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(71) Applicant : **BLACKSTONE SWEDEN AB**
Mjällby
S-294 02 Sölvesborg (SE)

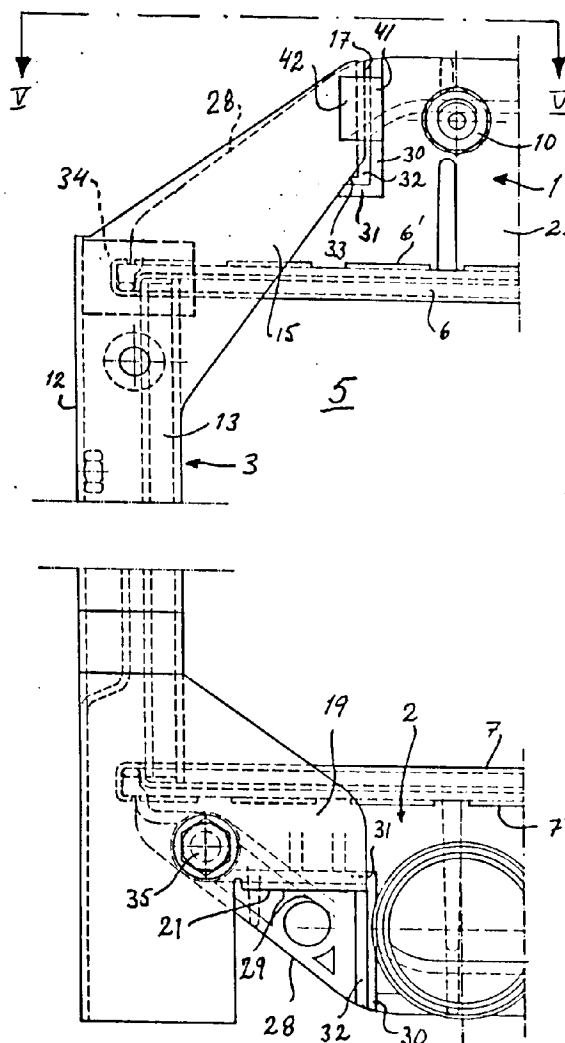
(72) Inventor : **Petersson, Lars**
Elvsbergsvägen 15
S-374 41 Karlshamn (SE)

(74) Representative : **Säfwenberg, Björn et al**
Axel Ehner's Patentbyrå AB Box 10316
S-100 55 Stockholm (SE)

(54) **Radiator for an internal combustion engine.**

(57) A radiator for an internal combustion engine includes upper and lower header boxes (1, 2), each having first and second ends, and side members (3, 4), each having first and second ends adapted to be connected to a respective one of said first and second ends of said header boxes to form a radiator frame enclosing a cooling block (5). A first box (1) has first engagement means (32) at each of its first and second end. Each of the side members (3, 4) has second engagement means (17, 18) at its first end for releasable engagement with the first engagement means (32) of the first header box. Resilient means (34) is interposed between said cooling block (5) and the side members (3, 4) at their first ends. The first engagement means (32) and the second engagement means (17, 18) are adapted, when mutually engaged, to allow displacement of the first ends of the side members (3, 4) substantially perpendicularly to the longitudinal direction of the first header box (1) and to prevent displacement in other directions. A second header box (2) has first guide means (33) at each of its first and second ends and each of the side members (3, 4) has second guide means (21, 22) at its second end. The first (33) and second (21, 22) guide means are adapted, when mutually releasably engaged, to allow displacement of the second ends of the side members (3, 4) substantially in the longitudinal direction of the second header box (2) and to prevent displacement in other directions. The resilient means (34) are compressed between the first ends of the side members and the cooler block (5) upon displacement of the second ends of the side members (3, 4) towards each other.

FIG. 3



The present invention concerns a radiator for an internal combustion engine, and more particularly for an internal combustion engine of a heavy vehicle, including upper and lower header boxes, each having first and second ends, and side members, each having first and second ends adapted to be connected to a respective one of said first and second ends of said header boxes to form therewith a relatively rigid frame, and, enclosed within said frame, a cooling block including a plurality of tubes communicating with their respective ends with said upper and lower header boxes for directing a flow of cooling fluid therebetween, a first of said header boxes having first engagement means at each of said first and second ends thereof, each of said side members having second engagement means at said first end thereof for releasable engagement with said first engagement means of said first header box.

A radiator of this general kind is disclosed in EP-A1-0 346 602. In order to provide a stable connection between the side members and the header boxes of this known radiator, without the need of time-consuming and expensive mounting work, a first header box of this known radiator is connected to a first end of a side member by hinge-like engagement means and snap-action engagement means, and the second header box is connected to the second end of the side member by a snap-action locking device. Still, this radiator utilizes a separate wedge introduced between the side member at its second end and the header box after locking of the locking device. Further, the header boxes are provided with several protrusions and the side members with corresponding recesses which inter-engage in the assembled position of the radiator.

