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Name	Execution Date
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Gary A. Jones	08/01/1999

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Patent Number:	5902447

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Total Attachments: 16
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ASSIGNMENT OF PATENT RIGHTS

We, Orin S. Johnson and Gary A. Jones, hereby assign to Am-Rad, Inc. the following two (2) United States Patents:

1. United States Patent No. 5,855,720 granted as of January 5, 1999, for a clamping head for use in joining plastic extrusions and method thereof. A copy of this Patent is attached hereto as Exhibit A; and

2. United States Patent No. 5,902,447 granted as of May 11, 1999, for the flashing head and method for joining plastic extrusions. A copy of this Patent is attached hereto as Exhibit B.

The Assignment herein runs in favor of Am-Rad, Inc.

The intent of this Assignment is to transfer any and all rights to the United States Patents attached hereto as Exhibit A and Exhibit B to Am-Rad, Inc. and for no other purposes.

Dated this 1st day of August, 1999.

Orin S. Johnson

Gary A. Jones

US005855720A

ıited States Patent [19]

nson et al.

[11] Patent Number: 5,855,720

[45] Date of Patent: Jan. 5, 1999

CLAMPING HEAD FOR USE IN JOINING PLASTIC EXTRUSIONS AND METHOD THEREOF

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Appl. No.: **842,006**

Filed: **Apr. 23, 1997**

Related U.S. Application Data

3] Continuation-in-part of Ser. No. 614,530, Mar. 13, 1996, abandoned.

1] **Int. Cl.**[6] **B29C 65/14**

2] **U.S. Cl.** **156/272.2**; 156/282; 156/304.2; 156/304.6; 156/359; 156/498

58] **Field of Search** 156/272.2, 282, 156/304.2, 304.6, 359, 379.6, 499, 503, 267, 498

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Primary Examiner—Michael W. Ball
Assistant Examiner—Sam Chuan Yao
Attorney, Agent, or Firm—Merchant, Gould, Smith, Edell, Welter & Schmidt, P.A.

[57] **ABSTRACT**

An apparatus and method for creating a flash-free weld between the ends of thermoplastic members, wherein the members are held in position by holders, the ends of the members are softened by a heater, the members and holders are brought together until the ends of the members are joined to result in a flash-free weld.

