separated by connecting members and being constructed and arranged to divide said passageway into a plurality of smaller intercommunicating air passageways of substantially equal dimensions, said fins consisting of a substantially planar base having a plurality of slits therein extending through and in transverse relationship to the longitudinal axis of said fins with each end thereof terminating within said planar base and a plurality of louvers turned out of the base plane adjacent said slits in a manner such that alternate louvers extend from said fin on opposite sides thereof, the directional alternation of the louvers of each fin being in reverse order with respect to the alternation of the louvers of the fins adjacent thereto thereby providing said air passageways with alternately converging and diverging sections, the alternation of said converging and diverging sections in a given air passageway being in reverse order with respect to the converging and diverging sections of the air passageways adjacent thereto.

3. In a radiator core, a tube separator comprising a strip of metal providing heat exchange surface common to a pair of adjacent tubes and dividing the space therebetween into a plurality of intercommunicating air passageways, said strip of metal comprising a plurality of slitted fins separated by connecting members, said fins consisting of a substantially planar base having a plurality of slits therein extending through and in transverse relationship to the longitudinal axis of said fins with each end thereof terminating within said planar base and a plurality of louvers turned out of the base plane adjacent said slits in a manner such that alternate louvers extend from said fin on opposite sides thereof, the directional alternation of the louvers of each fin being in reverse order with respect to the alternation of the louvers of the fins adjacent thereto thereby providing said air passageways with alternately converging and diverging sections.

4. In a radiator core, a tube separator comprising a

Fin B

Fin C

strip of metal providing heat exchange surface common to a pair of adjacent tubes and dividing the space therebetween into a plurality of intercommunicating air passageways, said strip of metal comprising a plurality of slitted fins separated by connecting members, said fins consisting of a substantially planar base having a plurality of slits therein extending through and in transverse relationship to the longitudinal axis of said fins with each end thereof terminating within said planar base and a plurality of louvers turned out of the base plane adjacent said slits in a manner such that alternate louvers extend from said fin on opposite sides thereof, the directional alternation of the louvers of each fin being in reverse order with respect to the alternation of the louvers of the

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5 fins adjacent thereto thereby providing said air passageways with alternately converging and diverging sections, the alternation of said converging and diverging sections in a given air passageway being in reverse order with respect to the converging and diverging sections of the air passageways adjacent thereto.

5. In an automobile heater core, a tube separator comprising a strip of metal providing heat exchange surface common to a pair of adjacent tubes and dividing the space therebetween into a plurality of intercommunicating air passageways, said strip of metal comprising a plurality of slitted fins separated by connecting members, said fins consisting of a substantially planar base having a plurality of slits therein extending through and in transverse relationship to the longitudinal axis of said fins with each end thereof terminating within said planar base and a plurality of louvers turned out of the base plane adjacent said slits in a manner such that alternate louvers extend from said fin on opposite sides thereof, the directional alternation of the louvers of each fin being in reverse order with respect to the alternation of the louvers of the fins adjacent thereto thereby providing said air passageways with alternately converging and diverging sections.

6. In an automobile heater core, a tube separator comprising a strip of metal providing heat exchange surface common to a pair of adjacent tubes and dividing the space therebetween into a plurality of intercommunicating air passageways, said strip of metal comprising a plurality of slitted fins separated by connecting members, said fins consisting of a substantially planar base having a plurality of slits therein extending through and in transverse relationship to the longitudinal axis of said fins with each end thereof terminating within said planar base and from which a plurality of louvers turned out of the base plane adjacent said slits in a manner such that alternate louvers extend from said fin on opposite sides thereof, the directional alternation of the louvers of each fin being in reverse order with respect to the alternation of the louvers of the fins adjacent thereto thereby providing said air passageways with alternately converging and diverging sections, the alternation of said converging and diverging sections in a given air passageway being in reverse order with respect to the converging and diverging sections of the air passageways adjacent thereto.

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7. A heat exchange and spacer element for use in a passageway between and in heat exchange relationship with conduits of a heat exchange device, said element comprising a corrugated metal strip having a plurality of slitted fins separated by connecting members and being constructed and arranged to divide said passageway into a plurality of smaller intercommunicating air passageways of substantially equal dimensions, each of said fins consisting of a substantially planar base having a plurality of slits therein extending through and in transverse relationship to the longitudinal axis of said fins with each end thereof terminating within said planar base and a single louver associated with each of said slits, each of said louvers being integral with said planar base, describing one side of the slit with which it is associated, and turned out of the base plane of said planar base in a manner such that alternate louvers of a given fin extend from said base plane on opposite sides thereof, the directional alternation of the louvers of each fin being in reverse order with respect to the alternation of the louvers of the fins adjacent thereto thereby providing said intercommunicating air passageways with alternately converging and diverging sections throughout the entire length of said passageway.

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