As is well known in the art of internal combustion engine radiators such radiators are exposed to thermal stresses due to widely varying internal temperatures during operation of the engine, e.g., from far below the freezing point up to the boiling point of water, as well as temperature differentials between the radiator and the environment. Radiators are also exposed to stresses caused by vibrations due to engine running and vehicle driving.

Temperature variations cause longitudinal expansion and contraction of the cooling fluid tubes leading to stresses in the connections between the header boxes and the lateral members.

Different solutions of this thermal stress problem are disclosed in US-A-4 540 044, US-A-4 738 306, EP-B-0 020 190 and FR-A-2 538 030.

US-A-4 540 044 proposes a solution of this problem by providing oblong holes for pins connecting the header boxes and the lateral members, said holes having their maximum transverse dimension extending in the longitudinal direction of the tubes, thereby to accommodate relative movements between the header boxes and the lateral members.

FR-A-2 538 030 proposes another solution of the same problem by providing the tube plates of the header boxes with deformable portions such that said portions, where the tubes are fastened to the tube plates, may move without transferring movement to the header boxes, and, thus, without affecting the distance between the header boxes defined by the lateral members rigidly connected thereto. Also, resilient means are provided between the lateral members and outer mounting members extending in the longitudinal direction of the lateral members. Threaded bars extend between the outer mounting members to exert a pulling force therebetween, thereby to keep the radiator package together. Also, the outer mounting members are secured to the header boxes by means of screws extending through holes provided in the mounting members and the header boxes.

EP-B-0 020 190 proposes a solution of the vibrational stress problem by completely enclosing the assembled radiator in a multi-piece frame or cradle. Resilient means are interposed in the corners between the radiator and the frame such that the resilient means are tensioned and keep the radiator under permanent compression. The complete radiator package is kept together by means of bolts and spot welds.

US-A-4 738 308 discloses an arrangement allowing compensation of differential dilatations which can occur between the cooling fluid tubes and the lateral members, or, flanges, due to different temperatures. The lateral members are generally C-shaped sections having a bottom, lateral sides and inwardly bent wings, the latter being engaged in notches provided in fins in which the tubes are engaged. Assembly of the header boxes and the side members of this prior art radiator includes plastic deformation, i.e., bending, of lugs provided on the lateral members.

All the four prior art structures last referred to above employ some kind of more or less permanent fastening or securing means to attach the side members to the header boxes, such as pins, threaded bars, welds and bent lugs, all increasing the manufacturing costs due to material and labour required.

The problem to be solved by the present invention is to provide a radiator of the kind initially stated, and particularly a connection between a side member and the header boxes of such a radiator, which - as taught by EP-A1-0 346 602 - widely avoids the use of fastening means, such as bolts or pins, or post-assembly treatment, such as welding or soldering, for obtaining a secure and releasable connection still allowing expansion and contraction of the radiator package due to heat variations. Preferably, the use of fastening means shall be completely avoided. In solving this problem, there shall be no need of separate mounting means, such as the wedge according to EP-A1-0 346 602, and the solution shall provide compensation for manufacturing tolerances and reduce vibration trans-

mission between the side member and the header box.

According to the present invention, a radiator as initially stated is characterized in that said first engagement means and said second engagement means are adapted, when mutually engaged, to allow displacement of said first ends of said side members substantially perpendicularly to the longitudinal direction of said first header box and to prevent displacement in other directions, that a second of said header boxes has first guide means at each of its first and second ends, that each of said side members has second guide means at its second end, said first and second guide means being adapted, when mutually releasably engaged, to allow displacement of said second ends of said side members substantially in the longitudinal direction of said second header box and to prevent displacement in other directions, and that resilient means is interposed between said cooling block and said side members at said first end thereof, said resilient means being compressed between said first ends of said side members and said cooler block upon displacement of said second ends of said side members towards each other along said first guide means.

Embodiments of the present invention will now be described, reference being made to the accompanying drawings, wherein:

Fig. 1 is a front view of an assembled radiator the cooling block of which being omitted;

Fig. 2 is a side view of the radiator of fig. 1;

Fig. 3 is a partial front view at an enlarged scale of the radiator of Fig. 1 showing the top left and bottom left corners thereof;

Fig. 4 is a side view corresponding to that of Fig. 2 at an enlarged scale showing the radiator corners seen from the left in Fig. 3;

Fig. 5 is a top view seen along line V-V of Fig. 3;

Fig. 6 is a section taken along line VI-VI of Fig. 7 through the lower header box shown therein and a side member mounted thereto but not shown in Fig. 7;

Fig. 7 is a front view of the left end portion of the lower header box;

Fig. 8 is a bottom view of the left end portion of the lower header box according to a second embodiment of the present invention;

Fig. 9 is a front view of the header box of Fig. 8;

Fig. 10 is a section taken along line X-X of Fig. 9;

Fig. 11 is a side view of the lower portion of a side member according to the second embodiment of the invention;

Fig. 12 a, b and c are front views of the left hand side of a radiator according to the present invention showing three steps of the assembly of a side member and the header boxes.

