Metal extrusions adapted for use in building constructions including a rigid spacer member capable of forming a thermal break. The extrusions comprise spaced apart structural members having a unique web member spanning the space between the structural members. The web member extends convexly between the structural members thereby providing an ideal surface for use in aligning the extrusions during processing. The extrusions also include flange members which with the structural members and the web member define a cavity within which the rigid spacer member of low thermal conductivity is constrained. A process of forming the extrusions is also claimed.

20 Claims, 6 Drawing Figures
BACKGROUND OF THE INVENTION

This invention relates to metal extrusions adapted for use in building constructions such as windows, doors, and curtain wall. The extrusions of this invention include a rigid spacer member of relatively low thermal conductivity which can provide a thermal break between the inside and outside of the building. The invention also includes a process for making the extrusions.

U.S. Pat. No. 3,204,324, granted Sept. 7, 1965, and U.S. Pat. No. 3,624,885, granted Dec. 7, 1971, deal with extrusions in the same general field as those of this invention. The extrusions of this invention, however, represent a marked improvement over those disclosed by the patents.

In accordance with the patents, there are disclosed extrusions incorporating a rigid spacer member for forming a thermal break. The extrusions in accordance with this invention incorporate a design which permits the elimination of the projections required by the designs of the patents and which further provides a self-aligning feature which makes it easier to align the extrusion during processing and thereby simplify the fixtureing and jiggling required.

SUMMARY OF THE INVENTION

In accordance with this invention, there are provided metal extrusions adapted for use in building constructions such as doors, windows, and curtain wall. The extrusion comprises first and second structural members positioned in adjacent spaced-apart relation, a flange member projecting outwardly from each of the structural members in the space between the structural members, a web member spanning the space between the structural members while being spaced apart from the flange members and rigidly joining the structural members together. The web member in accordance with this invention has a unique design whereby it extends convexly between the structural members in such a way that the space between the web member and the flange members decreases the further out the web member projects from each of the structural members.

A cavity is defined by the structural members, the web member, and the flange members; and a rigid spacer member of relatively low thermal conductivity is provided within the cavity.

In accordance with another embodiment of the invention, a slot is provided in the web member which separates the structural members to provide a thermal break. In this latter embodiment, the structural members are held together in rigid engagement by the spacer member, and a complete thermal break is provided between the structural members.

Preferably in accordance with this invention, the web member has a substantially "V" shaped cross section; and in accordance with a still more preferred embodiment, the flange members project outwardly from the structural members and are inclined with respect to the structural members so as to form a "bow tie" like cavity. The unique shape of the web member, particularly in the embodiment where it has a substantially "V" shaped cross section, provides an ideal surface for use in guiding the extrusions during processing, such as when the extrusions are being filled with the spacer material or when the slot is being machined in the web member.

The shape of the web member in accordance with this invention provides a self-alignment feature which substantially reduces the complexity of the apparatuses required to carry out the aforementioned processes. A still further improvement is provided by the fact that the extrusions may be guided and aligned during processing without the necessity of contacting the faces of the extrusion which are to be exposed to view, thereby eliminating potential causes of marring of the finish of these surfaces.

Accordingly, it is an object of this invention to provide metal extrusions for use in building constructions such as windows, doors, and curtain wall.

It is a further object of this invention to provide extrusions as above including a web member having a configuration which is adapted to provide for self-alignment of the extrusion during processing.

It is a further object of this invention to provide extrusions as above including a rigid spacer member of relatively low thermal conductivity which can provide a thermal break.

It is a further object of this invention to provide extrusions as above wherein a slot is provided in the web member to provide a complete thermal break.

It is another object of this invention to provide a process for forming the extrusions of this invention wherein the extrusions are aligned for processing, such as filling the cavity with spacer material, by engaging the web member with a suitable aligning device.

Other objects and advantages will become apparent to those skilled in the art as a detailed discussion of particular embodiments proceeds with reference to the drawings which form a part hereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross section of an extrusion in accordance with one embodiment of this invention.

FIG. 2 shows a cross section of an extrusion in accordance with a preferred embodiment of this invention.

FIG. 3 shows a cross section of part of a building construction employing an extrusion in accordance with this invention having a complete thermal break.

