TIB #07

Design Criteria for Tubular Radiator Cores

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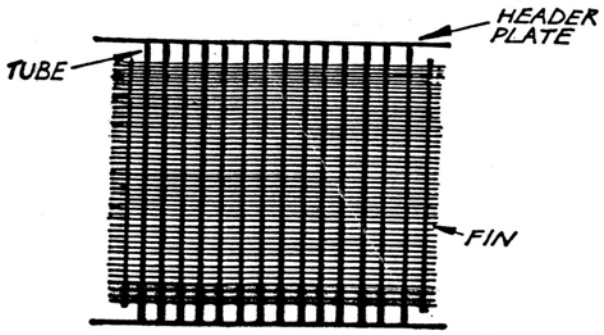
The principal purpose of tubular radiator cores is to exchange waste heat from an engine to the air passing through the core. Details of thermal operation are covered in our previous Technical Information Bulletins.

1. **There are five basic components of the core**

   (a) Tube
   (b) Fin
   (c) Header Plate (Tube Plate)
   (d) Solder
   (e) Gaskets



2. **Functions**

   (a) Tube (Primary Surface)
   To carry coolant, and providing there is a temperature differential, dissipate heat from the coolant to the tube's inner wall, hence through the wall of the tube.

   (b) Fin (Secondary Surface)
   (i) to collect heat from tube outer wall and dissipate to the passing air mass
   (ii) to support the tube during operation.

   (c) Header Plate
   To provide water-tight joint to accompanying manifold or tank.

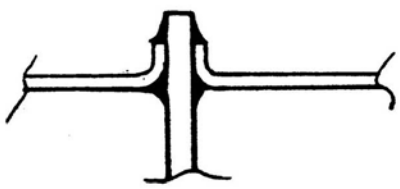
   (d) Solder
   The material used to :-
   (i) join the fin to the tube
   (ii) join the tube to the header plate

It should be clearly noted that the function of solder is to bond the two joints together. **The workable explanation would be that bonding in a soldering or brazing application is effected by the formation of an alloy layer between the bonding and the base metal**. This should form initially with the flow of material at the right temperature and will increase slightly depending on time and temperature.

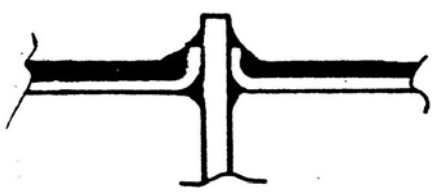
Bonding can occur with little or no alloy, which means the molten lead may wet and adhere to the brass, but not necessarily form an alloy.

Therefore, the purpose of solder is to join the materials and the addition of any extra solder is a waste of time and money.

Required



Not Required



(e) Gaskets

Gasket Material

(i) Paper or oil jointing may be used with cement on machined surfaces, ie: aluminium tanks, but is not suitable for steel tank bolt on radiators.

(ii) E.P.D.M. is inert to most inhibitors used today and provides adequate compressibility with a leak free joint. Therefore, it should be used on bolt on radiators (water). Gaskets are used without any cement, thus decreasing time between final assembly and tenting. (Maximum temperature 125°C or 250°F).

(iii) Charge air to air (intercooling) - high temperature "Klinger" gasket material.

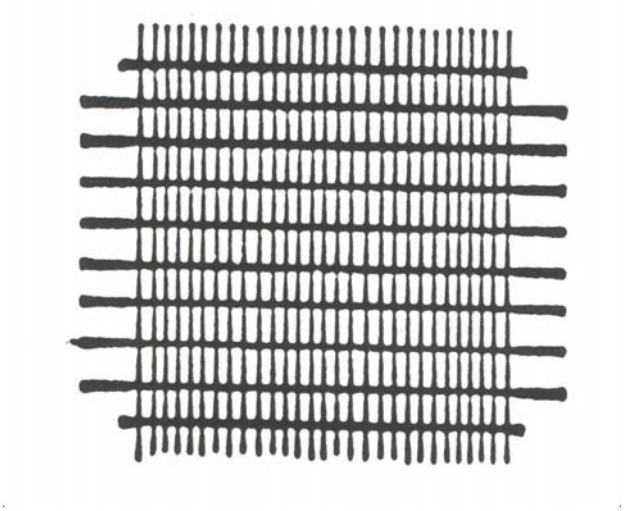
Bolt Tension

After assembly by hand, header bolts should be tensioned using a torque wrench. For water radiators using 10mm bolts 12 to 15 ft lb, 8mm bolts 10 to 12 ft lbs. Over tensioning will distort gasket around bolt, induce leakage and early deterioration of gasket material.

