

A PROCESS AND AN APPARATUS FOR FORMING A PROFILED ELEMENT

The present invention relates to a process and an apparatus for forming a profiled element which is intended particularly, but not exclusively, for use as a heat dissipating element such as a semi-conductor heat-sink.

Heat dissipating elements such as semi-conductor heat-sinks can be of various profiled forms but often comprise a predetermined length cut from a profiled extruded metal member. The profiles of the extruded members used for forming such elements are dictated by the profiles of the dies through which the members are extruded and the profile of an element formed from an extruded member varies across only its width transverse to its direction of extrusion.

US patent 4 884 331 refers to a process for forming a semi-conductor heat-sink by cross-cut gang sawing in a transverse direction a longitudinally extending profiled extruded metal member. The extruded member comprises a longitudinally extending sheet-form member having a plurality of longitudinally extending transversely spaced ribs upstanding therefrom. By cross-cut sawing the ribs depthwise in a transverse direction at locations along their length and then parting off a predetermined length from a processed portion of the extruded member, a semi-conductor heat-sink comprising a base member having a plurality of transversely spaced rows of longitudinally extending rib portions is formed. The arrangement of the rib portions enhances the heat dissipating efficiency of the heat-sink so formed.

A disadvantage of this process for forming a semi-conductor heat-sink is that it is relatively expensive and slow. The

cross-cutting of the ribs creates sharp burrs on the sawn edges which must be removed before the heat-sink can be utilised. The additional step of removing the burrs adds to the expense of the manufacturing process.

5 Because the rib portions of the heat-sink are formed by cross-cut gang sawing the ribs of an extruded member, the rib portions of adjacent rows are transversely aligned which may limit the heat dissipating efficiency of the heat-sink.

10 It is an object of the present invention to obviate and mitigate the aforesaid disadvantages.

15 According to a first aspect of the invention there is provided a process for forming a profiled element from a generally longitudinally extending extruded member having a plurality of transversely spaced longitudinally extending ribs upstanding therefrom, said process comprising the step of removing longitudinally spaced apart portions from some of said ribs by means of a transversely acting punching means.

20 The process may include the step of removing a number of longitudinally spaced apart portions from a rib in a single punching operation.

 The process may also include the step of removing a longitudinal portion from each of a number of said ribs in a single punching operation.

25 The step of removing a longitudinal portion from each of a number of ribs may be achieved by means of a punching tool which, in use, engages the ribs sequentially within a single stroke of its operation.

 The process may further include the step of removing a number of successive longitudinal portions from each of a number

of ribs in a depthwise direction of the ribs. This may be achieved in a single punching operation.

This step may be achieved by a punching tool which, in use, engages the ribs sequentially within a single stroke of its operation, wherein the punching tool has a number of successive cutting edges, each of which extends farther in a depthwise direction normal to a stroke direction of the tool than a cutting edge preceding it in the tool stroke forward direction.

The process may be such that the length of gaps formed in the ribs by removal of longitudinally spaced apart portions are generally equal to the length of rib portions remaining after such removal.

The process may be such that rib portions remaining after removal of longitudinally spaced apart portions from adjacent ribs may generally be in transverse alignment.

Alternatively, the process may be such that the rib portions remaining after removal of longitudinally spaced apart portions from adjacent ribs are not generally in transverse alignment.

The process may be such that the rib portions remaining after removal of longitudinally spaced apart portions taper progressively, or incrementally, in a depthwise direction toward the extruded member.

The process may include the step of parting-off from an already processed portion of the extruded member a measured length thereof thereby forming a profiled element of predetermined length.

The element parted-off from the already processed portion of the extruded member may be parted-off by a saw means, or

alternatively, by a punching means acting normally to the plane of the extruded member.

Where the rib portions of adjacent rows of such portions are not in generally transverse alignment, the normally acting punching means may be provided with a punch head having a suitably profiled cutting edge which, in use, transversely engages the extruded member in gaps between the longitudinally extending rib portions of the transversely spaced rows of such portions.

10 The process according to the preceding paragraphs may be applied to an extruded member as aforesaid to form heat dissipating elements such as semi-conductor heat-sinks.

Preferably therefore, the extruded members are formed from metal or any other suitable thermally conductive material.