FIG. 4 shows a cross section of part of a building construction employing a preferred embodiment of an extrusion in accordance with this invention having a complete thermal break.

FIG. 5 is a perspective view showing an extrusion in accordance with yet another embodiment of this invention.

FIG. 6 is a perspective view showing an extrusion in accordance with yet another embodiment of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown a cross section of an extrusion 1 in accordance with one embodiment of this invention. The extrusion 1 comprises first and second structural members 2 and 3 which are positioned in adjacent spaced-apart relation. Flange members 4 project outwardly from each of the structural members 2 and 3 in the space between the structural members.
2 and 3 with each of the flange members 4 having a free edge 5. A web member 6 spans the space between the structural members 2 and 3. The web member 6 is spaced apart from the flange members 4 and rigidly joins together the structural members 2 and 3.

In accordance with a unique feature of the extrusion of this invention, the web member 6 extends convexly between the structural members 2 and 3 so that the space between the web member 6 and the flange members 4 decreases the further out the web member 6 projects from each of the structural members 2 and 3.

A cavity 7 is defined by the structural members 2 and 3, the web member 6, and the flange members 4. A rigid spacer member 8 of relatively low thermal conductivity is constrained within the cavity 7. The spacer member 8 substantially fills up the cavity 7 to provide a rigid joint between the structural members 2 and 3 when a slot 9 as in FIG. 3 is formed in the web member 6 to provide a complete thermal break.

In the embodiment of FIG. 1, the flange members 4 extend out from the structural members 2 and 3 in a direction generally normal to the faces 10 of the structural members 2 and 3.

In accordance with other preferred embodiments of the invention as shown in FIGS. 2, 5, and 6, the flange members 4 may extend out from the structural members at an angle with respect to the faces 10 of the structural members 2 and 3, the flange members 4 being angled in such a way that they extend outwardly from the structural members 2 and 3 and toward the web member 6.

The combination of the inclined flange members 4 and the "V" shaped web member 6 form a "bow tie" like cavity 7. Further, referring to FIG. 2, it is possible to provide integral overflow lips 11 coextensive with the edges 5 of the flanges 4 so as to make it easier to completely fill the cavity 7 without spilling spacer material on other portions of the extrusion 1.

Referring again to FIG. 1, the web member 6 is convexly disposed between the spaced-apart structural members 2 and 3. The web member 6 shown extends out from each of the structural members 2 and 3 at an angle to the faces 10 thereof in a direction toward the flange members 4. A flat portion 12 of the web member 6 extends generally normal to the structural members. This normally extending portion 12 of the web member 6 is approximately the width of the slot 9 which will eventually be formed in the web member 6 to provide the thermal break. The web member 6 in FIG. 1, therefore, has a generally "V" shaped cross-section with a flat 12 at the vertex of the "V".

In accordance with this invention, the web member 6 may have any desired convex shape which is adapted to provide the self-aligning and locating feature which will be described in more detail with reference to FIG. 5 later. The web member 6 shown in FIG. 1, however, is one of the preferred embodiments since it provides self-alignment of the extrusion 1 during the spacer 8 material filling operation and during the slot 9 machining operation. With respect to the slot 9 machining operation, the use of a flat 12 as in FIG. 1 provides for uniform metal removal thereby making the web member 6 easier to machine. The sloped sides 13 of the V-shaped web member 6 provide the self-aligning feature, since the cutter 24 as in FIG. 6 contacting the web member 6 as in FIG. 1 will slide down the sloped sides 13 to the flat.

In the extrusion of FIG. 2, the web member 6 is completely "V" shaped and the flat 12 has been eliminated. This configuration is also a preferred embodiment in accordance with this invention and provides excellent self-locating and aligning properties for the web member 6.

FIG. 3 shows the extrusion 1 of FIG. 1 after the slot 9 has been machined in the web member 6 so as to provide a complete thermal break between the structural members 2 and 3. After the slot 9 has been formed in the web member 6, the web member 6 becomes two portions 14 in opposing relationship to the flange members 4. The rigid spacer member 8 joins the structural members 2 and 3 together in a rigid fashion. The convexity of the web member portions 14 or the slope of the portions 14 as shown in FIG. 3 effectively locks the spacer member 8 to each of the structural members 2 and 3. This results from the fact that the web portions 14 extend out from each of the structural members 2 and 3 at an angle with respect to the faces 10. The web portions 14 are angled in such a way that they extend outwardly from the structural members 2 and 3 and toward the flange members 4.