The assembled outer structure of the radiator shown in the drawings includes two equally shaped

header boxes, an upper header box 1 having in its mounted position an inverted U-shaped section (Fig. 4, upper part) and a lower header box 2 having a U-shaped section (Fig. 4, lower part), and two equally shaped side members, a first side member 3 and a second side member 4, the header boxes and the side members forming in their mounted position according to Fig. 1 a relatively rigid frame. Enclosed in this frame is a cooling block 5 (not shown in detail), conventionally having a plurality of vertically extending tubes, the upper and lower ends of which being fluid tightly engaged in a respective one of upper and lower tube plates 6 and 7. Tube plates 6 and 7 have lugs 6', 7', respectively, folded around circumferential rims 1', 2' of the header boxes, thereby closing the respective open U-section of the upper and lower header boxes 1 and 2 so as to form in each header box a fluid chamber. Thus, in operation, a cooling fluid introduced through an upper header box inlet 8, communicating with an internal combustion engine not shown, is distributed within the interior of the upper header box and directed downwards through the plurality of tubes to be collected in the lower header box and returned to the engine through an outlet 9.

As mentioned, the header boxes are equally shaped, preferably being molded from a thermoplastic synthetic material in one and the same mould, and, thus, in their mounted positions, one header box is turned upside down and rotated 180° relative to the other header box. Consequently, the inlet 8 of the upper header box and the outlet 9 of the lower header box are corresponding portions of the respective header box located near one end thereof. Near the other end of the respective header box is formed a threaded hole in which is fitted a nipple 10 in the upper header box for ventilating the radiator system, and, in the lower header box a plug 11.

Since side members 3 and 4 are equally shaped, as are header boxes 1 and 2, only side member 3 and the left hand end portions of the header boxes according to Fig. 1 will be described more in detail.

Side member 3 has a generally U-shaped section comprising a web portion 12 and two flange portions 13, 14, the U-section being open towards the non-shown cooling block. At the upper end of side member 3 the flange portions 13, 14 are obliquely extended lengthwise beyond the web portion 12 and inwardly towards the vertical centre of the radiator to form wings 15, 16 terminating in vertical lugs 17, 18, respectively, bent 90° relative to the respective wing 15, 16 (Fig. 5). At the lower end of side member 3 the flange portions 13, 14 extend inwardly to form wings 19, 20, respectively, horizontal lower edges of which are bent 90° towards each other to form horizontal lugs 21, 22, respectively (Fig. 6).

The U-shaped sections of the header boxes have substantially parallel outer side walls 23, 24 terminating in the above-mentioned circumferential rims 1', 2',

and, respectively, a flat outer top and bottom wall 25 having lengthwise and crosswise extending integral reinforcement ribs 26, 27. The ends of the U-shaped sections are closed by inclined walls 28 the inclination of which substantially corresponds to the inclination of the upper wings 15, 16. Between thickened portions 29 of the side walls and vertically and horizontally extending ribs 30, 31, respectively, are formed vertical and horizontal grooves or slots 32, 33. The vertical slots 32 are dimensioned to receive the vertical lugs 17, 18 and the horizontal slots 33 to receive the horizontal lugs 21, 22 of the upper and lower wings, respectively, of the side member.

When mounting a side member 3 to the upper and lower header boxes the lugs 17, 18 are first introduced from above into the vertical slots 32 (Fig. 12a). During this operation, the lower end of the side member must be kept somewhat outside the left end of the lower header box 2 in order to keep the horizontal lugs 21, 22 free from said end. Consequently, the vertical slots 32 must be made wider than the thickness of the vertical lugs 17, 18 in order to enable such inclination of side member 3. When upper end of side member 3 has been lowered to the position shown in Fig. 12b, lower end thereof is moved to the right (Fig. 12c), the horizontal lugs 21, 22 being guided along the horizontal slots 33.

According to the present invention there is provided at least one resilient means between each side member and the cooling block 5. In the embodiment of Figs. 1 - 7, a resilient element 34 is inserted between the upper portion of each side member 3, 4 and the respective end of the upper header box 1. The position of such resilient element 34 is shown in Fig. 3. Preferably, element 34 is U-shaped in a vertical cross-section (Fig. 12a) so as to grip around an end portion of header box 1, or, header plate 6 and its lugs 6' folded around the circumferential rim 1' of the header box, thereby to be kept in place during the assembly. It is preferred, also, that element 34 has a U-shaped horizontal cross-section (Fig. 5), thereby to grip around the corners of the rim of the header box.