15 According to a second aspect of the invention there is provided a heat dissipating element formed from the aforesaid process, said element comprising a longitudinally extending base member having a plurality of transversely spaced rows of longitudinally extending and spaced apart rib portions
20 upstanding therefrom.

The rib portions may have tapered profiles widening progressively, or incrementally, in a depthwise direction towards the extruded member.

The rib portions of adjacent rows may be arranged so as not
25 to be generally in transverse alignment.

According to a third aspect of the invention there is provided an apparatus for use in the process according to the first aspect of the invention, said apparatus comprising means for conveying a longitudinally extending extruded member having
30 a plurality of transversely spaced longitudinally extending ribs

upstanding therefrom towards punching means, said punching means including a transversely acting punch head, a die means and a means for imparting drive to said punch head, wherein, in use, the die means locates adjacent a side surface of an upstanding rib with the punch head located on an opposing side of said rib, whereby the drive means, in use, imparts drive to the punch head to cause transverse movement of the punch head towards the die means resulting in the removal from the rib of a longitudinally extending portion thereof.

10 The drive means may comprise a press.

The die means may comprise a number of die members each of which, in use, locate adjacent a side surface of a respective rib.

Some of the die members may be capable of small pivotal movement in a direction normal to the direction of travel of the extruded member to accommodate relative positional deviations of the ribs of the extruded member.

The apparatus may include means for lowering the punching means into contact with an upper surface of the extruded member in a direction generally normal to said surface.

The means for lowering the punching means into contact with the extruded member also permits transverse movement of the punching means relative to the extruded member prior to the punch head and die means being lowered to contact with the upper surface of said member.

The punching means may include a row of punch heads and die members arranged in a longitudinal direction relative to the direction of travel of the extruded member to allow removal of a number of longitudinally extending portions from a rib, whereby

the drive means acts to impart drive to each of the punch heads to cause simultaneous transverse movement of the punch heads towards their respective die members.

The punching means may include a column of punch heads and die members arranged in a transverse direction relative to the direction of travel of the extruded member to allow removal of a number of longitudinally extending portions from adjacent ribs.

The punching means may be of a matrix-type configuration having a plurality of rows and columns of punch heads and their respective die members allowing a number of longitudinally extending portions to be punched from each of a plurality of adjacent ribs.

The apparatus may include a parting-off tool for parting off a predetermined length from a portion of already processed extruded member to thereby form a profiled element of predetermined length.

The parting-off tool may be a saw means.

Alternatively, the parting-off tool may be a punching means arranged to act normally to the plane of the extruded member and said means may include a punch head having a suitably profiled cutting edge which, in use, transversely engages the extruded member in gaps between longitudinally extending rib portions of transversely spaced rows of such portions.

According to a fourth aspect of the present invention there is provided a punching tool when used in the apparatus of the invention, said tool comprising a number of successive planar blade members arranged along its length, wherein each blade member extends farther in a depthwise direction than an adjacent blade member preceding it in a tool stroke forward (cutting)

direction and each blade member has a leading cutting edge extending widthwise normal to the plane of the blade and an arcuate cutting edge extending rearwardly from said leading cutting edge.

- 5 The blade members may be of increasing width along the length of the tool in the tool stroke forward (cutting) direction.

The foregoing and further features of the present invention will be more readily understood from the following description
10 with reference to the accompanying drawings, of which:

Figure 1 is an end-on view of an extruded member;

Figure 2 is a plan view of the extruded member of figure 1 with a leading end portion thereof having been processed in accordance with the process of the invention;

- 15 Figure 3 is a plan view of a profiled element formed by the process of the invention;

Figure 4 is an elevated side view of section X-X of figure 3;

- Figure 5 is a schematic block diagram of an apparatus
20 according to the invention;

Figure 6 is an enlarged sectional end view of part of the extruded member engaged by a die means forming part of the apparatus of the invention;

Figure 7 depicts a die plate;

- 25 Figure 8 is an enlarged side view of a punching tool;

Figure 9 is an end-on view of the punching tool of figure 8;

Figure 10 is a plan view of another extruded member with a leading edge portion thereof having been processed in accordance with alternative aspects of the process of the invention;

Figure 11 is a plan view of a profiled element formed by the alternative aspects of the process of the invention; and

Figure 12 is an enlarged plan view of the element of figure 11.