FIG. 3 shows a typical portion of a building construction, namely an extrusion 1 in accordance with this invention, engaging a panel 15 which might be employed in a curtain wall. Weather strips 16 are provided which are secured to the structural members 2 and 3 by means of the slots 17 and which resiliently engage the panel 15.

FIG. 4 shows the most preferred configuration of the extrusion 1 in accordance with this invention wherein the flange members 4 project out from the structural members 2 and 3 at an angle with respect to the faces 10 and in a direction toward the web portions 14. The web member 6 in FIG. 2 has been slotted to provide the web portions 14 in the extrusion 1 of FIG. 4. The extrusion 1 of FIG. 4 is preferred because the engagement of the flange members 4 in addition to the engagement of the web portions 14 provides a superior locking action between the thermally insulating spacer member 8 and the structural members 2 and 3.

The cavity 7 of the extrusion 1 of FIG. 2 and the resulting spacer member 8 in the construction of FIG. 4 have a "bow tie" like shape which is very effective in preventing the structural members 2 and 3 from pulling apart from each other and provides a very strong rigid joint between the structural members 2 and 3. The extrusion 1 of FIG. 4 is shown engaged with a glass window pane 18 in a manner similar to the engagement with the panel shown in FIG. 3. Resilient sealing gaskets 6 are secured to the extrusion 1 by means of the slot 17 and resiliently engage the window 18.

From the discussion of FIGS. 1 through 4, it is clear that this invention deals with two types of extrusions 1. The first type, as exemplified by the extrusions of FIGS. 1 and 2, includes a web member 6 spanning the gap between the structural members 2 and 3 which rigidly joins the structural members 2 and 3 together. The extrusions 1 in this form are most useful for production purposes, since the desired window shapes, door shapes, or curtain wall shapes can be fabricated without damaging the spacer member 8.

In accordance with the embodiment of FIGS. 3 and 4, an extrusion 1 is provided wherein the web member...
6 has been separated into portions 14 with a slot 9 in between. This represents the desired form of the extrusion 1 after fabrication has been accomplished and a thermal break structure is desired. These extrusions are essentially similar to those of FIGS. 1 and 2 with the exception that the web member 6 has been slotted to form spaced apart portions 14 and thereby provide a complete thermal break between the structural members 2 and 3 of the extrusion 1.

Since the inclination of the web portions 14 or of the web portions 14 and the flange members 4 provide a "bow tie" like structure which effectively joins the structural members 2 and 3 to the rigid spacer member 8 in accordance with this invention, the projections required by the prior art to keep the structural members 2 and 3 from pulling apart have been eliminated without the loss of their function.

The self-locating and alignment feature of the extrusion 1 in accordance with this invention is clearly shown in FIG. 5. FIG. 5 shows an extrusion 1 similar to the design of FIGS. 2 and 4, but without the optional overflow lips 11 along the free edges 5 of the flanges 4. As shown in FIG. 5, a guide wheel 19 or other means for aligning the extrusion 1 with a dispensing nozzle 20 is provided. The guide wheel 19 in the illustration engages the web member 6 and has a "V" shaped contour which mates with the "V" shaped contour of the web member 6. While only one guide wheel 19 is shown, it is obvious that the apparatus for carrying out this process should probably include a plurality of such wheels 19.

A roller 21 is provided in opposing relationship to the guide wheel 19 and engages the edges 22 of the structural members 2 and 3 so as to push the web member 6 against the guide wheel 19. Therefore, it is readily evident that the convex shape of the web members 6 of the extrusions 1 of this invention provide a relatively easy means for locating the extrusions 1 and aligning the extrusions 1 during processing. Further, since the locating means 19 does not contact the faces 10 of the structural members 2 and 3 which are visible when the extrusions are in use, there is a much lesser tendency for these faces 10 to be marred or damaged during processing.