The dimension of the resilient element 34 is such that it is compressed between the side member and the header box during assembly, starting approximately in the position of Fig. 12b and increasing towards full compression in the position of Fig. 12c. Both ends of side member 3, thus, will be urged outwardly by element 34, movement of the upper end of side member, however, being positively prevented by the engagement of the vertical lugs 17, 18 in the vertical slots 32 of the upper header box. In the embodiment of Figs. 1 - 7 the lower end of side member 3 is blocked against movement due to expansion of resilient element 34 by means of a conventional bolt 35 inserted in corresponding holes through side member 3 and lower header box 2, such hole 36 through lower header box being shown in Fig. 7.

The second embodiment of the present invention according to Figs. 8 - 12 differs from the first embodiment according to Figs. 1 - 7 only regarding retainment of the lower ends of the side members to the ends of the lower header box 2. According to the second embodiment, thus, the lower ends of side members and the ends of the lower header box are provided with interengaging means to establish a snap-action locking connection between the side member and the header box.

More precisely, the side walls 23, 24 of the header boxes are formed with integral engagement means 37 having a T-shaped configuration when viewed in Fig. 9 including an inclined cam surface portion 38 (Fig. 8) and an abutment portion 39 perpendicular thereto and also perpendicular to the respective side wall of the header box. The lower wings 19, 20 of the side members are provided with T-shaped openings 40 (Fig. 11) adapted to receive the abutment portion 39 and a portion of the cam surface portion 38. When, during assembly of the radiator, the lower end of side member 3 is to be connected to the left end of header box 2 (Fig. 12b), the wings 19, 20 are resiliently flexed outwards by the inclined cam surface portion 38 until the T-shaped opening 40 snaps over the abutment portion 39 and the portion of the cam surface portion closest thereto (Fig. 12c). In this position the lower end of side member 3 is positively kept in its intended position by inter-engagement between the abutment portion 39 and the corresponding portion of T-shaped opening 40.

In order to make this second embodiment connection between the lower end of the side member and the header box more stable, it is preferred to interpose a resilient element 34' corresponding to the element 34 therebetween also at this end as is shown particularly in Fig. 12a.

To prevent the upper wings 15, 16 of the side member to possibly be forced apart due to the load exerted on the lugs 17, 18 by the resilient element 34 compressed between the web portion 12 of the side member and the header box portions of the vertically extending ribs 30 are provided with L-shaped outward extensions 41 (Figs. 3, 5, 7) having legs 42 directed towards the side member so as to extend over portions of the wings 15, 16.

Claims

1. A radiator for an internal combustion engine, and more particularly for an internal combustion engine of a heavy vehicle, including upper and lower header boxes (1, 2), each having first and second ends, and side members (3, 4), each having first and second ends adapted to be connected to a respective one of said first and second ends of said header boxes to form therewith a

relatively rigid frame, and, enclosed within said frame, a cooling block (5) including a plurality of tubes communicating with their respective ends with said upper and lower header boxes (1, 2) for directing a flow of cooling fluid therebetween, a first of said header boxes (1) having first engagement means (32) at each of said first and second ends thereof, each of said side members (3, 4) having second engagement means (17, 18) at said first end thereof for releasable engagement with said first engagement means (32) of said first header box, **characterized in**

- that said first engagement means (32) and said second engagement means (17, 18) are adapted, when mutually engaged, to allow displacement of said first ends of said side members (3, 4) substantially perpendicularly to the longitudinal direction of said first header box (1) and to prevent displacement in other directions,
- that a second of said header boxes (2) has first guide means (33) at each of its first and second ends,
- that each of said side members (3, 4) has second guide means (21, 22) at its second end,

said first (33) and second (21, 22) guide means being adapted, when mutually releasably engaged, to allow displacement of said second ends of said side members (3, 4) substantially in the longitudinal direction of said second header box (2) and to prevent displacement in other directions, and

- that resilient means (34) is interposed between said cooling block (5) and said side members (3, 4) at said first end thereof, said resilient means (34) being compressed between said first ends of said side members and said cooler block (5) upon displacement of said second ends of said side members (3, 4) towards each other along said first guide means (33).

2. A radiator according to claim 1, **characterized in** that said first engagement means comprise slots (32) in said first header box (1), said slots being directed substantially perpendicularly to the longitudinal direction of said first header box (1), and that said second engagement means comprises lugs (17, 18) on said side members (3, 4), said lugs being directed towards each other for engagement in said slots (32) of said first header box (1).
3. A radiator according to claim 1 or 2, **characterized in** that said first guide means comprise slots (33) in said second header box (2), said slots being directed substantially in the longitudinal direction of said second header box (2), and that

said second guide means comprise lugs (21, 22) on said side members (3, 4), said lugs being directed towards each other for slidable engagement in said slots (33) of said second header box (2).