3. **Terminology**

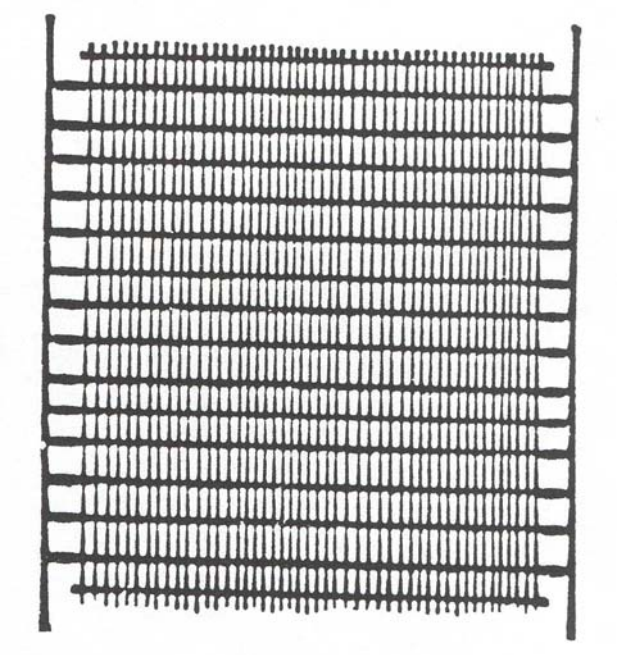
(a) Core Block

An assembled fin and tube block prior to fitting the header plate.



(b) Core

A core block with header plates



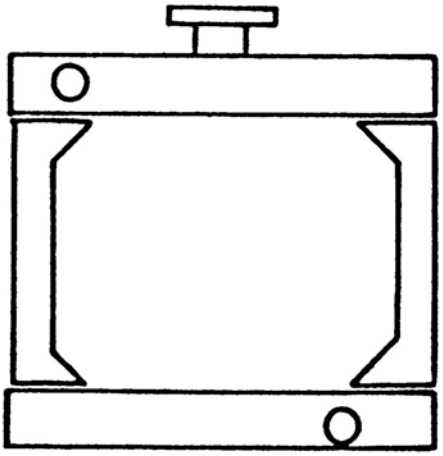
4. **Radiator Assembly**

Falls into two basic categories; soldered and bolt on construction.

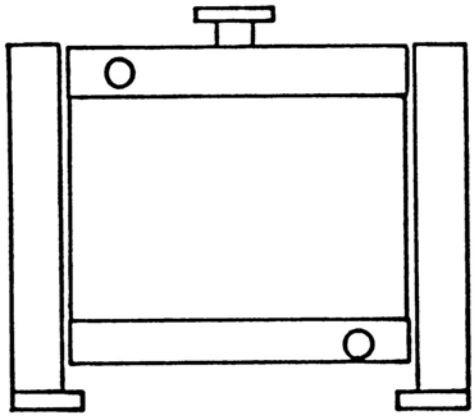
(a) **Soldered construction;** is normally a brass tank (either hand fabricated or pressed from tooling). **Header plates** are **folded** and soldered to the tanks. These are normally limited to smaller units due to lack of overall strength of the finished assembly.

(b) **Bolt on construction** is normally a steel tank, fabricated or pressed from tooling. **Header plates** are **flat** and use gaskets for sealing to tanks. 'Bolt on' fall into two categories.

(i) Internal side support
These radiators are normally offered for mobile equipment applications where chassis weave, or movement may be encountered.



(ii) External side support
These radiators are normally offered for stationary skid mounted equipment, such as generator sets, pumps, etc.



5. **Mounting**

All units must be mounted to prevent:-
(a) Mechanical stress under all aspects of operation.
(b) Transmitted cyclic vibration from the diesel engine.
(c) Must be earthed to main frame to prevent electrolysis.

For more details regarding mounting refer to TIB #3.

6. **Core Design (Mechanical)**

Selection of the core components is dependent on a number of factors:-

(a) Pressure rating.

(b) Required cycle life.

(c) Duty - application.

7. Basic Core Construction

(a) Oven Baked

Fin and tube block is fluxed and then soldered by baking in a high temperature oven.

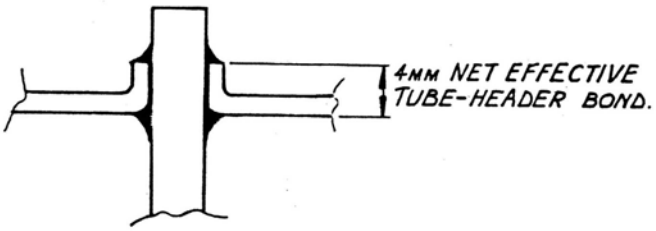
8. Header Plates

There are three types :-

(a) Pierced and flanged (extruded), which is adopted on material gauges up to 1.6mm.
(b) Punched from 2.0mm upwards.
(c) Semi extruded from 2.0mm upwards.