The extrusion 1 shown in FIG. 5 is a further alternative embodiment in accordance with this invention and includes a further feature not yet discussed, namely the extrusion 1, includes a plurality of holes 23 in the flanges 4 which are small enough to prevent the spacer 8 material from easily flowing out of them, but large enough to allow for some flow of the spacer 8 material into them. The advantage of this construction is that it provides means for preventing the structural members 2 and 3 from moving longitudinally with respect to one another in addition to preventing them from being pulled apart.

Referring now to FIG. 6, an extrusion 1 similar to that of FIG. 5 without the holes 23 is shown. The extrusion 1 is in the process of having the slot 9 machined in the web member 6 to provide the separate web portions 14 and the complete thermal break. It is readily evident that the "V" shape of the web member 6 provides a similar type of self-alignment with the cutter 24 during the machining operation, thereby reducing the fixturing necessary to carry out the machining and the chances of marring or damaging the extrusion 1.

The process in accordance with this invention comprises providing an extrusion 1 including first 2 and second 3 structural members positioned in adjacent spaced apart relation, a flange member 4 projecting outwardly from each of the structural members 2 and 3 in the space between the structural members 2 and 3 and a web member 6 spanning the space between the structural members 2 and 3 while being spaced apart from the flange members 4 and rigidly joining the structural members 2 and 3 together. The web member 6 extends convexly between the structural members 2 and 3 in such a way that the space between the web member 6 and the flange members 4 decreases the further out the web member 6 projects from each of structural members 2 and 3. The extrusion 1 further includes a cavity 7 defined by the structural members 2 and 3, the web member 6 and the flange members 4.

The extrusion 1 thus provided is aligned under a suitable dispensing means 20 for dispensing a spacer material of relatively low thermal conductivity into the cavity 7. The alignment is accomplished by engaging the concave side of the web member 6 with a suitable means 19 for aligning the extrusion 1 as in FIG. 5. The dispensing means 20 may comprise a nozzle as in FIG. 5 or any other suitable type of device. Conventional grouting or caulking equipment can be used for this purpose. After the extrusion 1 has been aligned beneath dispensing means 20 spacer material having a relatively low thermal conductivity is dispensed so that it flows into and fills the cavity 7. The flowing and filling of the cavity may be facilitated by the use of vibration.

The spacer material of relatively low thermal conductivity may be any desired insulating material used for such purposes in the art. In the preferred embodiment of the invention the insulating spacer material is formed of a resinous material and may also include fillers and/or fibers that are selected for the strength as well as the insulating properties they impart. The insulating spacer material is compounded to have tensile strength, dimensional stability, resistance to impact, moisture and sub-freezing temperatures as required by the particular installation. Preferably, the insulating spacer material should exhibit good adhesion to the metal of the extrusion 1. In the case of this invention the extrusions 1 may be made of any desired metal such as aluminum, aluminum alloys, copper, copper alloys and other metals found in similar applications. This adhesion property is not an essential aspect of this invention.

After the cavity has been filled with the spacer material of low thermal conductivity the spacer material is allowed to solidify, as for example, by curing of a resinous composition to harden it and thereby provide a rigid spacer member 8 joined to each of the structural members 2 and 3. The processing may further include the step of machining a slot 9 in the web member 6 to separate it into separate portions 14 and thereby provide a complete thermal break. The machining may be accomplished by the use of a milling cutter 24 as shown in FIG. 6 or by sawing or the use of a cut-off wheel or any other desired means.

To provide an extrusion in accordance with FIG. 5, it is necessary prior to the step of machining the slot 9 that the holes 23 or perforations be formed in the flange members 4. This may be accomplished by any conventional technique such as punching or drilling or
by such exotic techniques such as laser or electron beam machining.

The extrusions 1 provided in the process of the present invention may have any desired structure such as the preferred structures illustrated in FIGS. 1 through 6. In accordance with this invention the structural members 2 and 3 may have planar faces 10 as shown in FIGS. 1 through 6 or they may have any desired configuration or sectional shape as are well-known in the art. For example, one or both of the structural members 2 and 3 may comprise a plurality of pieces in interlocking engagement. The extrusions 1 illustrated in FIGS. 1 through 6 are merely exemplary and are not meant to be limited of the invention.

The extrusions 1 are adaptable to a large number of constructions and are particularly adaptable for use in configurations such as frames for supporting edges of windows or panels.