19 Claims, 9 Drawing Sheets

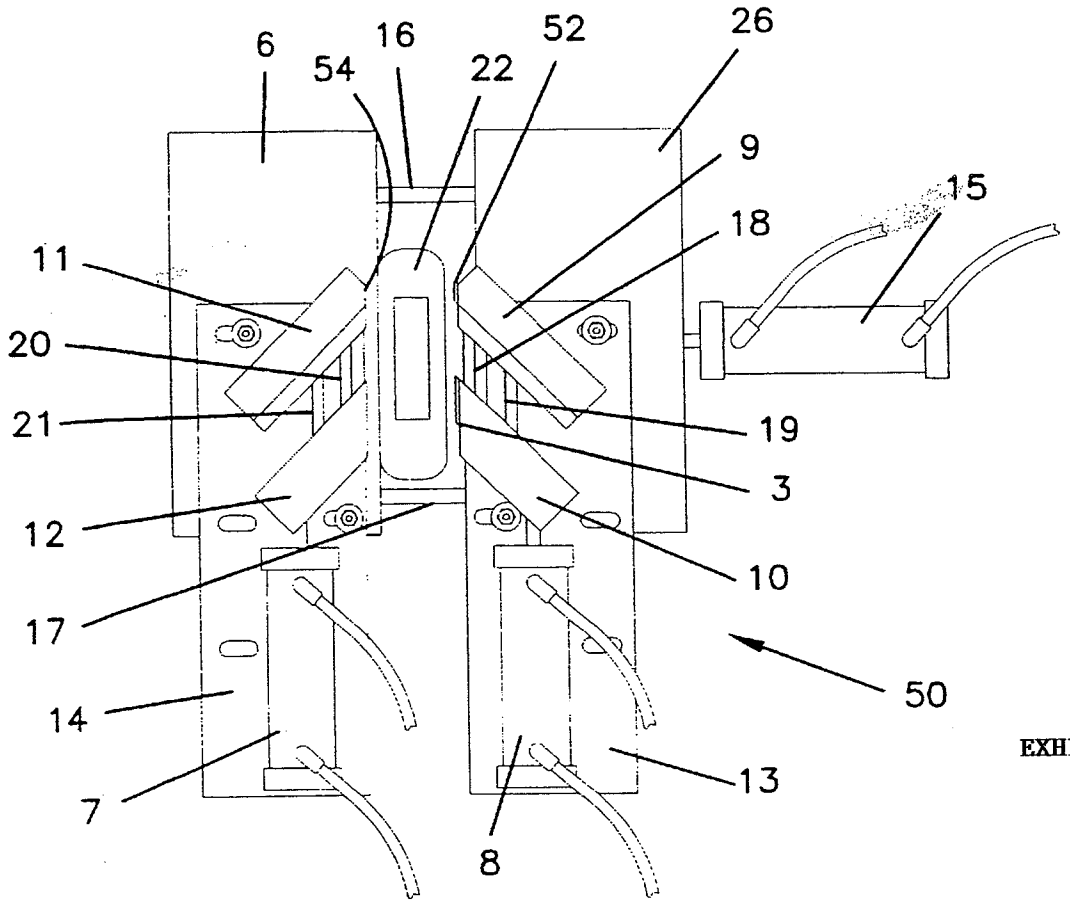


EXHIBIT A

FIG. 3

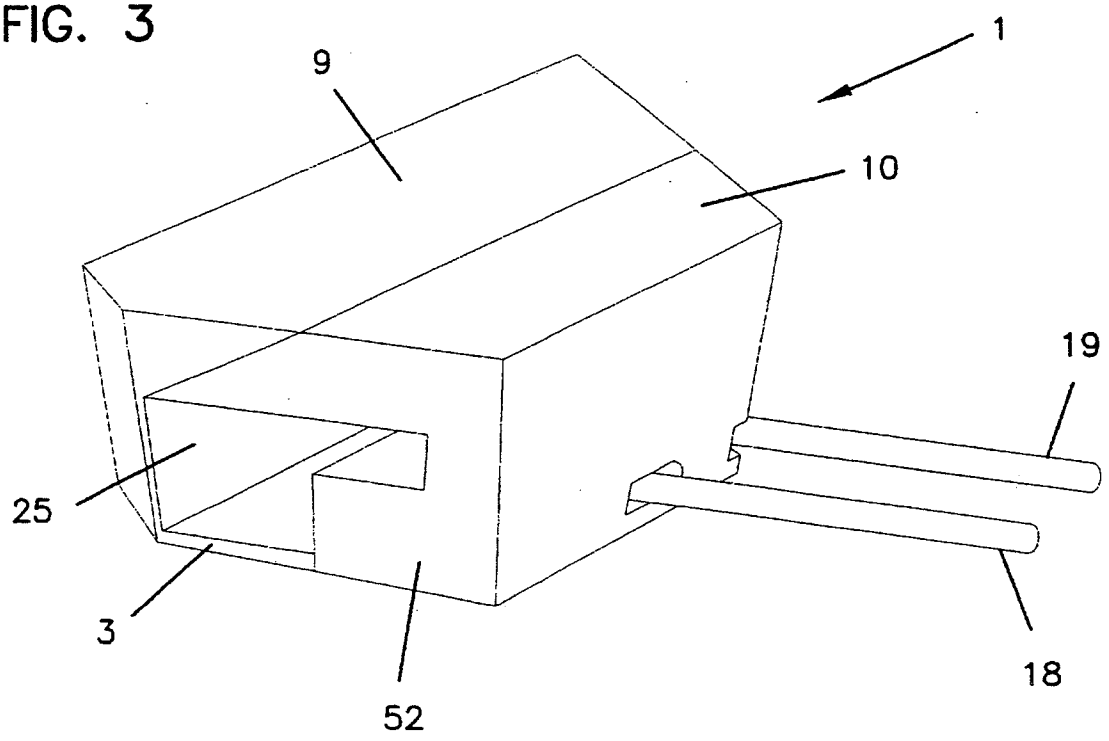


FIG. 4

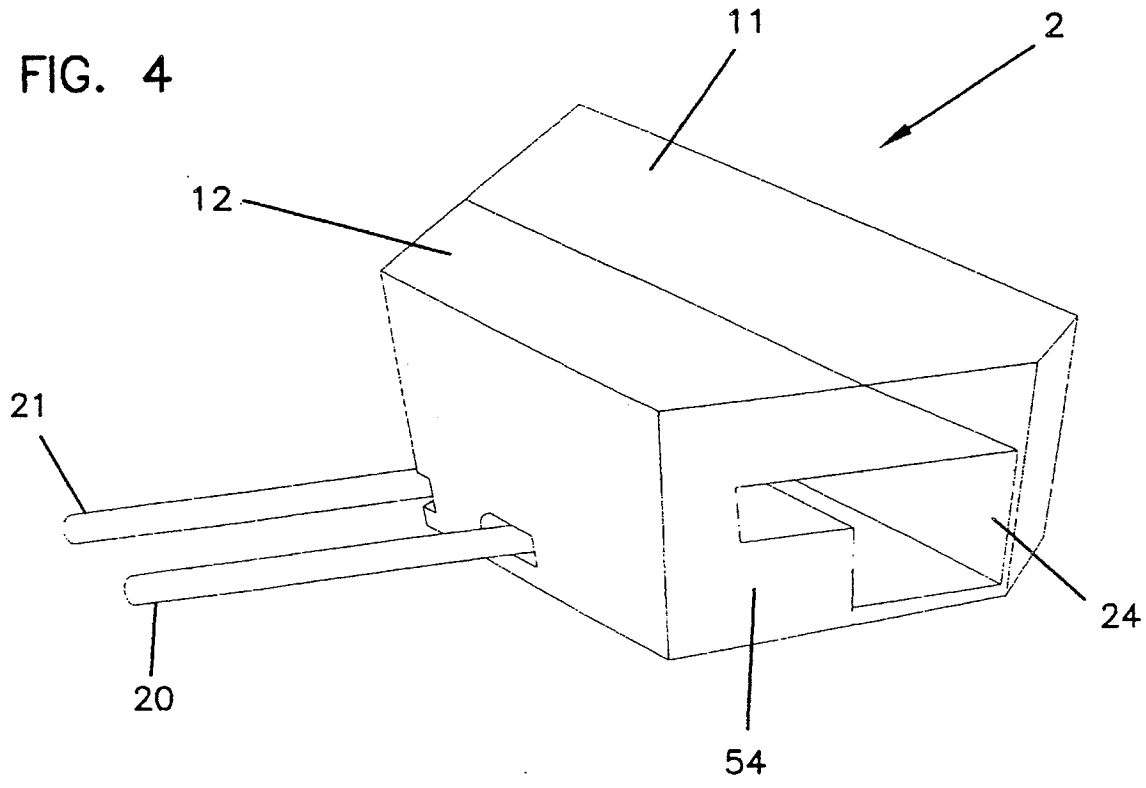


FIG. 6

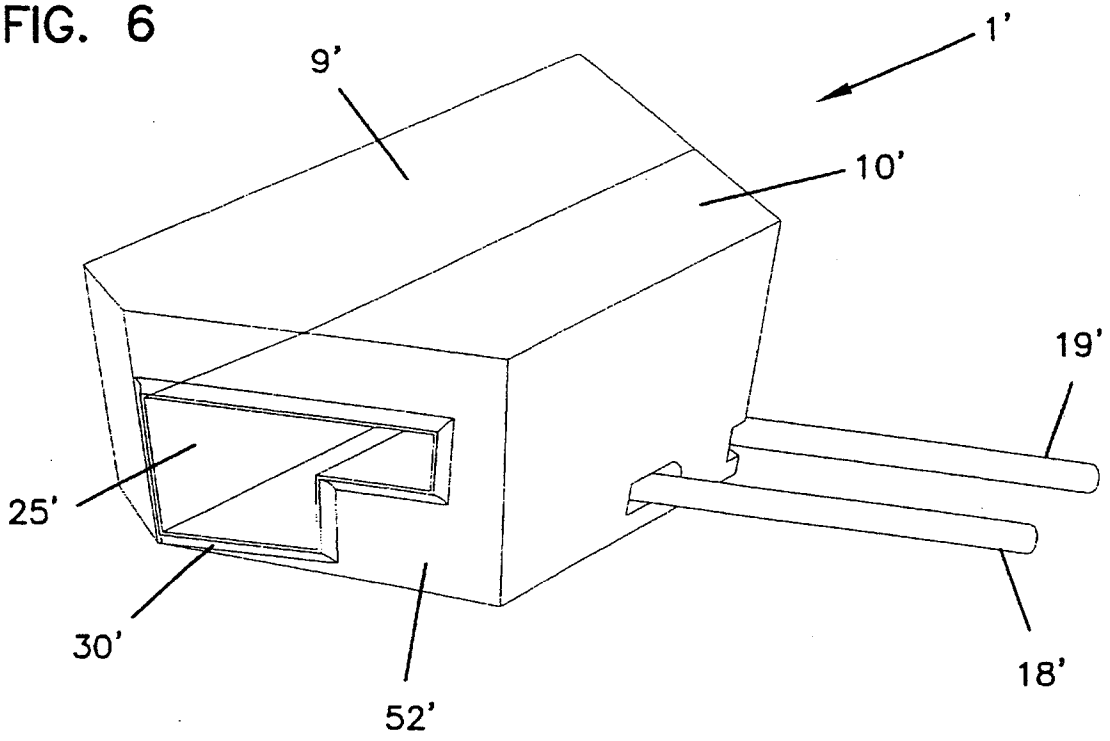


FIG. 7

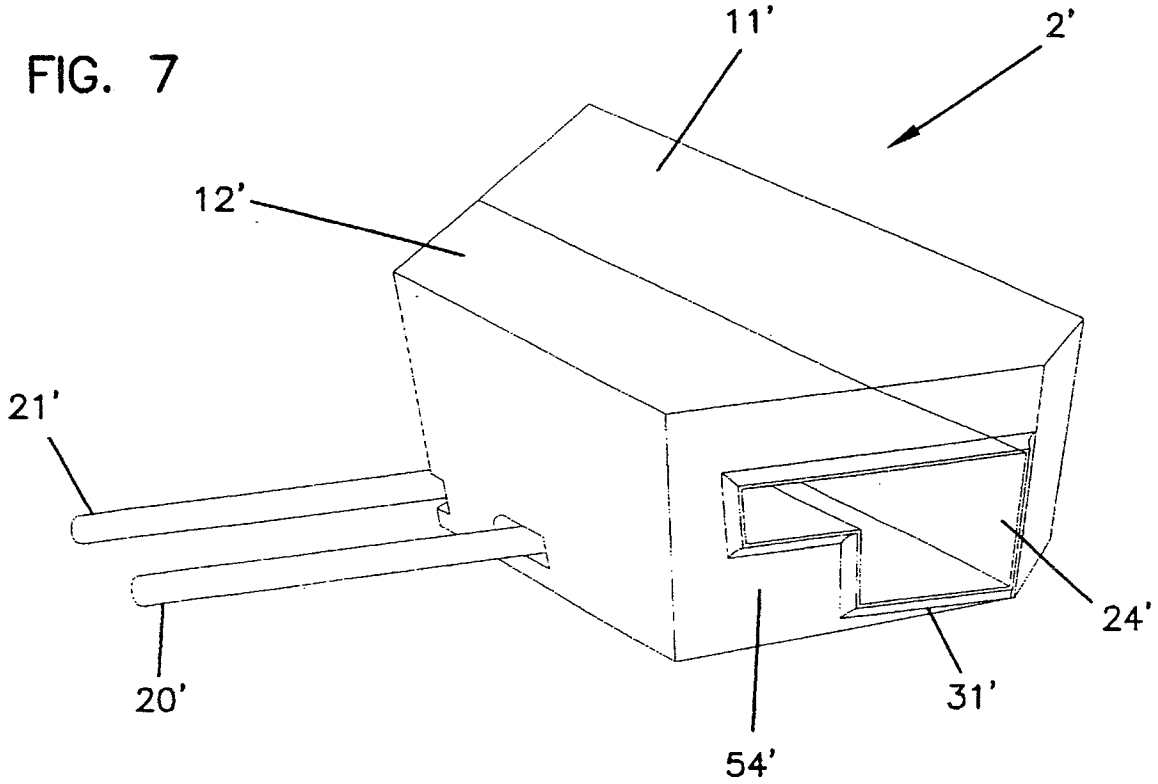


FIG. 9A

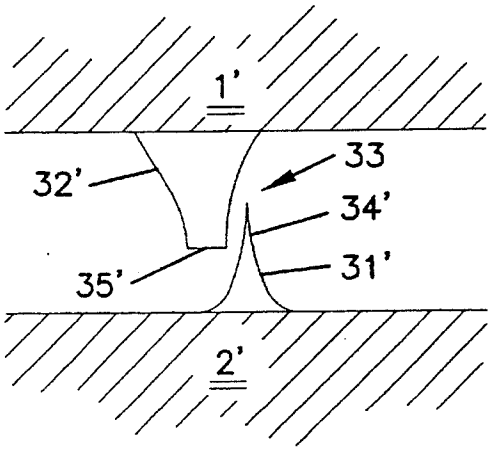


FIG. 9B

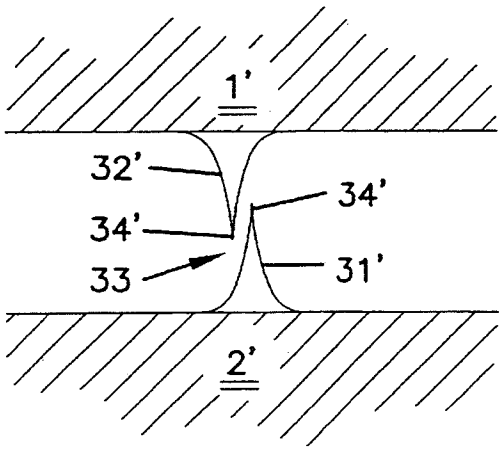


FIG. 10A

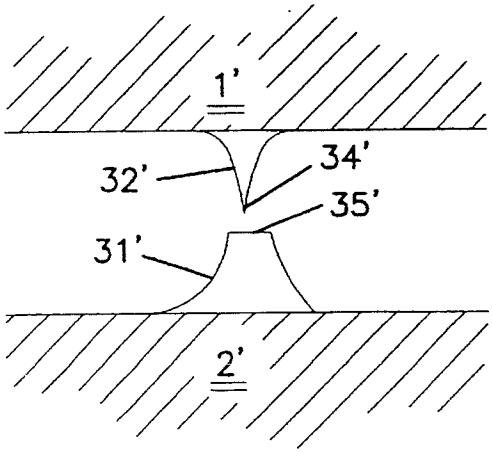


FIG. 10B

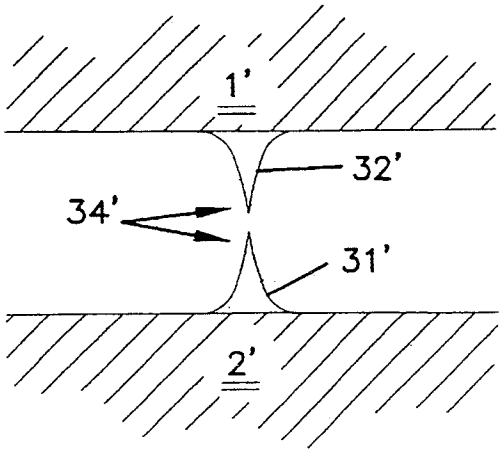


FIG. 13

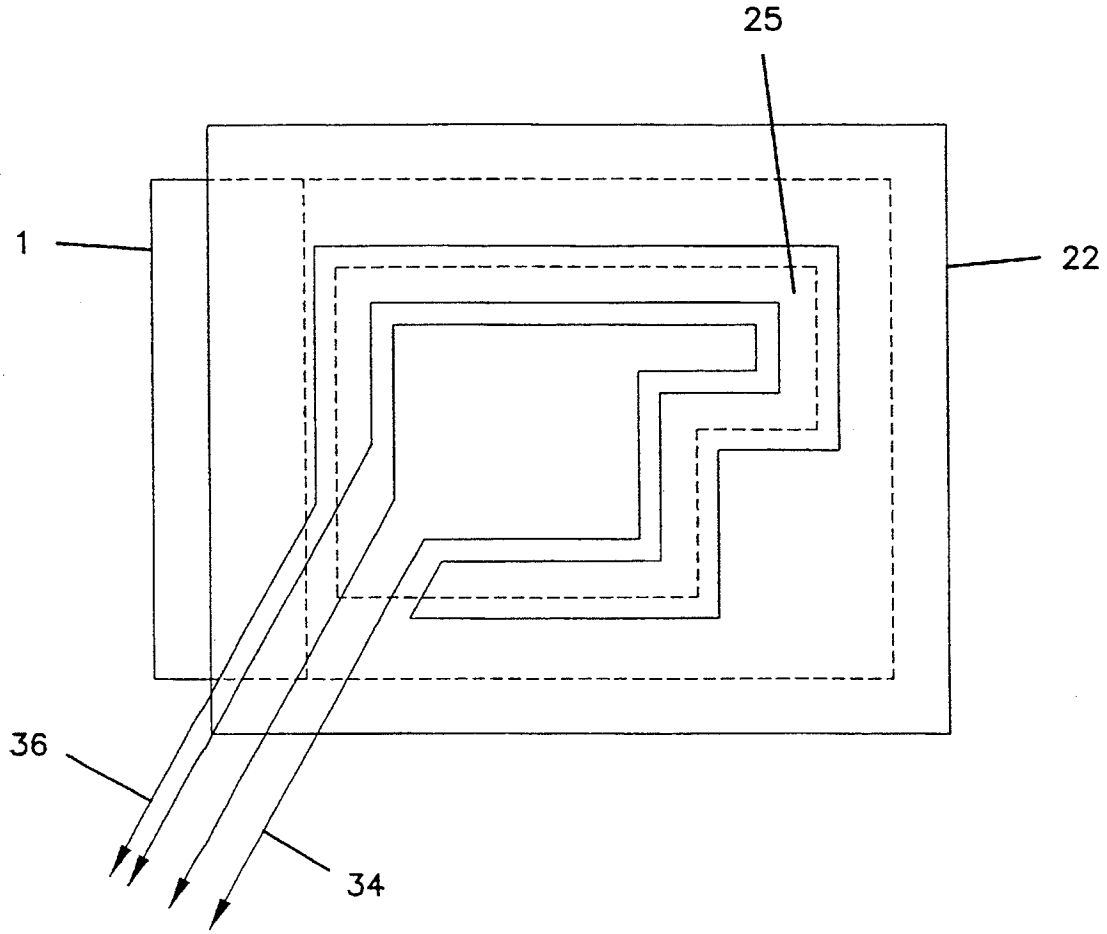
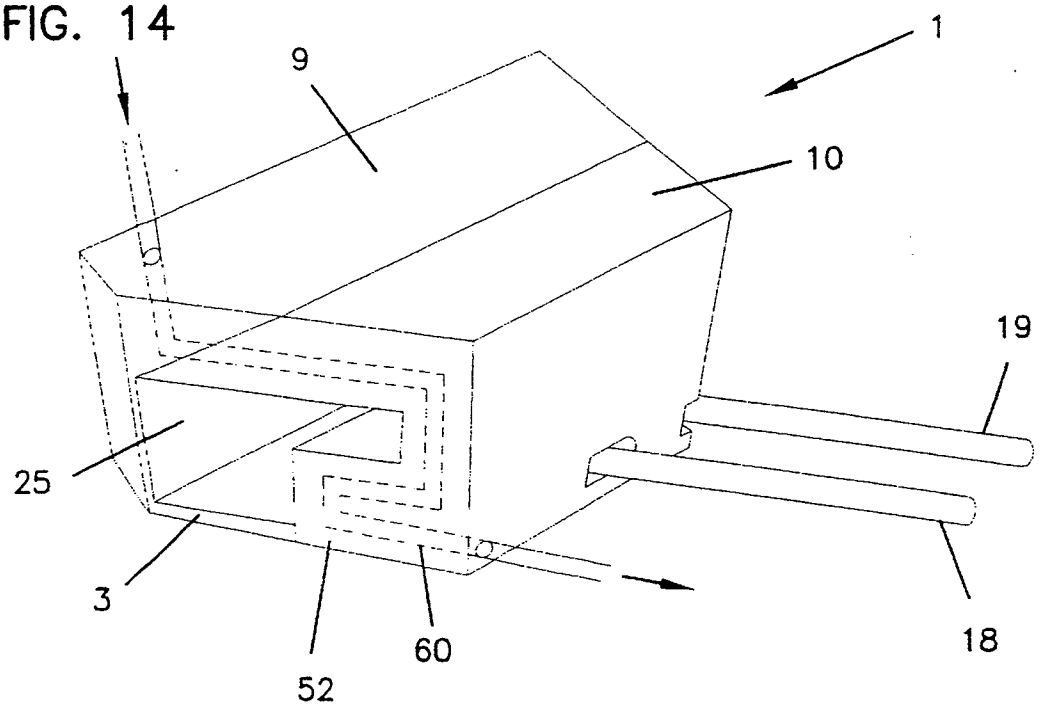


FIG. 14



CLAMPING HEAD FOR USE IN JOINING PLASTIC EXTRUSIONS AND METHOD THEREOF

This application is a continuation-in-part of application Ser. No. 08/614,530, filed on Mar. 13, 1996, now abandoned hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to an apparatus and process for welding thermoplastic members, and more particularly, to an apparatus and process for creating a substantially flash-free weld.

2. Description of Related Art

In order to weld thermoplastic members, to be used in window or door frames, for example, machines are known in which the thermoplastic members are clamped, the ends of the members are softened by a heating plate, and the softened ends are joined. The resulting flash can be removed while the joint is still warm or machined off after the joint has cooled. If the flash is to be removed after the joint has cooled, the welded members are removed from the welding apparatus and then placed in a second machine in which a router, grinder, or knife blade is used to remove the flash. Depending on the profile of the member, e.g., the inside surface where the window glass will rest, an additional step of removing some of the flash by hand may be necessary. Still other systems choose to remove the flash from the entire profile by hand.