5 Referring to the drawings, figure 1 shows an end-on view of an extruded member 10 comprising a longitudinally extending sheet-form base member 12 (more easily seen in figure 2) having a plurality of transversely spaced longitudinally extending ribs 14 depending upwardly from said base member substantially at
10 right angles to the plane thereof.

The process of the invention can, in principle, be better understood from figure 2 which shows, in plan, the extruded member 10 of figure 1, which is of indeterminate length. A leading end portion 10a of the extruded member has already been
15 partly processed in readiness for parting-off from the member 10 to form a profiled element 16 (see figures 3 and 4).

The process of the invention generally comprises the step of removing longitudinally extending portions 18 (some of which are shown in broken outline in figures 3 and 4) from the upstanding
20 ribs 14 by means of a transversely acting punching means. Removal of such portions 18 from said ribs 14 results in the formation of transversely spaced rows 20 (coinciding with the ribs) of rib portions 22.

Whilst transverse punching of the ribs 14 to remove
25 longitudinally extending portions 18 could be a step-wise process along the length of each rib 14 of the extruded member 10, it is intended that a punching means capable of sequentially engaging a number of adjacent ribs 14 at a number of locations along extended portions of their lengths in order to

transversely punch a number of portions from each of said adjacent ribs in a single punching operation is employed. The punching means could be processor controlled.

The size of a profiled element 16 formed by this process is determined by the width of the extruded member being processed and the length chosen for parting-off a portion of said extruded member.

Experience has shown that transversely punching portions 18 from the ribs 14 does not lead to excessive burring of edges of the rib portions 22 (unlike cross-cut sawing) and any burring which does occur is at an acceptable level and does not require further processing to remove it.

Figure 5 shows a schematic block diagram of an apparatus 30 for use in the process of the invention to form profiled elements. The apparatus comprises means 32 for conveying an extruded member 10 towards a punching means 34. Movement of the extruded member 10 is controlled in a step-wise fashion to provide intervals during which the punching means 34 engages respective portions of the extruded member.

The punching means 34 comprises at least one punch head (punching tool) and a die means which, in use, engage the extruded member 10 such that die members 36 (figure 6) of the die means locate adjacent respective side surfaces of ribs 14 and the punch head locates to an opposing side of said ribs. The punching means also includes a means (not shown) for imparting driving force to said punch head to cause said punch head, in use, to move transversely past said die members 36 resulting in the sequential removal from each of the ribs 14 of a longitudinally extending portion 18 thereof.

Figure 6 shows an enlarged sectional view of a part of the die means 35 forming a part of the apparatus. The die means 35 is shown in engagement with an extruded member 10. The die means comprises a fixed die member 36a against which, in use, the extruded member 10 slides when being conveyed toward the punching means 34. The fixed die member 36a is located on a side of the apparatus 30 opposite to that of the punching means 34. The die means 35 also includes a number of further die members 36 whose free ends, in use, locate in gaps between ribs 14 of the extruded member 10 and which each contact a side surface of a respective rib. However, the further die members 36 are pivotally mounted to support member 38 to allow some variance in the transverse positions of their free ends to allow for deviations in the ribs along their lengths.

The view in figure 6 is such that a portion of the face of die members 36 are shown. Figure 7 shows one die member 36a which is a plate of hardened steel about 4" (10 cms) square. A slot 36b in the face of each die member 36 allows the cutting portion of the punching head to pass to successive die members. The portion 36c of the slot allows the back edge of the blade to pass through the die.

Figures 8 and 9 show different views of a tool 40 (punching head) particularly suited for use in the apparatus 30 to provide a relatively fast speed of operation. The tool 40 is designed to sequentially engage each adjacent rib 14 across the width of an extruded member 10 thereby sequentially removing a longitudinal portion from each rib 14. In a preferred embodiment, the tool has a number of cutting blades 42 (a, b, c, d,) which are arranged behind each other along the length of the

tool 40. Each cutting blade has a leading cutting edge 44 extending widthwise in a direction normal to the plane of the blade and an arcuate cutting edge 46 extending in the plane of the blade rearwardly away from said leading edge 44.