This invention may be embodied in other forms or carried out in other ways without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered as in all respects illustrative and not restrictive, the scope of the invention being indicated by the appended claims, and all changes which come within the meaning and range of equivalency are intended to be embraced therein.

What is claimed is:

1. A metal extrusion adapted for use in building constructions, said extrusion consisting essentially of:
   - first and second structural members positioned in adjacent spaced-apart relation;
   - a flange member projecting outwardly from each of said structural members in said space between said structural members, each of said flange members having a free edge;
   - a web member spanning the space between said structural members, said web member being spaced apart from said flange members and rigidly joining together said structural members, said web member extending convexly between said structural members so that the space between said web member and said flange members decreases as said web member projects out from each of said structural members;
   - a cavity defined by said structural members, said web member, and said flange members;
   - a rigid spacer member of relatively low thermal conductivity constrained within said cavity.

2. A metal extrusion as in claim 1 wherein said flange members are angled with respect to said structural members so that they extend outwardly from the structural members and toward the web members.

3. An extrusion in accordance with claim 1 wherein each flange member has an integral overflow lip along its free edge, said overflow lips being coextensive with said flange members.

4. A metal extrusion as in claim 1 wherein said web member has a substantially "V" shaped cross-section.

5. A metal extrusion as in claim 4 wherein a flat is present at the vertex of said "V" shaped web member.

6. An extrusion as in claim 2 wherein said web member has a substantially "V" shaped cross-section whereby said cavity has a "bow tie" like shape.

7. An extrusion as in claim 3 wherein said web member has a substantially "V" shaped cross-section whereby said cavity has a "bow tie" like shape.

8. An extrusion as in claim 1 wherein said flange members have a plurality of holes.

9. A metal extrusion adapted for use in building constructions said extrusion consisting essentially of:
   - first and second structural members positioned in adjacent spaced apart relation;
   - a flange member projecting outwardly from each of said structural members, in said space between said structural members, each of said flange members having a free edge;
   - web portions projecting outwardly from each of said structural members in said space between said structural members said web portions extending towards said flange members and being spaced apart from said flange members, said web portions defining a slot;
   - a cavity defined by said structural members, said web portions and said flange members;
   - a rigid spacer member of relatively low thermal conductivity constrained within said cavity and rigidly joining together said structural members.

10. A metal extrusion as in claim 9 wherein said flange members are angled with respect to said structural members so that they extend outwardly from the structural members and toward the web portions.

11. An extrusion in accordance with claim 9 wherein each flange member has an integral overflow lip along its free edge, said overflow lips being coextensive with said flange members.

12. An extrusion as in claim 2 wherein said cavity has a "bow tie" like shape.

13. An extrusion as in claim 9 wherein said flange members have a plurality of holes.

14. An extrusion as in claim 10 wherein said flange members have a plurality of holes.

15. A process of forming a metal extrusion adapted for use in building constructions said process comprising:
   - providing a metal extrusion consisting essentially of first and second structural members positioned in adjacent spaced-apart relation, a flange member projecting outwardly from each of the structural members in the space between the structural members each of the flange members having a free edge, a web member spanning the space between the structural members, the web member being spaced apart from the flange members and rigidly joining together the structural members, the web member extending convexly between the structural members so that the space between the web member and flange members decreases as the web member projects out from each of the structural members and a cavity defined by the structural members, the web member and the flange members;
   - aligning said extrusion with a means for dispensing a solidifiable spacer material of low thermal conductivity into said cavity, by engaging said convexly extending web member with means for aligning said extrusion;
   - filling said cavity with said solidifiable spacer material from said dispensing means; and
   - solidifying said spacer material to form a rigid spacer member constrained within said cavity.
16. A process as in claim 15 wherein said spacer material comprises a resinous insulating material and wherein said solidification step comprises the step of curing said resinous material to harden it.

17. A process as in claim 15 further including the step of perforating said flange members prior to said alignment step to provide a plurality of holes therein.

18. A process as in claim 15 further including the step of machining a longitudinally extending slot in said web member.

19. A process as in claim 18 wherein said machining is carried out by milling.

20. A process as in claim 19 wherein said solidifiable spacer material comprises a resinous insulating material and said solidifying step comprises the curing of said resinous material to harden it.