If the flash is removed while still warm, deformation in the zone of the weld may result. To prevent this deformation, other systems, such as that disclosed in U.S. Pat. No. 4,239,574, use a two-step process of first, pinching the flash, and second, manually dragging a scraper around the edges of the joint to remove the remaining flash. The '574 patent discloses a guide means to guide the scraper around the area of the weld, but the actual removal of the flash is not caused by the clamping head, but by a manual scraper. All these systems require additional time, effort, and apparatus to remove the flash after the weld is formed.

SUMMARY OF THE INVENTION

To overcome the limitations in the prior art described above, and to overcome other limitations that will become apparent upon reading and understanding the specification, the present invention discloses an apparatus and process to create a flash-free weld for thermoplastic members.

The present invention solves the above-described problems by providing a clamping head with which thermoplastic members are heated by radiant heat so that the ends of the members are not contaminated, thereby avoiding the necessity of generating flash to dispose of the contaminated thermoplastic. Alternatively, the clamping head has one or more cutting edges in the profile of the members that forcefully engage the holders or each other, thus cutting off the flash without deforming the surface of the member.

One embodiment of a clamping head of the present invention includes two holders, each holder having an opening in a face shaped in the profile of a thermoplastic member. The clamping head also includes a moving structure for moving the heads between an open and a closed position. In the open position, the holders are spaced apart. In the closed position, the holders are engaged. The ends of heater can be moved toward and away from a position between the two holders.

Another embodiment of the present invention includes providing extensions on the faces of both holders with one or, alternatively, both extensions having a cutting edge, for removing the flash by cutting it with the cutting edge when the holders are brought together.

In one aspect of the above implementation, the holders include two blocks which can be separated to insert or remove a thermoplastic member or welded piece and can be urged together to clamp a member.

In another aspect, the holder includes a channel through which fluid can flow to cool the member after or during heating.

In another embodiment, the holder has a heat shield made using a portion of the holder, the heat shield being connected to the rest of the holder and designed for reducing the amount of heat transferred to portions of the thermoplastic member away from the end to be heated.

One further aspect is a heater having two or more heating zones with each zone having a heating element. One embodiment of this heater includes a peripheral zone for heating a peripheral region of each of the thermoplastic members and an interior zone for heating an interior region of each of the members.

Another embodiment of the invention is directed to a method for creating a flash-free weld by placing a thermoplastic member in each of two holders. The holders each have an opening in their faces in the profile of the corresponding member. The holders are placed in an open position with the holders spaced apart and a heater is provided between the holders. The surfaces of the members are heated by the heater and then the holders are moved together, in the absence of the heater, into a closed position. The heated surfaces of the two members engage to form a weld.

In one implementation of this embodiment, the two holders each have an extension surrounding at least a portion of the opening. One or, alternatively, both of the extensions have a cutting edge. The cutting edge removes the flash as the holders are moved together.

These and various other advantages and features of novelty which characterize the invention are pointed out with particularity in the claims annexed hereto and form a part hereof. However, for a better understanding of the invention, its advantages, and the objects obtained by its use, reference should be made to the drawings which form a further part hereof, and to accompanying descriptive matter, in which there is illustrated and described specific examples of an apparatus in accordance with the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

FIG. 1 is a top view of an embodiment of a clamping head, according to the invention;

FIG. 2 is a top plan view of the clamping head of FIG. 1 mounted on a moving structure, according to the invention;

FIG. 3 is a perspective view of an embodiment of a first holder, according to the invention;

FIG. 4 is a perspective view of an embodiment of a second holder, according to the invention;

FIG. 5 is a perspective view of expanded holders of FIGS. 3 and 4 separated into blocks for removal or insertion of

rods **20**, **21** (see FIG. **4**) which are attached to a piston **7**. Piston **7** opens and closes holder **2**. Pistons **7**,**8** may be hydraulically, pneumatically, or manually controlled. In one embodiment of the invention, pistons **7**,**8** are connected to a controller which opens and closes holder **1** and holder **2** substantially simultaneously.

FIG. **5** shows welded member **23** removed from blocks **9**,**10** of holder **1** and blocks **11**,**12** of holder **2**. Welded member **23** is not removed by separating holder **1** from holder **2**, as that would break the weld. Rather, welded member **23** is removed by opening blocks **9**,**10** and blocks **11**,**12**. Blocks **9**,**10** are opened by piston **8** and blocks **11**,**12** are opened by piston **7**.

In an alternative embodiment of the first and second holders, illustrated in FIGS. **6**–**7**, holder **1'** has an extension **30'** integrally formed on holder **1'**. Extension **30'** protrudes from face **52'** and surrounds opening **25'**. Holder **2'** has an extension **31'** integrally formed on holder **2'** which protrudes from face **54'** and surrounds opening **24'**. FIG. **8** is a side view of holder **1'** which shows that extension **30'** surrounds opening **25'** and is in the profile of thermoplastic member **4**. Extensions **30'**, **31'** may have a blunt head **35'** or a cutting edge **34'** as shown in FIGS. **9**A–B and **10**A–B. In some embodiments, one of extensions **30'**, **31'** has a cutting edge **34'**, and the other has a blunt edge **35'**, as shown in FIGS. **9**A,**10**A. Alternatively, both extensions **30'**, **31'** have cutting edges **34'**, as illustrated in FIGS. **9**B,**10**B. Cutting edges **34'** are sharpened to cut flash formed during the welding of thermoplastic members **4**,**5**.

Profiles of several embodiments of extensions **30'**, **31'** are shown in FIGS. **9**A–B and **10**A–B. In the embodiments illustrated in FIGS. **9**A-B, extensions **30'**, **31'** are slightly offset to provide an overbite. By "offset," it is meant that when holders **1'**, **2'** are brought together, one of the extensions is displaced from the other by a space **33** so that the two edges do not engage each other. Space **33** is defined as the nearest distance between adjacent edges of extensions **30'**, **31'** In one preferred application, space **33** between cutting edges **30'**, **31'** is about $\frac{1}{1000}$ to about $\frac{1}{16}$ inch and more preferably about $\frac{1}{500}$ to about $\frac{1}{100}$ inch.

When holders **1'**, **2'** are brought together to weld the thermoplastic members in the holders, extension **30'** passes adjacent to extension **31'** so that extension **30'** engages holder **2'** and extension **31'** engages holder **1'**.

Alternatively, the cutting edges are not offset, as shown in FIGS. **10**A–B, so that when holders **1'**, **2'** are brought together, the two extensions **30'**, **31'** engage each other. Typically, either one extension **30'**, **31'** has a cutting edge **34'** and the other extension has a blunt edge **35'**, as shown in FIG. **10**A, or both extensions **30'**, **31'** have cutting edges **34'**, as shown in FIG. **10**B.

Both extensions **30'**, **31'** and edges **34'**, **35'** are integrally formed with their respective holders **1'**, **2'** so that no other attachment means are necessary. Extensions **30'**, **31'** typically extend approximately $\frac{1}{16}$" to $\frac{1}{8}$" beyond the face of the holder. Cutting edges on one or more of the extensions remove all of the flash from a weld so that no extra steps must be performed or other tools used to remove flash to obtain a clean joint. Because of the force necessary to clamp members **4**,**5**, it is recommended that the cutting edge or edges **34'** be made of a hard, non-corrosive material, such as tempered or stainless steel, so that they are sufficiently sharp and strong to cut the flash.

Because the shape of cutting edge or edges **34'** is typically in the profile of members **4**,**5**, all the flash surrounding the weld is removed. Deformation in the welded area is minimized because the shape of the softened ends of the members **4**,**5** is held intact by holders **1'**, **2'** as the cutting edges **34'** on one or more of extensions **30'**, **31'** pinch off the flash. In some cases, however, it may not be necessary to remove the flash from all edges of the joint. In such cases, a cutting edge need only be provided along the edge of the opening where is it necessary to cut off the flash.

Returning to FIGS. **1**–**2**, holders **1**,**2** are part of an apparatus **50** for forming a flash-free weld between the ends of two thermoplastic members **4**,**5**. Holders **1**,**2** are mounted on a moving structure **56** configured for moving holders **1**,**2** toward and away from one another so that, for example, members **4**,**5** can be separated during heating and then moved together to form a weld. One embodiment of moving structure **56**, illustrated in FIG. **2**, includes a piston **15** for moving holder **1** towards holder **2** by sliding a mounting plate **26**, upon which holder **1** is mounted, towards a mounting plate **6**, upon which holder **2** is mounted. Piston **15** may be hydraulically, pneumatically, or manually controlled. Moreover, piston **15** may be part of moving structure **56** or may be provided as part of an external apparatus, not shown, on which moving structure **56** is mounted. This external apparatus also includes structures, such as guide rods **16**,**17**, for positioning mounting plate **26** correctly with respect to mounting plate **6** so that a proper weld is formed. Other methods and structures may be used to position and mount moving structure **56** on an external welding apparatus.