5 In use, a blade 42 of the tool 40 is caused to engage a side surface of a rib 14 of the extruded member 10. Movement of the tool 40 transverse to the extruded member 10 causes the leading cutting edge 44 followed by the arcuate cutting edge 46 to cut through the rib 14 punching a portion 18 from the rib 14. The
10 portion 18 punched from the rib has a profile substantially similar to the blade cutting profile. The arcuate cutting edge 46 also cuts to remove the punched out portion 18 of the rib 14 away from the extruded member 10 to prevent such punched out portions 18 from fouling following punching operations.

15 Each blade 42 (a, b, c, d) of the tool 40 extends outwardly beyond the next blade 42 such that one stroke of the tool 40 across the extruded member 10 results in a number of successive longitudinal portions 18 being removed from each rib 14. The width of the leading cutting edge 44 of each blade 42 (b, c, b,
20 a) increases in a tool stroke forward (cutting) direction (i.e. from right to left starting with blade 42d as viewed in figure 8) of the tool such that a preceding blade 42 provides some clearance for a following blade. The depth of each blade 42 (d, c, b, a) decreases in a tool stroke forward direction, i.e.,
25 from right to left.

The use of this preferred punching tool 40 results in the rib portions 22 of the profiled elements 16 formed by the process of the invention having tapered profiles (figure 4), being wider at their bases adjacent to the base member 12. In a

not shown embodiment, the blades 42 of the punching tool 40 are profiled such that the rib portions 22 have a "Christmas tree" profile, incrementally widening towards their bases.

The repetition of the punching operation along the length of the extruded member 10 results in the transformation of each rib 14 to a row of rib portions 22 separated by gaps 23 which are, in this case, of equal length to the rib portions 22.

The width of the gaps 23 can be of any length but are preferably equal in length to the rib portions 22.

Movement of the extruded member 10 relative to the punching means 34 is controlled by the conveyance means 32 although, it is envisaged, that the punching means 34 may itself be movable relative to the extruded member 10 which, in such a case, would be held stationary.

Whilst a punching means 34 having only one punch head (punching tool) and associated die means could be controlled to process the extruded member in a step-wise manner as aforesaid, in a preferred embodiment the punching means has a plurality of punch heads and a common die means arranged such that, in use, a plurality of adjacent ribs 14 can be engaged over extended portions of their lengths for simultaneous removal of a number of longitudinally extending portions 18 from each of said ribs 14. In such an arrangement, the drive means which could be a press is arranged to provide a driving force to each of said punch heads. The punch heads may be driven simultaneously or sequentially.

Figures 10 to 12 show an extruded member which has been processed in accordance with the invention to provide a profiled element 16 having a different arrangement of rib portions 22 to

that shown in figures 3 and 4. Like numerals are used to denote like parts. In this case the punching means 34 of the apparatus 30 is such that it is only capable of engaging a single rib 14 to remove a longitudinally extending portion 18 therefrom.

5 The punching means 34 is processor controlled to adapt to any width of extruded member 10 by controlled transverse movement as well as longitudinal movement relative to the extruded member 10 prior to engaging it for processing as aforesaid.

10 One advantage of this process is that it provides a profiled element 16 in which the rib portions 22 of adjacent ribs 14 are staggered, i.e. not in transverse alignment. It is not possible to achieve this arrangement of rib portions 22 by cross-cut sawing in which all rib portions lie one-behind-the-other in the
15 transverse direction.

The apparatus used to produce this profiled element is generally the same as that for forming the profiled element 16 of figures 3 and 4.

20 The punching means 34 comprises at least one punch head 50 and a die 52 (shown in position in figure 12) which, in use, are lowered into contact with an upper surface 54 of the extruded member 10 such that the die 52 locates adjacent a side surface of a rib 14 and the punch head 50 locates on an opposing side of said rib (see figure 12).

25 The repetition of the punching operation along the length of each rib 14 results in the transformation of a rib to a row of rib portions 22.

The punching head 34 is movable transversely relative to the extruded member 10 to allow said punching means 34 to process extruded members 10 of various transverse widths.