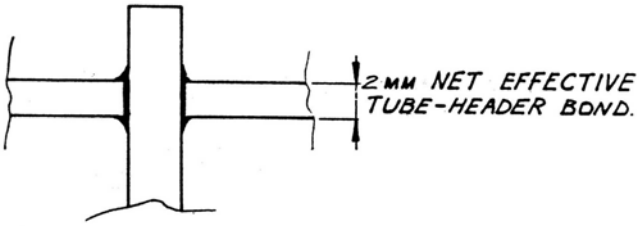
(a) **Pierce and Flange**

As shown below, is to provide an extended joint to be effective.



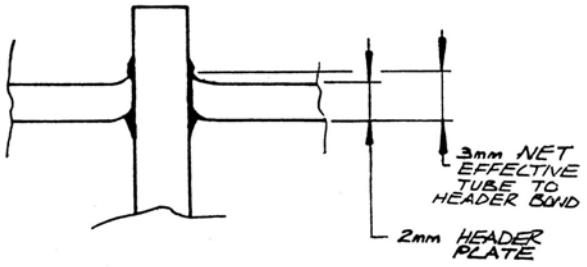
(b) **Punched**

Straight punched section uses material thickness for soldered joint.



(c) **Semi Extruded**

To provide an extended contact area at the tube to header plate joint for header plate thickness above 2.0mm.



9. Header Plate Selection

Is conditional on:-

(a) pressure
(b) mass core block weight
(c) thermal expansion
(d) overhangs, front and side
(e) assembly design
(f) application

(a) **Pressure**

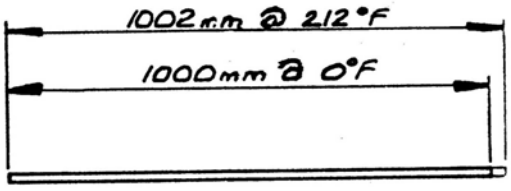
High pressure requires minimum overhang - material gauge to suit.

(b) **Mass Core Block Weight**

Minimum overhang - material gauge to suit.

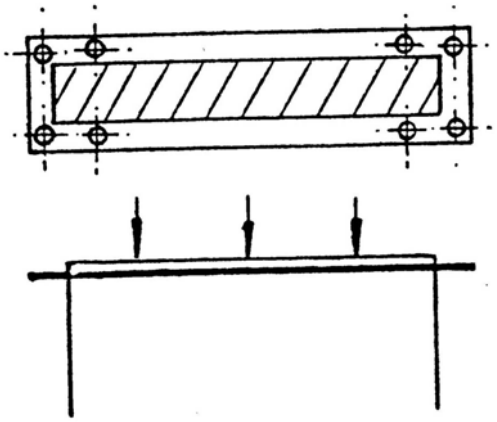
(c) **Thermal Expansion**

The co-efficient of brass is 0.00001°F which over a temp. range of 0°C (32°F) to 100°C (212°F), the net expansion is 1.8mm (0.010") per metre length.

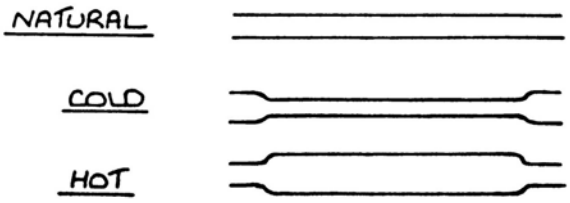


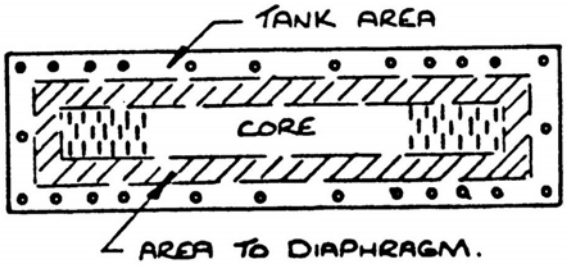
The force imposed on a header plate is from two areas.

On the water side there is a static operating pressure and on the air side there is the mechanical forces of the tube expanding (and contracting), which on a header plate, of say one metre wide could well exceed a force of 1500 kgs.