Moving structure **56** moves holders **1**,**2** between a closed position, shown in FIG. **2**, and an open position, shown in FIGS. **11**–**12**. In the open position, faces **52** and **54** are spaced apart from one another. FIG. **11** shows blocks **9**,**10** and blocks **11**,**12** in an open position so that thermoplastic members can be inserted into holders **1**,**2**. FIG. **12** shows members **4**,**5** clamped into holders **1**,**2**.

When holders **1**,**2** are separated, a heater **22** (shown in FIGS. **11** and **12**) is provided between holders **1**,**2** to heat thermoplastic members **4**,**5**. As illustrated in our related application, Ser. No. 08/614,530, incorporated by reference herein, heater **22** does not touch members **4**,**5**; rather, radiant heat from heater **22** is used to soften members **4**,**5** to prepare the members for forming a weld. The amount of heat needed to soften the thermoplastic members will vary depending on the material and thickness of the members, the amount of time the members are exposed to the heater, and the distance between the heater and the members. As a non-limiting, illustrative example, members made of polyvinyl chloride having a thickness of approximately 0.070 inches which are exposed for about **9**–**35** seconds to a heater that is about ¼" away from the members and has a temperature between about 1100°–1500° F. should have sufficiently softened ends to produce a strong weld. Softer or thinner thermoplastic members will typically require less heat or less exposure time, and harder or thicker members will typically require a higher temperature or more exposure time.

By using a radiant heat source, the ends of members **4**,**5** are not contaminated by contact with the heat source. Although no particular theory with respect to this observation is asserted herein, it may be that because the ends are not contaminated, they can be welded together flash-free (i.e., the two ends can be welded together by touching the two ends together). In contrast, if the ends of the thermoplastic members are contaminated by contact with the heat source, as in conventional techniques, then significant flash is created as the contaminated material must be pushed away and removed from the weld site in order to produce a strong weld.

block **10** engages block **9**, thus clamping member **4**. After member **5** is placed between blocks **11**,**12**, piston **7** closes holder **2** by sliding block **12** along rods **20**,**21** until block **12** engages block **11**, thus clamping member **5**. Holders **1**,**2** are designed such that the opening through holders **1**.**2** is in the profile of members **4**.**5**, thus preventing members **4**.**5** from sliding when members **4**.**5** are clamped in holders **1**.**2**.

After members **4**.**5** are clamped in holders **1**.**2**, a heater **22** is raised between the ends of members **4**.**5** to soften the ends. Heater **22** may have a single heating element or may have multiple heating elements such as illustrated in FIG. **13**. Typically, heater **22** is positioned intermediate holders **1**.**2** and spaced a distance from members **4**.**5** to prevent contamination of the members by contact with the heater. Heater **22** heats the ends of members **4**.**5** to a temperature sufficient to soften the members. This temperature will vary depending on the material and thickness of the members. For polyvinyl chloride members having a thickness of about 0.070 inches and separated from the heater by about ¼", a heater temperature of about 1100°–1500° F. applied for about **9**–**35** seconds should sufficiently soften the ends of the members to produce strong weld. Once the ends of members **4**.**5** are softened, heater **22** is removed from between the ends of members **4**.**5**.

While the ends of members **4**.**5** are still soft, piston **15** moves holder **1** towards holder **2** by sliding mounting plate **26** towards mounting plate **6**. After holders **1**.**2** move together, illustrated in FIG. **2**, the softened ends of members **4**.**5** bond. Radiant heat is used and the resulting weld is relatively flash-free. After the weld has cooled sufficiently that the weld will not break or warp upon removal of members **4**.**5**, which are now joined as welded piece **23**, pistons **7** and **8** are engaged so that holders **1**.**2** are opened to allow removal of welded piece **23**.

In an alternative embodiment, holders **1'**, **2'** with extensions **30'**, **31'** are used. The same steps described above in connection with FIGS. **11** and **12** are used. However, if extensions **30'**, **31'** are offset, as shown in FIGS. **9**A–B, extension **30'** engages holder **2'** and extension **31'** engages holder **1'**, when holders **1'**, **2'** are brought together. The one or more cutting edges **34'** on extensions **30'**, **31'** trim away the flash. If extensions **30'**, **31'** are not offset, as shown in FIG. **10**A–B, then extensions **30'**, **31'** will instead engage each other. The impact of the one or more cutting edges **34'** engaging each other, a blunt edge **35'**, or holders **1'**, **2'** removes the flash to create a flash-free weld. The one or more cutting edges **34'** completely cut off the flash from around the entire surface of the weld. No additional scraping is needed to remove the flash. In other words, the one or more cutting edges **34'**, by completely removing the flash, remove the need to perform the additional step of scraping off the flash.

The force exerted by the piston **15** is great enough that the one or more cutting edges **34'** cut the flash. The force exerted by pistons **7**,**8** to keep members **4**.**5** clamped in holders **1'**, **2'** should be great enough that members **4**.**5** do not slide within the holders.

The gap between holder **1'** and holder **2'** when they are closed together is determined by the thickness of extensions **30'**, **31'** The gap between the faces of holders **1'**, **2'** needs to be wide enough such that the flash is cut off and falls away. A larger gap is needed for thicker flash. Thicker flash can be formed, for example, if members **4**.**5** are clamped with longer portions extending beyond the face of holders **1'**, **2'**, or if members **4**.**5** are extruded from thicker thermoplastic. In this embodiment, recommended for 0.075" PVC members, extensions **30'**, **31'** have a thickness of ⅛". Members **4**.**5** extend approximately 1/16" each beyond extensions **30'**, **31'**, respectively. Furthermore, in order to accommodate thicker extrusions, a thicker cutting edge could be used or a cutting edge could be placed on both holders **1'** and **2'**.

If holders **1**.**2** or holders **1'**, **2'** include optional fluid channel **60** (see FIG. **14**) then cooling fluid may flow through channel **60** to cool members **4**.**5**. In one embodiment, fluid flows through channel **60** only after the weld between members **4**.**5** is formed to cool the weld more quickly and reduce the cycle time. Alternatively, fluid flows during at least a portion of the heating of members **4**.**5** by heater **22**, thereby reducing the amount of heat in portions of members **4**.**5** away from the ends of those members. Suitable cooling fluids include gases, such as air or nitrogen, and liquids, such as water.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention and in construction of this without departing from the scope or spirit of the invention. As an example, the inventors contemplate that holders **1**, **2** could be preheated, depending on the member to be welded. Holders **1**, **2** would be heated by one of several means contemplated. For example, holes could be drilled in the holders and a heater coil inserted in the holes. Alternatively, the holders could be heated by direct current resistance. Several advantages are realized by preheating the holders. For example, preheating better ensures a strength in accordance to industry standards. Furthermore, shorter cycle times would result.

The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

We claim:

1. A method for creating a flash-free weld when welding ends of thermoplastic members, comprising:

(a) placing a first thermoplastic member in a first holder, the first holder having a first face with a first opening shaped in a profile of the first member, the first face having a first extension protruding from the first face along at least a portion of the first opening, the first extension having a first cutting edge;

(b) placing a second thermoplastic member in a second holder, the second holder having a second face with a second opening shaped in a profile of the second member;

(c) positioning the first and second holders in an open position with the first face and the second face spaced apart;

(d) positioning a heater between the first and second holders and spaced apart from the first and second thermoplastic members, the heater having one or more heating zones, each zone having a heating element;

(e) radiantly heating a surface of the first member and a surface of the second member with the heater spaced apart from the first and second thermoplastic members; and

(f) moving the first and second holders together, in the absence of the heater, into a closed position to weld together the heated surfaces of the first and second members and to engage the first cutting edge and the

protruding from the second face along at least a portion of the second opening, the second extension having a second cutting edge, the second cutting edge being offset from the first cutting edge;

(c) positioning the first and second holders in an open position with the first face and the second face spaced apart;

(d) positioning a heater between the first and second holders and spaced apart from the first and second thermoplastic members, the heater having one or more heating zones, each zone having a heating element;

(e) radiantly heating a surface of the first member and a surface of the second member with the heater spaced apart from the first and second thermoplastic members; and

(f) moving the first and second holders together, in the absence of the heater, into a closed position to weld together the heated surfaces of the first and second members and to engage (i) the first cutting edge and the second face and (ii) the second cutting edge and the first face to remove a flash arising from welding the first and second members.

19. The method of claim **11**, wherein the first extension surrounds the first opening and the second extension surrounds the second opening.

* * * * *

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United States Patent [19]

Johnson et al.

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[45] Date of Patent: May 11, 1999

[54] **DEFLASHING HEAD AND METHOD FOR JOINING PLASTIC EXTRUSIONS**

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Related U.S. Application Data

[63] Continuation of application No. 08/614,530, Mar. 13, 1996.

[51] **Int. Cl.**[6] **B29C 65/14**

[52] **U.S. Cl.** **156/499**; 156/433; 156/510; 156/556; 156/267; 156/304.2; 156/304.6; 156/309.9

[58] **Field of Search** 156/267, 304.2, 156/304.6, 309.9, 556, 499, 510, 433, 515

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Attorney, Agent, or Firm—Merchant, Gould, Smith, Edell, Welter & Schmidt, P.A.