Whilst a punching means 34 having only one punch head 50 and die 52 could be controlled to process the extruded member 10 in a step-wise manner as aforesaid, in a preferred embodiment the punching means 34 has a plurality of punch heads 50 and their respective dies 52 arranged in a matrix configuration whereby, in use, said punch heads 50 and dies 52 engage a plurality of adjacent ribs 14 over extended portions of their lengths for simultaneous removal of a number of longitudinally extending portions 18 (shown in broken outline in figure 12) from each of said ribs 14. In such an arrangement, a drive means such as a press is arranged to provide a driving force to each of said punch heads 50 simultaneously.

It can be seen that the arrangement of the rib portions 22 relative to each other in their respective rows 20 is determined by the arrangement of punch heads 50 of the punching means 34 and this enables any pattern of rib portions 22 to be achieved by the use of an appropriately designed punching means 34.

The apparatus also includes means 60 (figure 5) for parting-off predetermined lengths of the already processed portion 10a of the extruded member 10 in order to form profiled elements 16 of such predetermined lengths.

The means 60 for parting-off may be a saw means but this would have the disadvantage of creating sawn edges as discussed aforesaid. In the preferred embodiment, the parting-off means comprises a punching means (not shown) arranged to act normally to the plane of the sheet-form base member 12 of the extruded

member 10 and which transversely engages said member across gaps 23 between rib portions 22. Consequently, in the case where the rib portions are arranged not to be in transverse alignment (figures 10 to 12), the profile of a cutting edge 62 of the 5 normally acting punching means must be designed accordingly and as can be seen from figures 9 to 11 results in step-wise profiled edges on the profiled elements 16.

It is envisaged that the profiled elements formed by the process of the invention will be utilised as semi-conductor 10 heat-sinks since their arrangement of transversely spaced rows of rib portions provides improved heat dissipating characteristics. As such they should be formed from an extruded metal member or an extruded member of any other suitable thermally conductive material.

**CLAIMS**

1. A process for forming a profiled element from a generally longitudinally extending extruded member having a plurality of transversely spaced longitudinally extending ribs upstanding therefrom, said process comprising the step of removing longitudinally spaced apart portions from at least some of said ribs by means of a transversely acting punching means.

2. A process as claimed in claim 1, wherein it includes the step of removing a number of longitudinally spaced apart portions from a rib in a single punching operation.

3. A process as claimed in claims 1 or 2, wherein it includes the step of removing a longitudinal portion from each of a number of said ribs in a single punching operation.

4. A process as claimed in claim 3, wherein it includes the step of removing a number of successive longitudinal portions from each of a number of ribs in a depthwise direction of the ribs.

5. A process as claimed in claim 4, wherein the step of removing a number of successive longitudinal portions from each of a number of ribs is achieved in a single punching operation.

6. A process as claimed in any preceding claim, wherein the length of gaps formed in the ribs by removal of longitudinally spaced apart portions are generally equal to the length of rib portions remaining after such removal.

7. A process as claimed in any preceding claim, wherein the rib portions remaining after removal of longitudinally spaced apart portions from adjacent ribs are generally in transverse alignment.



8. A process as claimed in any preceding claim, wherein the rib portions remaining after removal of longitudinally spaced apart portions taper progressively, or incrementally, in a depthwise direction toward said extruded member.

5 9. A process as claimed in any preceding claim, wherein it includes the step of parting-off from an already processed portion of the extruded member a measured length thereof thereby forming a profiled element of predetermined length.

10. A process as claimed in claim 9, wherein the element parted-off from the already processed portion of the extruded member is parted-off by a saw means or a punching means acting normally to the plane of the extruded member.

11. A process as claimed in claim 10 in which the rib portions of adjacent rows of such portions are not in generally transverse alignment, wherein the normally acting punching means has a punch head having a suitably profiled cutting edge which, in use, transversely engages the extruded member in gaps between the longitudinally extending rib portions of the transversely spaced rows of such portions.

12. A heat dissipating element comprising an extruded longitudinally extending base member having a plurality of transversely spaced rows of longitudinally extending and spaced apart rib portions upstanding therefrom, wherein the gaps between said spaced apart rib portions are removed in a transverse punching operation and said base member and rib portions are formed of metal or other suitable thermally conductive material.