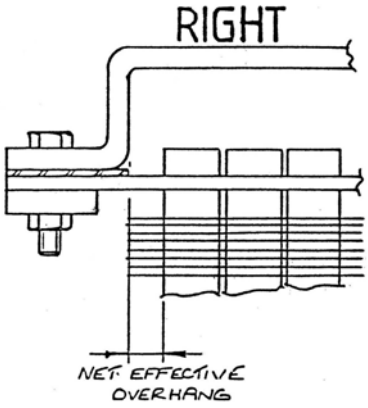
Therefore, header plates must be designed with overhang to permit the header plate to diaphragm.

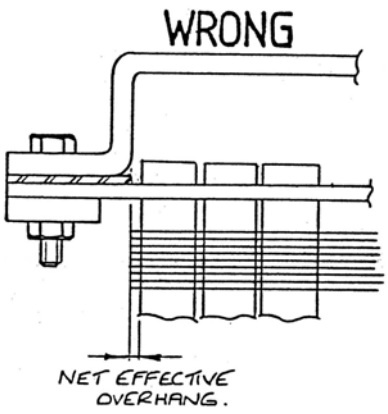




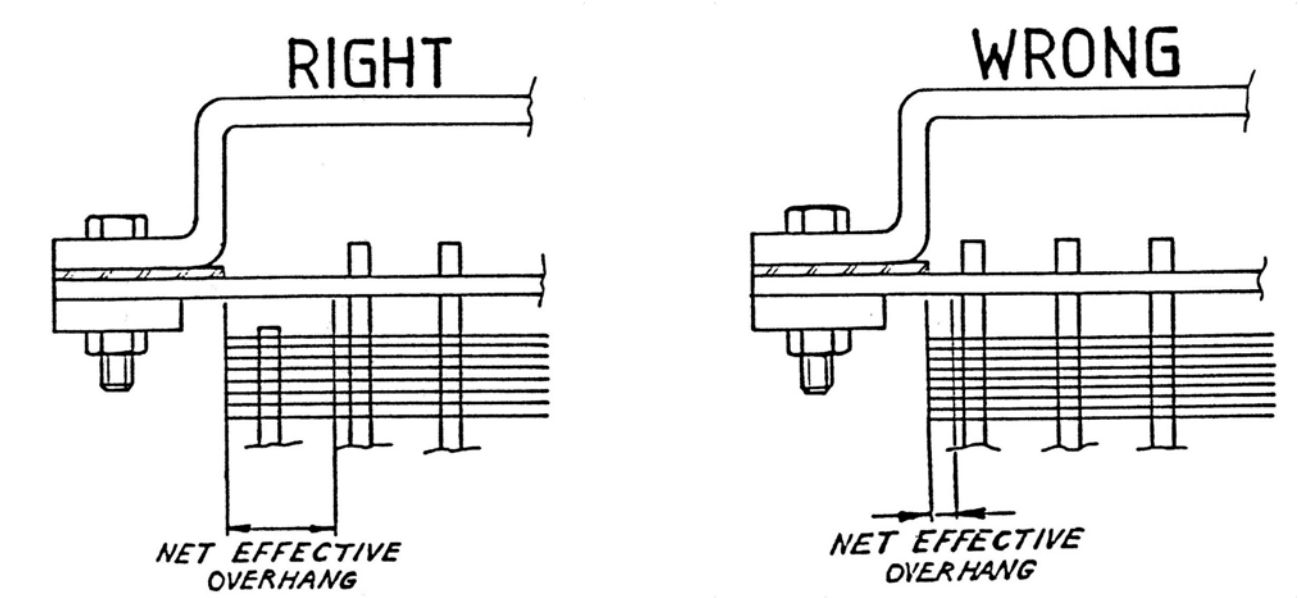
(d) **Overhangs - Front and Side**
Are accommodated in our radiators as follows :-

(i) **Front Overhang**
By allowance of material between tube and tank.



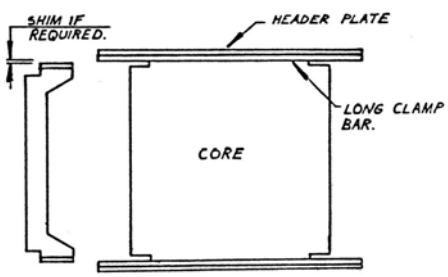


(ii) **Side Overhang**
This dead tube is cut off prior to header plate. This also retains integrity within the core.



(e) **Assembly Design**
Clamping plates are full length to provide maximum clamp at gasket joint.

Side supports are made to fit into clamp plates, however, due to manufacturing tolerances, shims may be needed to provide an accurate fit.



Flanges must be adequate for duty.

10. **Assembly**

Assembly of the unit to final stage requires proficiency and care by the operator.
Refer assembly instructions, TIB #8.

For further information, contact Air Radiators.
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