[57] **ABSTRACT**

An apparatus and method for creating a flash-free weld between the ends of thermoplastic members, wherein the members are held in position by holders, the ends of the members are softened by a heater, the members and holders are brought together until the ends of the members are joined to result in a flash-free weld.

14 Claims, 6 Drawing Sheets

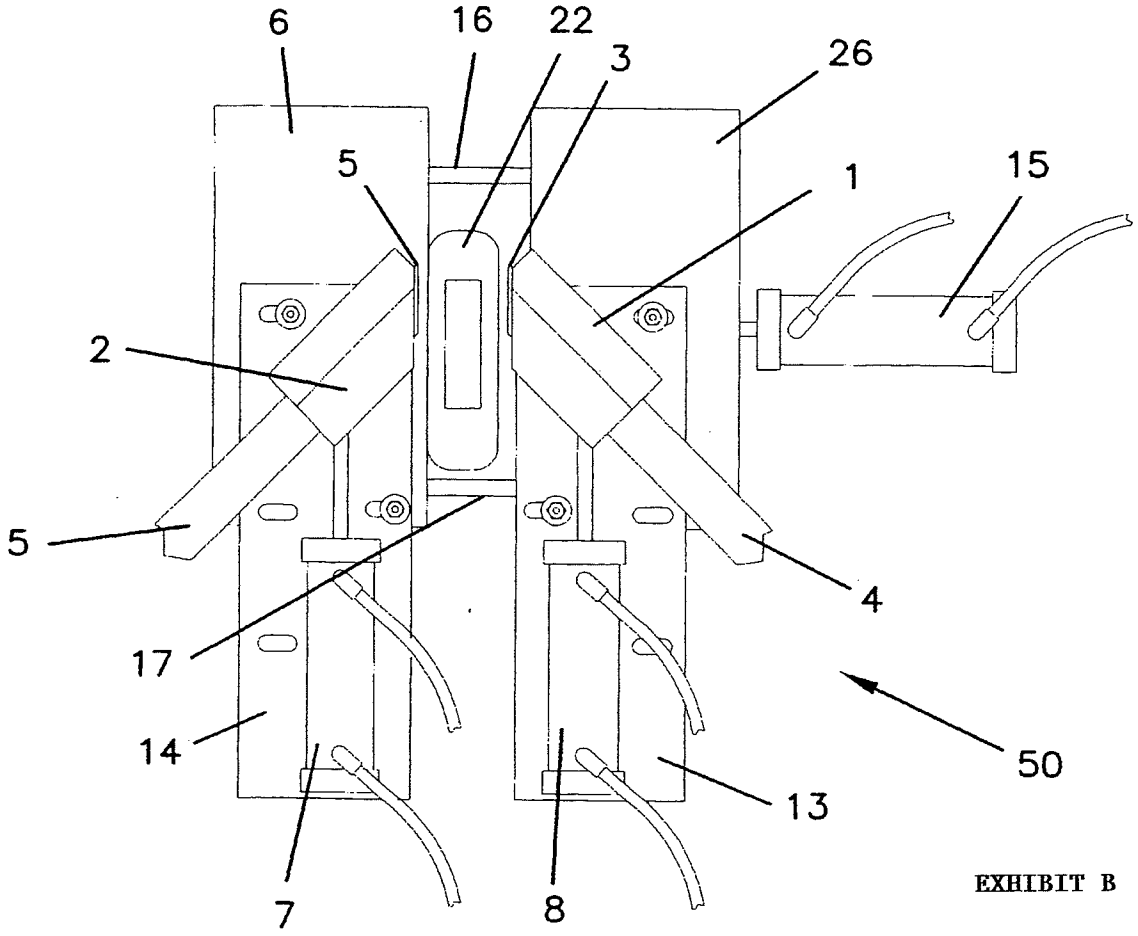


EXHIBIT B

FIG. 3

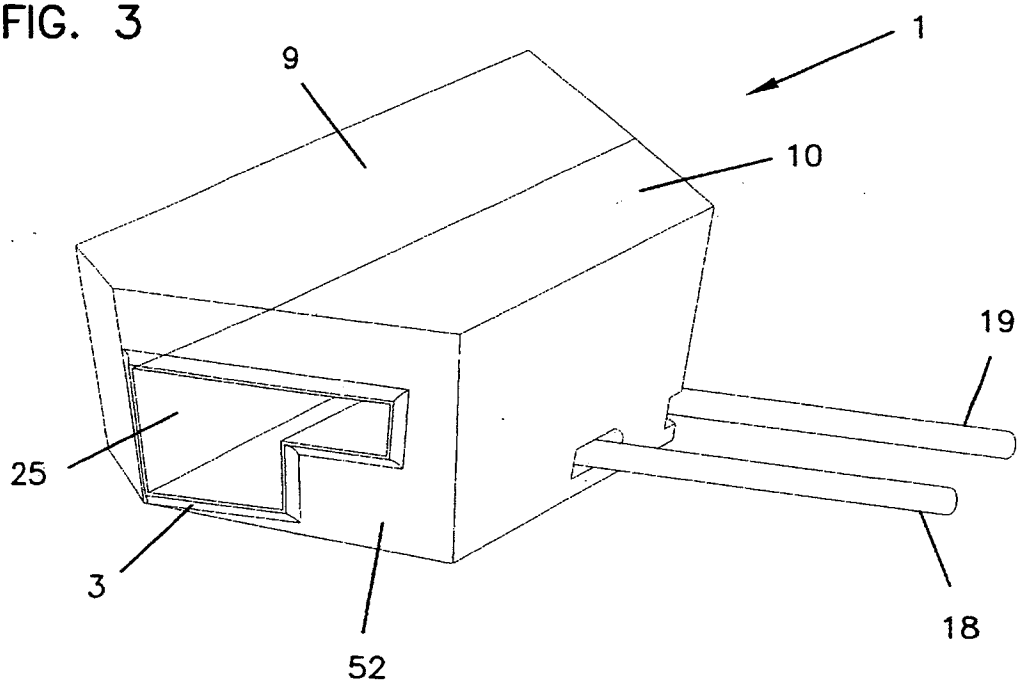


FIG. 4

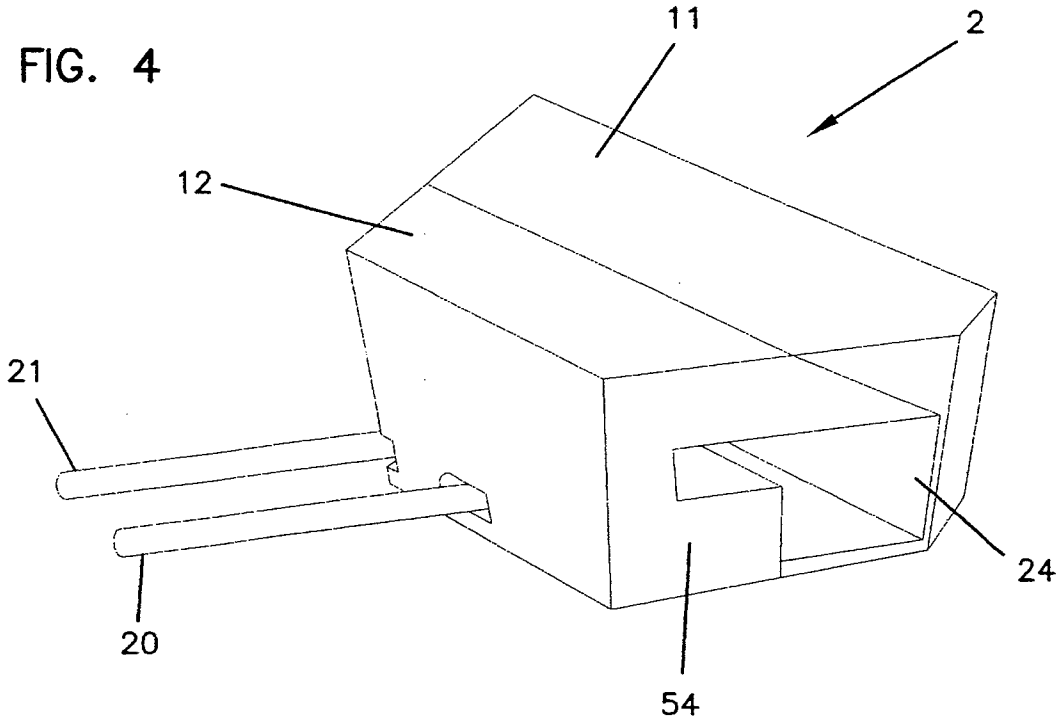
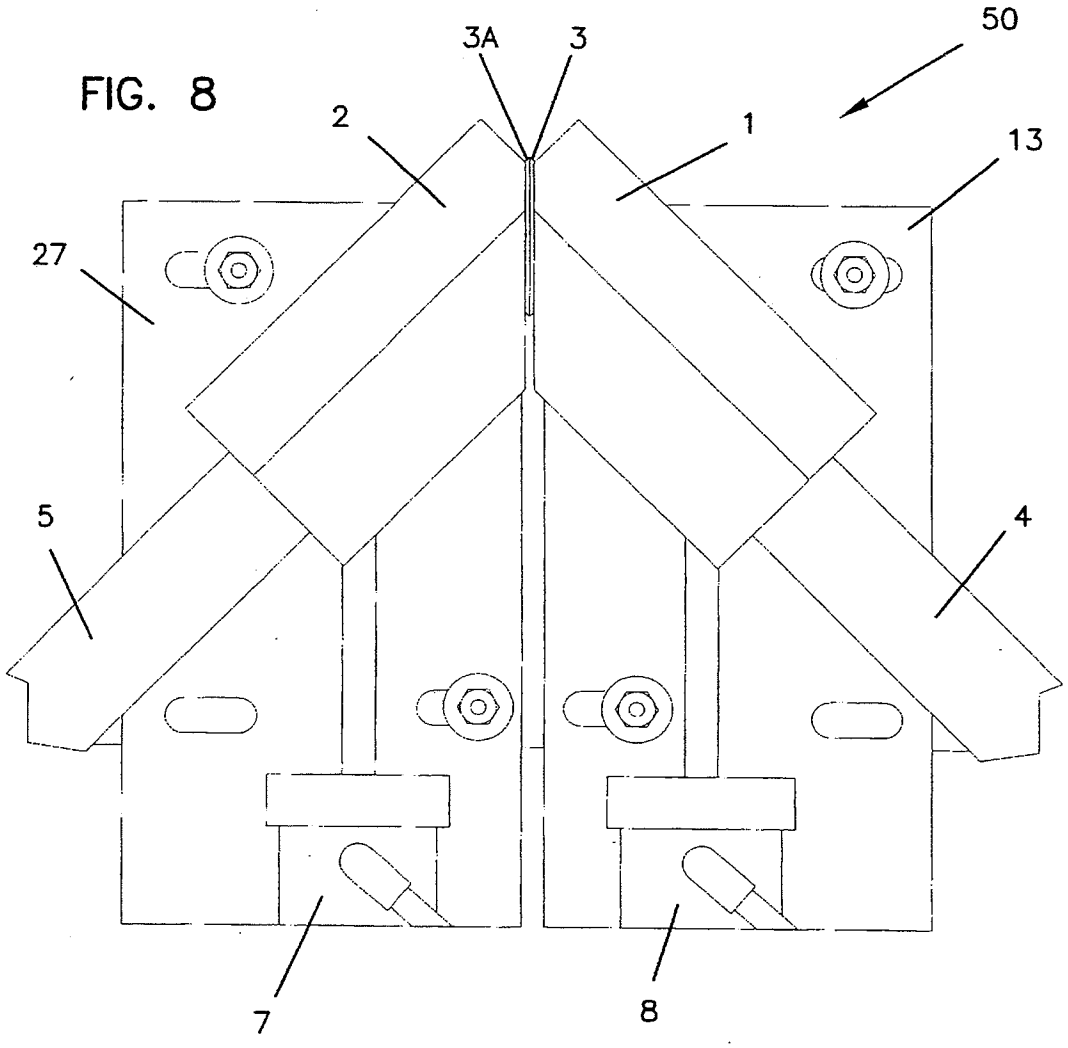


FIG. 8



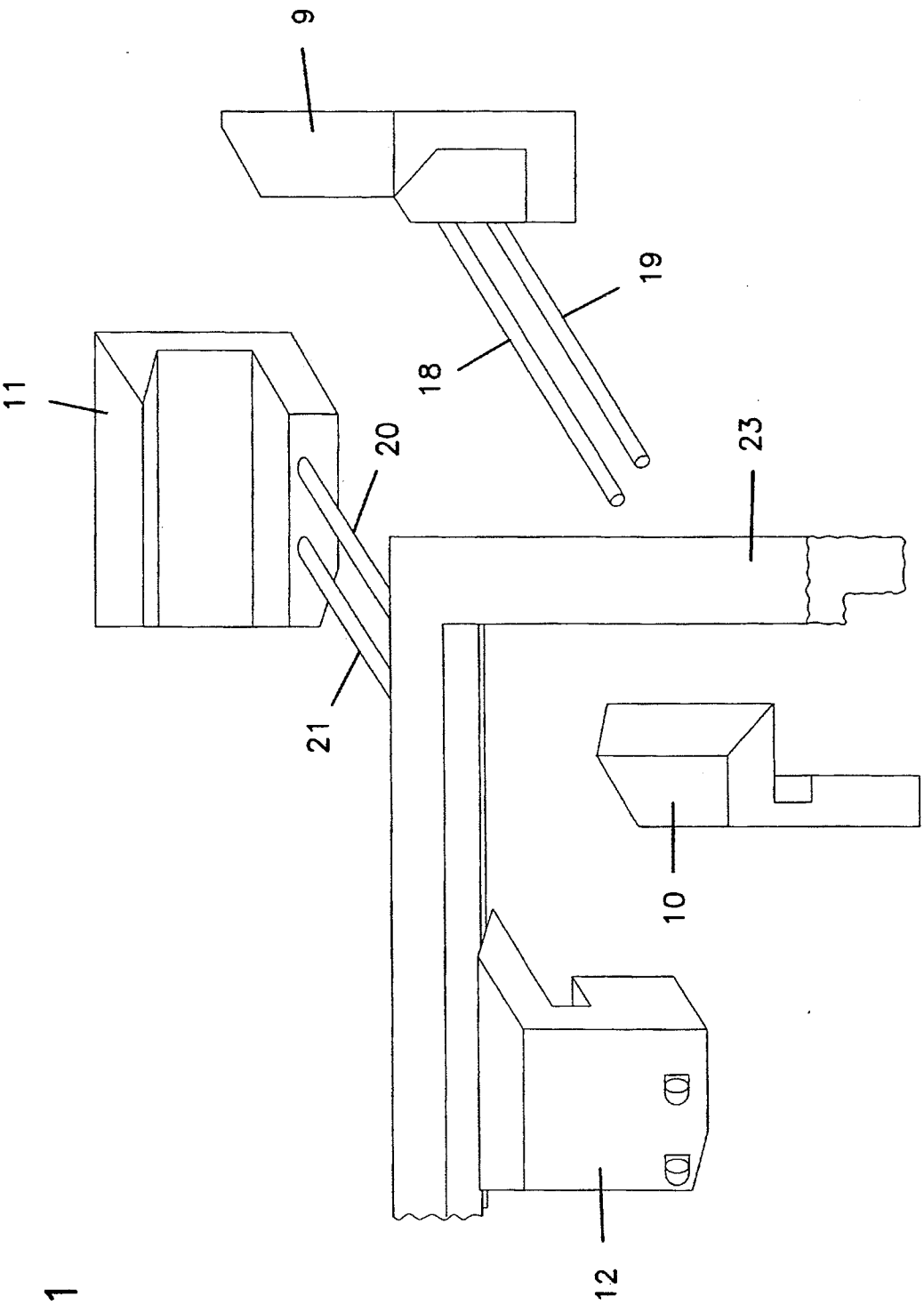


FIG. 11

holders are in the profile of the members. Since all the surfaces of the members are supported by the holders in the area of the weld, no deformation occurs as the ends of the members are pressed together and the cutting edge cuts the flash.

In accordance with the invention, an apparatus creates a flash-free weld when welding the ends of thermoplastic members. As embodied herein, and illustrated in the FIGS. an apparatus for creating a flash-free weld is shown generally at **50**.

In accordance with the invention, the apparatus includes first and second holders constructed and arranged for holding members to be welded together. In the particular embodiment illustrated in FIG. **1**, a first holder **1** and a second holder **2** are shown holding first and second members **4**, **5** to be welded together. FIG. **5** illustrates a side view of the holder **1**. In accordance with the invention, the first holder has a first planar face with a first opening shaped in the profile of the member, and the first opening is surrounded by a cutting edge protruding beyond the first planar face. As embodied herein and illustrated in FIG. **3**, first holder **1** defines a first planar face **52**. Along the surface of face **52** is an opening **25**, shaped in the profile of first member **4**. Completely surrounding the edge of opening **25** is a cutting edge **3**. Cutting edge **3** engages holder **2** to cut off the flash from a weld between thermoplastic first and second members **4** and **5**. Cutting edge is formed integrally with first holder **1**. No attachment means are necessary, as the cutting edge is formed and sharpened unitary with first holder **1**. As will be seen in the description which follows, this cutting edge completely surrounding the opening, in combination with the other features, functions to advantageously result in a weld with all of the flash removed. No extra steps must be performed or other tools used to remove flash, and result in a clean joint. It is contemplated by the inventors that in certain circumstances, depending on the particular application, it may not be necessary to remove the flash from all edges of the joint. In those cases, a cutting edge is only needed along the edge of the opening where is it necessary to cut off the flash.