4. A radiator according to claim 1 or 2, **characterized by** a connecting means (35) extending through each of said second ends of said side members (3, 4) and a respective one of said first and second ends of said second header box (2).
5. A radiator according to any one of claims 1 - 4, **characterized by** inter-acting connecting means (37, 40) on each of said second ends of said side members (3, 4) and each of said first and second ends of said second header box, said inter-acting connecting means being adapted to automatically inter-lock each of said second ends of said side members to a respective one of said first and second ends of said second header box upon compression of said resilient means (34).
6. A radiator according to claim 5, **characterized in** that said inter-acting connecting means include fixed means (37) on said second header box (2) and flexible means (19, 40) on said side members providing a snap-action releasable locking.
7. A radiator according to claim 5 or 7, **characterized in** that a second resilient means (34') is interposed between each of said second ends of said side members and a respective one of said first and second ends of said second header box (2).
8. A radiator according to any one of the preceding claims, **characterized in** that said first and said second header boxes (1, 2) are substantially identically shaped.

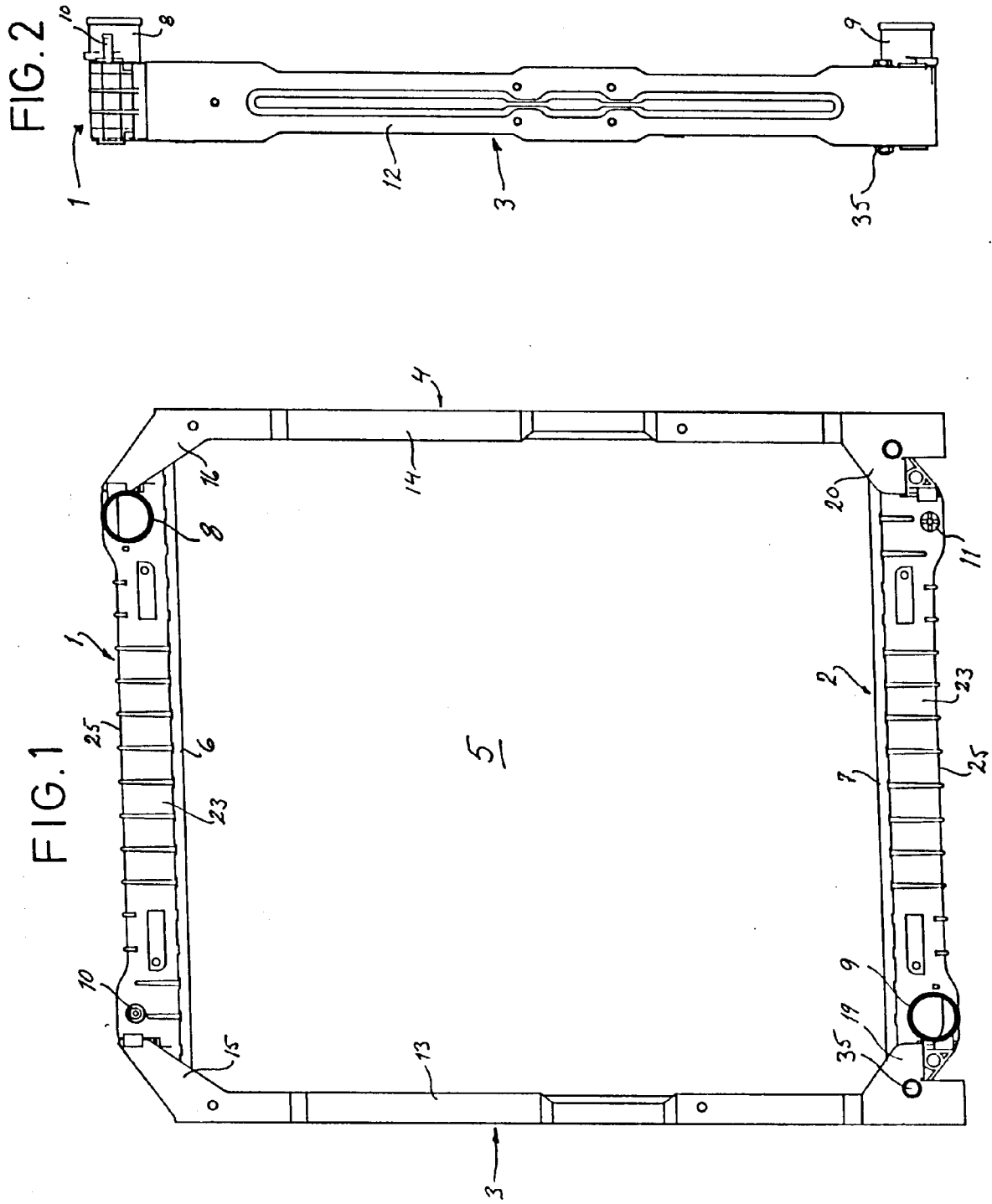


FIG. 3

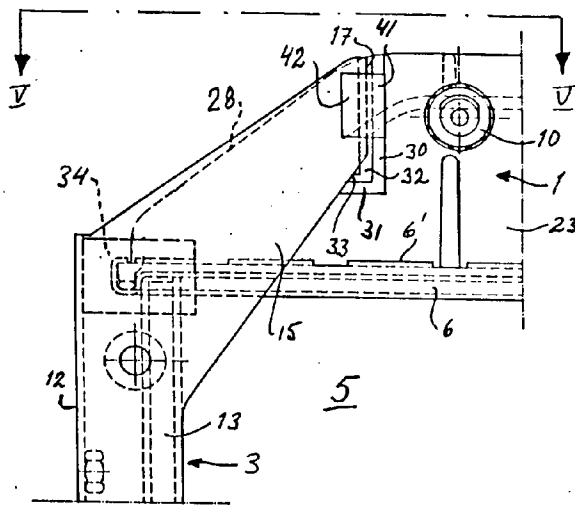


FIG. 4

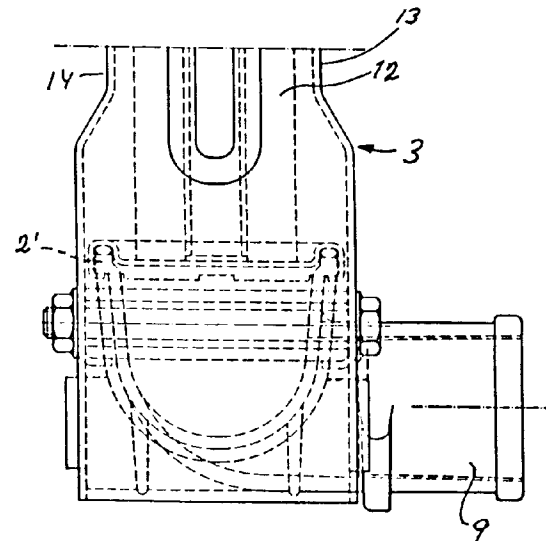
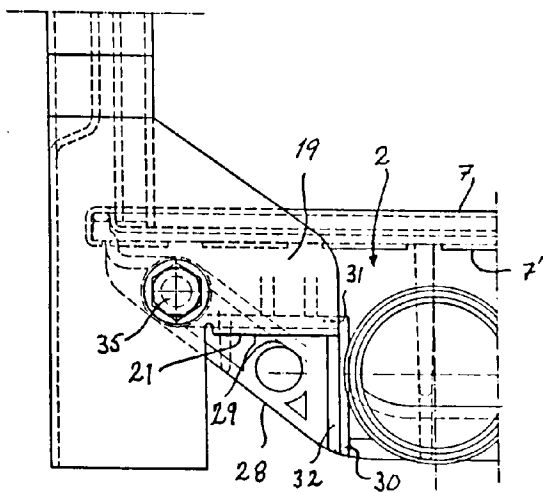
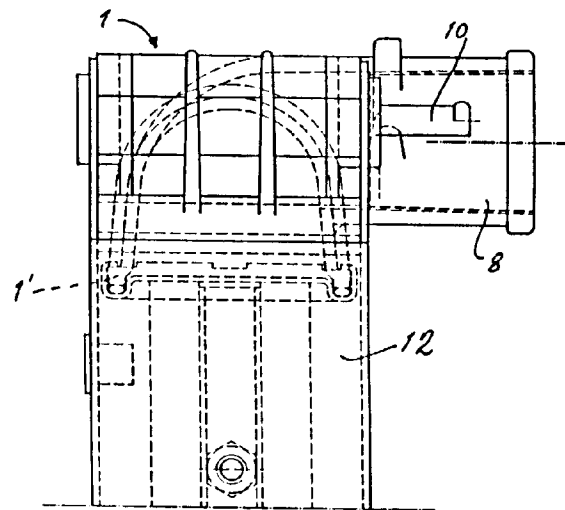


FIG. 5

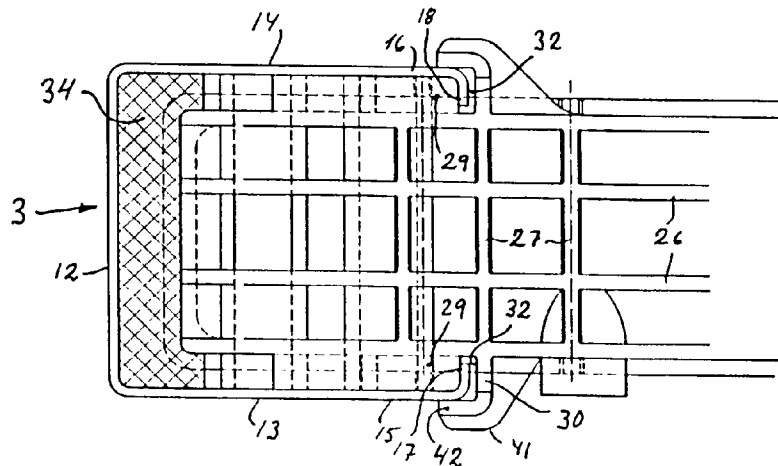


FIG. 6

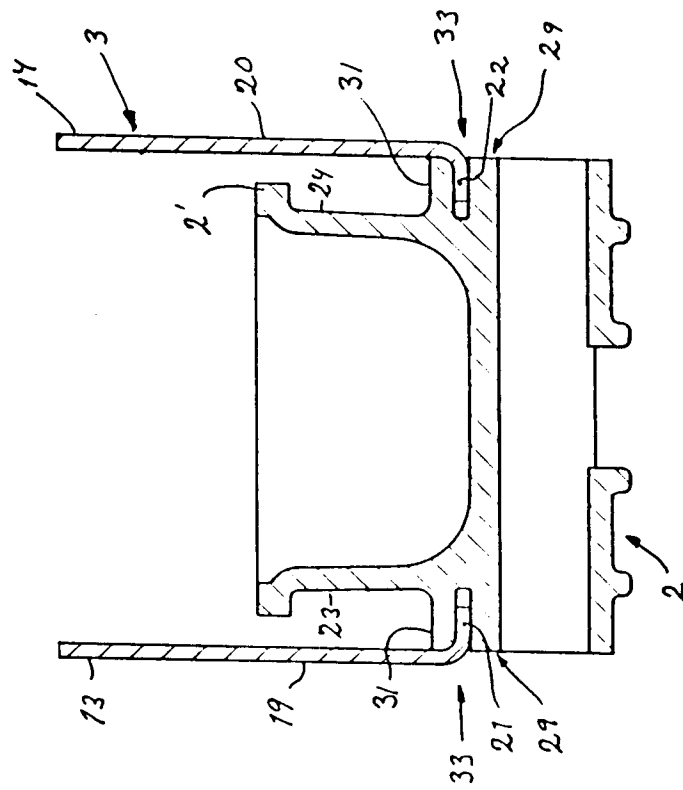
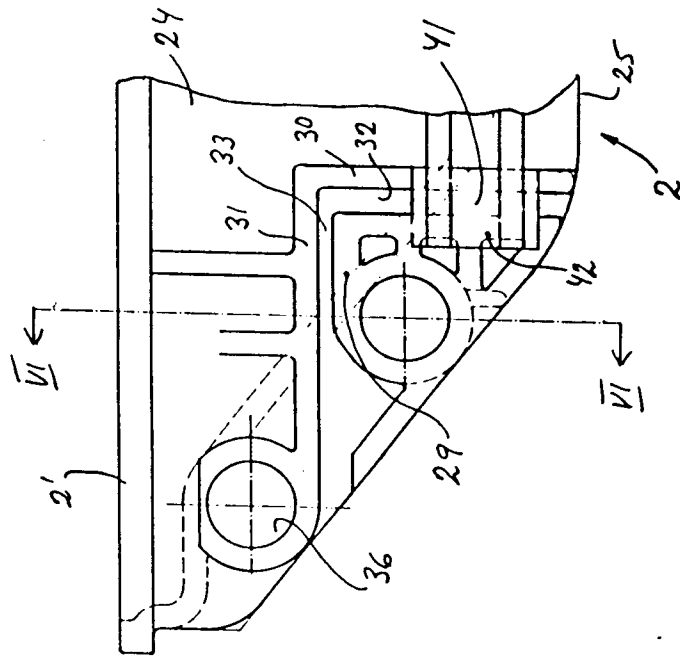


FIG. 7



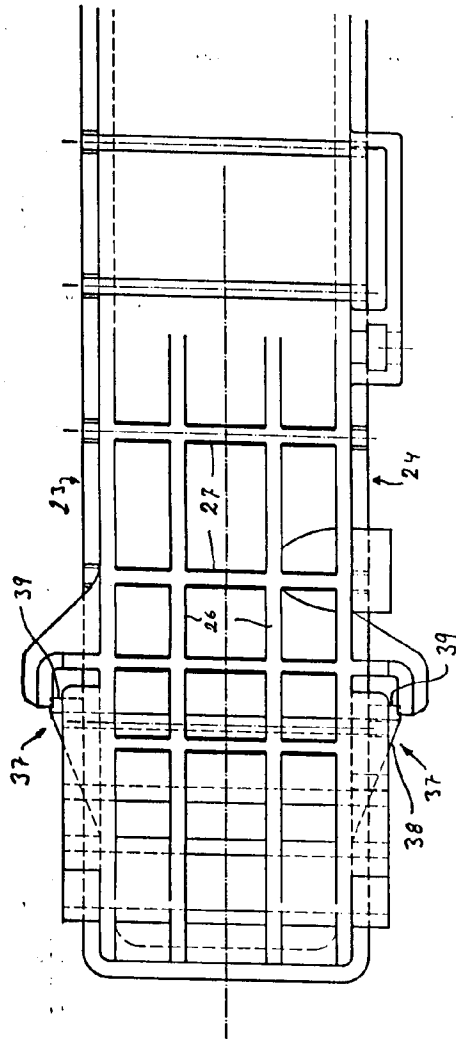


Fig. 8

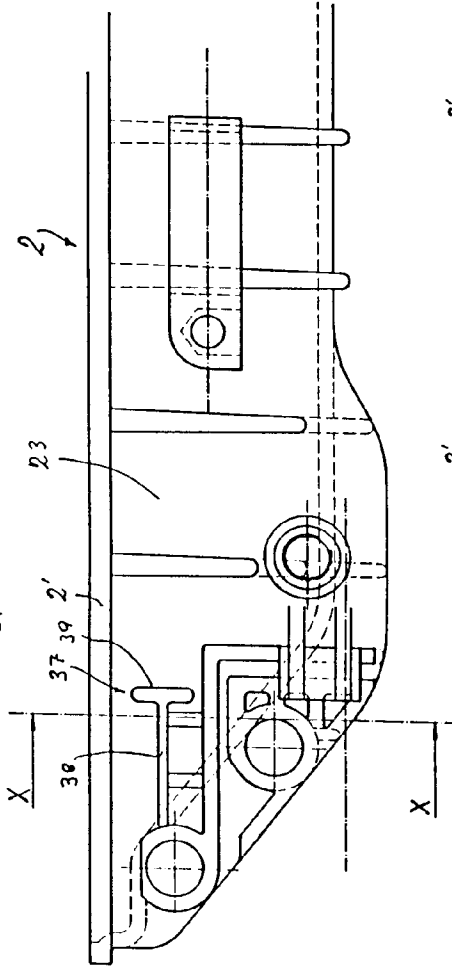


Fig. 9

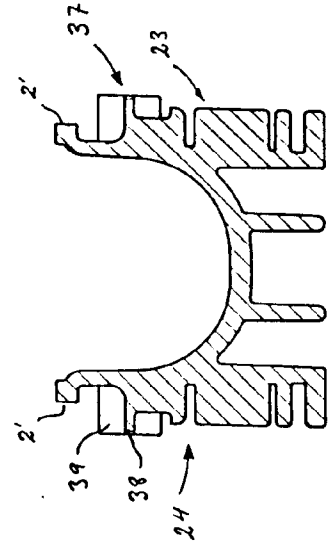


Fig. 10

Fig. 11

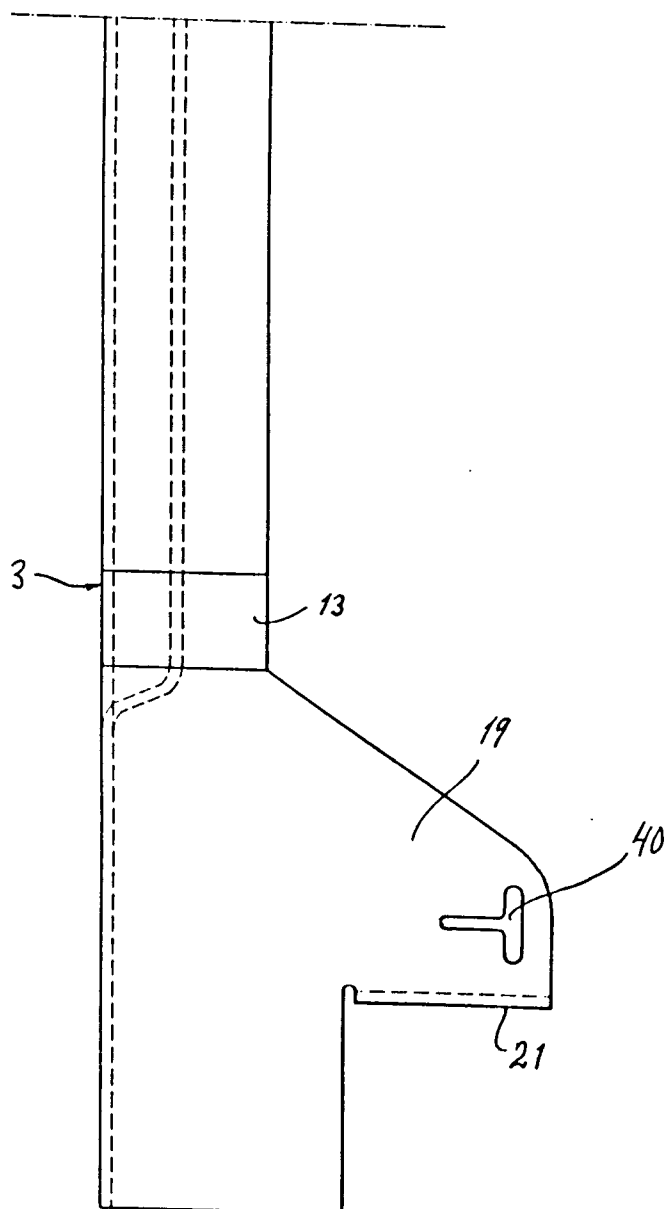


Fig. 12