13. A heat dissipating element as claimed in claim 12, wherein the rib portions have tapered profiles widening progressively, or incrementally, in a depthwise direction towards the extruded base member.

5 14. A heat dissipating element as claimed in claim 12 or 13, wherein the rib portions of adjacent rows are arranged so as not to be generally in transverse alignment.

15. A heat dissipating element made by the process according to any of claims 1 to 11.

10 16. An apparatus for forming profiled elements, said apparatus comprising means for conveying a longitudinally extending extruded member having a plurality of transversely spaced longitudinally extending ribs upstanding therefrom towards punching means, said punching means including a
15 transversely acting punch head, a die means and a means for imparting drive to said punch head, wherein, in use the die means locates adjacent a side surface of an upstanding rib with the punch head located on an opposing side of said rib, whereby the drive means, in use, imparts drive to the punch head to
20 cause transverse movement of the punch head towards the die means resulting in the removal from the rib of a longitudinally extending portion thereof.

17. An apparatus as claimed in claim 16, wherein the die comprises a number of die members each of which, in use, locate
25 adjacent a side surface of a respective rib.

18. An apparatus as claimed in claim 17, wherein some of the die members are capable of pivotal movement in a direction normal to the direction of travel of the extruded member to accommodate relative positional deviations of the ribs of the
30 extruded member.



19. An apparatus as claimed in claim 16 or 17, wherein the apparatus includes means for lowering the punching means into contact with an upper surface of the extruded member in a direction generally normal to said surface.

5 20. An apparatus as claimed in claim 19, wherein the means for lowering the punching means into contact with the extruded member also permits transverse movement of the punching means relative to the extruded member prior to the punch head and die being lowered to contact with the upper surface of said member.

10 21. An apparatus as claimed in claims 19 or 20, wherein the punching means includes a row of punch heads and die members arranged in a longitudinal direction relative to the direction of travel of the extruded member to allow removal of a number of longitudinally extending portions from a rib, whereby the drive
15 means acts to impart drive to each of the punch heads to cause simultaneous transverse movement of the punch heads towards their respective die members.

22. An apparatus as claimed in claims 19 or 20, wherein the punching means includes a column of punch heads and die
20 members arranged in a transverse direction relative to the direction of travel of the extruded member to allow removal of a number of longitudinally extending portions from adjacent ribs.

23. An apparatus as claimed in claims 19 or 20, wherein the punching means has a matrix-type configuration having a
25 plurality of rows and columns of punch heads and their respective die members allowing a number of longitudinally extending portions to be punched from each of a plurality of adjacent ribs.



24. An apparatus as claimed in any of claims 16 to 23, wherein the apparatus includes a parting-off tool for parting off a predetermined length from a portion of already processed extruded member to thereby form a profiled element of
5 predetermined length.

25. An apparatus as claimed in claim 24, wherein the parting-off tool is a punching means arranged to act normally to the plane of the extruded member and has a suitably profiled cutting edge which, in use, transversely engages the extruded
10 member in gaps between longitudinally extending rib portions of transversely spaced rows of such portions.

26. A punching tool when used in the apparatus as claimed in claims 16 to 18, wherein said tool comprises a number of successive planar blade members arranged along its length,
15 wherein each blade member extends farther in a depthwise direction than an adjacent blade member preceding it in a tool stroke forward (cutting) direction and each blade member has a leading cutting edge extending widthwise normal to the plane of the blade and an arcuate cutting edge extending rearwardly from
20 said leading cutting edge.

27. A punching tool as claimed in claim 26, wherein the blade members are of increasing width along the length of the tool in the tool stroke forward (cutting) direction.

28. A process as substantially herebefore described with
25 reference to figs 1 to 8 of the drawings.

29. A process as substantially herebefore described with reference to figs 9 to 11.

30. A heat dissipating element as substantially herebefore described with reference to figs 1 to 4.



31. A heat dissipating element as substantially herebefore described with reference to figs 9 to 11.

32. An apparatus as substantially herebefore described with reference to figs 1 to 8.

5 33. An apparatus as substantially herebefore described with reference to fig 5 and figs 9 to 11.

34. A punching tool as substantially herebefore described with reference to figs 7 and 8.