In accordance with the invention, the second holder includes a second planar face with a second opening shaped in the profile of the second member. As illustrated in the embodiment of FIG. **4**, second holder **2** has a second planar face **54**. A second opening **24** is defined by the surface of face **54**. Second opening **24** is in the shape of a profile of second member **5**.

In accordance with the invention, the invention includes moving structure configured for moving the first and second holders toward and away from one another along linear paths between an open and closed position. It is envisioned by the inventors that the moving structure could be embodied in a wide variety of designs, provided that the first and second members are allowed to be first separate from each other while being heated and then moved together in order to be welded together. In one particular embodiment illustrated in the drawings, one moving structure is shown at **56** (FIG. **2**). The moving structure **56** illustrated in this particular embodiment includes a piston **15** for moving the holder **1** towards the holder **2** by sliding a mounting plate **26** towards a mounting plate **6** along rods **16** and **17**. The piston **15** may be hydraulically controlled or pneumatically controlled. Further, the inventors contemplate this may be manually operated, as well. Moving structure **56** moves the holder **1** and holder **2** between open and closed positions. One open position is illustrated in FIGS. **9** and **10**. In the open position, first planar face **52** and second planar face **54** are parallel and spaced apart from one another. A closed position is illustrated in FIGS. **1** and **2**. In the closed position, first planar face **52** and second planar face **54** remain parallel to each other, but cutting edge **3** engages the second planar face **54**. As will be explained below, this results in a flash-free weld.

In accordance with the invention, first and second holders include first and second blocks for holding a member therein. As embodied herein and illustrated in FIG. **3**, first holder **1** includes two sections, block **9** and block **10**, which separate to accept first member **4** inside first holder **1**. Second holder **2** includes two sections, block **11** and block **12**, which separate to accept second member **5** inside second holder **2**.

The invention includes mounting structure for slidingly mounting the blocks for movement toward and away from one another along linear paths between expanded positions, wherein the members are placed intermediate the blocks, and contracted positions, wherein the second block engages the first block fixably enclosing the members. In the particular embodiment shown in the drawings herein, block **10** is slidably mounted to the block **9** by mounting rods **18** and **19**, which are urged together by piston **8**. Block **12** is slidably mounted to the block **11** by mounting rods **21** and **20**, which are urged together by piston **7**. Pistons **7**, **8** may be hydraulic or pneumatically controlled. The inventors contemplate a variety of other ways of slidingly mounting the blocks.

FIGS. **3** and **4** show the holders **1** and **2**, respectively, in clamped positions. FIG. **11** shows an expanded view of the holders **1** and **2**. The blocks **9** and **10**, including holder **1**, and the blocks **11** and **12**, including the holder **2**, are in an expanded position, such that welded thermoplastic member **23**, formed from welding the members **4** and **5** shown in FIG. **1**, can be removed from the holders **1** and **2**. The blocks **9** and **10** clamp the member **4** such that the opening created through the holder **1** is in the profile of member **4**. The force exerted on the block **9** clamping the blocks **9** and **10** together is great enough that the member **4** cannot slide within the holder **1**. The design of the holder **1** is such that when the holder is open, the blocks **9** and **10** separated, the member **4** can be inserted into the holder or the welded member **23** can be removed from the holder **1**. When the members **4** and **5** are welded, the flash is removed by the cutting edge **3** on the holder **1**, in FIG. **3**, engaging the holder **2** on the planar surface surrounding the opening **24**, in FIG. **4**.

FIG. **6** is an end view of holder **1**. The cutting edge **3** is on the face of the holder **1** and is in the profile of the member **4**. The cutting edge **3** surrounds the opening **25** in the holder **1** that extends through the holder **1**. In FIG. **4**, the holder **2** has opening **24** on its face that extends Although the holder **2**. The opening **24** is in the profile of the member **5**.

FIG. **7** shows a cross-section of the cutting edge **3** in FIG. **6**. The cutting edge **3** extends approximately ⅛" beyond the face of the holder **1**. Because the opening **24** in the holder **2**, and the cutting edge **3** and the opening **25** in the holder **1**, are in the profile of the members **4** and **5**, deformation in the welded area is minimized because the shape of the softened ends of the members **4** and **5** is held intact as the cutting edge **3** pinches off the flash. Furthermore, with the shape of the cutting edge **3** and the openings **24** and **25** in the profile of the members **4** and **5**, all the flash surrounding the weld is removed. No additional scraping is needed to remove the flash from interior surfaces of the welded member.

Because of the force necessary to clamp the members **4** and **5**, it is recommended that the holders **1** and **2** be

(c) moving structure configured for moving the first and second holders toward and a way from one another along paths between an open and closed position; the open position being when the first face and the second face are spaced apart from one another; and the closed position being when the first face and second face are parallel and the first cutting edge engages the second face; and

(d) a heater for softening ends of the first and second members; the heater being movable toward and away from a heating position where the member ends are softened;

(i) the heating position being: intermediate the first and second faces; and spaced from the ends of the first and second members a first distance when the first and second holders are in the open position.

2. An apparatus as recited in claim **1** wherein:

(a) said first cutting edge completely surrounds the first opening and protrudes beyond the first face.

3. An apparatus as recited in claim **1** wherein:

(a) the first holder further includes:

(i) first and second blocks for holding the first member; and

(ii) first mounting structure for slidingly mounting the blocks for movement toward and away from one another along linear paths between expanded positions, where the first member is placed intermediate the first and second blocks, and contracted positions, where the second block engages the first block fixably enclosing the first member.

4. An apparatus as recited in claim **3** wherein:

(a) the second holder further includes:

(i) third and fourth blocks for holding the second member; and

(ii) second mounting structure for slidingly mounting the third and fourth blocks for movement toward and away from one another along linear paths between expanded positions, where the second member is placed intermediate the third and fourth blocks, and contracted positions, where the third block engages the fourth block fixably enclosing the second member.

5. An apparatus as recited in claim **4** wherein:

(a) the first mounting structure includes:

(i) first parallel mounting rods attached at a proximate end of the first block; the second block being slidably attached to the first mounting rods.

6. An apparatus as recited in claim **5** wherein:

(a) the second mounting structure includes:

(i) second parallel mounting rods attached at a proximate end of the third block; the fourth block being slidably attached to the second mounting rods.

7. An apparatus as recited in claim **1** wherein:

(a) said first and second faces are planar.

8. An apparatus as recited in claim **2** wherein:

(a) said first holder and said first cutting edge comprise steel; and

(b) said second holder and said second cutting edge comprise steel.

9. An apparatus for creating a flash-free weld when welding ends of thermoplastic members comprising:

(a) a first holder constructed and arranged for holding a first member; the first holder having a first face with a first opening shaped in a profile of the first member;

(i) said first holder including a first cutting edge along at least a portion of said first opening; said first cutting edge protruding outwardly beyond said first face;

(b) a second holder constructed and arranged for holding a second member to be joined; the second holder having a second face with a second opening shaped in a profile of the second member;

(i) said second holder including a second cutting edge along at least a portion of said second opening; said second cutting edge protruding beyond the second face;

(c) moving structure configured for moving the first and second holders toward and away from one another along paths between an open and closed position; the open position being when the first face and the second face are spaced apart from one another; and the closed position being when the first face and second face are parallel and the first cutting edge engages the second cutting edge; and

(d) a heater for softening ends of the first and second members; the heater being movable toward and away from a heating position where the member ends are softened;

(i) the heating position being intermediate the first and second faces; and spaced from the ends of the first and second members a first distance when the first and second holders are in the open position.

10. An apparatus as recited in claim **9** wherein:

(a) said first cutting edge completely surrounds the first opening and protrudes beyond the first face; and

(b) said second cutting edge completely surrounds the second opening and protrudes beyond the second face.

11. An apparatus for joining the ends of two elongated thermoplastic members, comprising

first and second holders constructed and arranged for holding the members to be joined, the first holder having a first face with a first opening shaped in the profile of the member formed therein; the first holder having a first cutting edge along a portion of the first opening and protruding beyond the first face; the second holder having a second face with a second opening shaped in the profile of the member formed therein, wherein the first and second holders are configured for securing the members with ends projecting beyond the first and second openings and with the ends facing one another;

means for mounting the holders for movement toward and away from one another along linear paths between open positions, wherein the first face and the second face are spaced apart from one another, and closed positions, wherein the first face and second face are parallel and the first cutting edge engages the second face;

a heater for softening the member ends, the heater being movable toward and away from a heating position intermediate and non-touching the ends of the thermoplastic members when the holders are in the open positions;

means for moving the heater to the heating position and for removing the heater from the heating position after softening the member ends; and

means for moving the first and second holders to the closed positions to weld the softened member ends and to completely remove the flash when the first cutting edge engages the second face.

12. An apparatus as recited in claim **11** wherein:

(a) said first cutting edge completely surrounds the first opening.

13. An apparatus for joining the ends of two elongated thermoplastic members, comprising: