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[54] RADIATION SHIELDING MEANS JOINT

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[52] U.S. Cl. ..... 250/506, 250/106 R; 108 R
[51] Int. Cl. G21f 3/00
[58] Field of Search ..... 250/108 R, 108 WS, 250/106 R, 106 S

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Primary Examiner—Archie R. Borchelt
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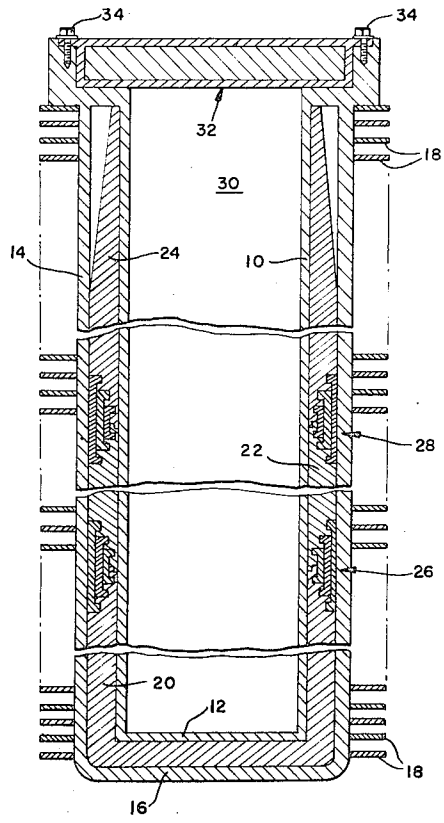
[57] ABSTRACT

A pair of radiation shielding members to be joined include end portions provided with mechanical interlock portions. The joint means includes one or more joint members having cooperating mechanical interlock portions in the form of peripherally extending ribs and grooves for mechanically interlocking the pairs of shielding members with one another. The joint members are arcuate even when the radiation shielding members are not of circular cross-sectional configuration, as for example when the radiation shielding members define a plurality of apexes.

17 Claims, 8 Drawing Figures



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SHEET 1 OF 2

FIG. 1.

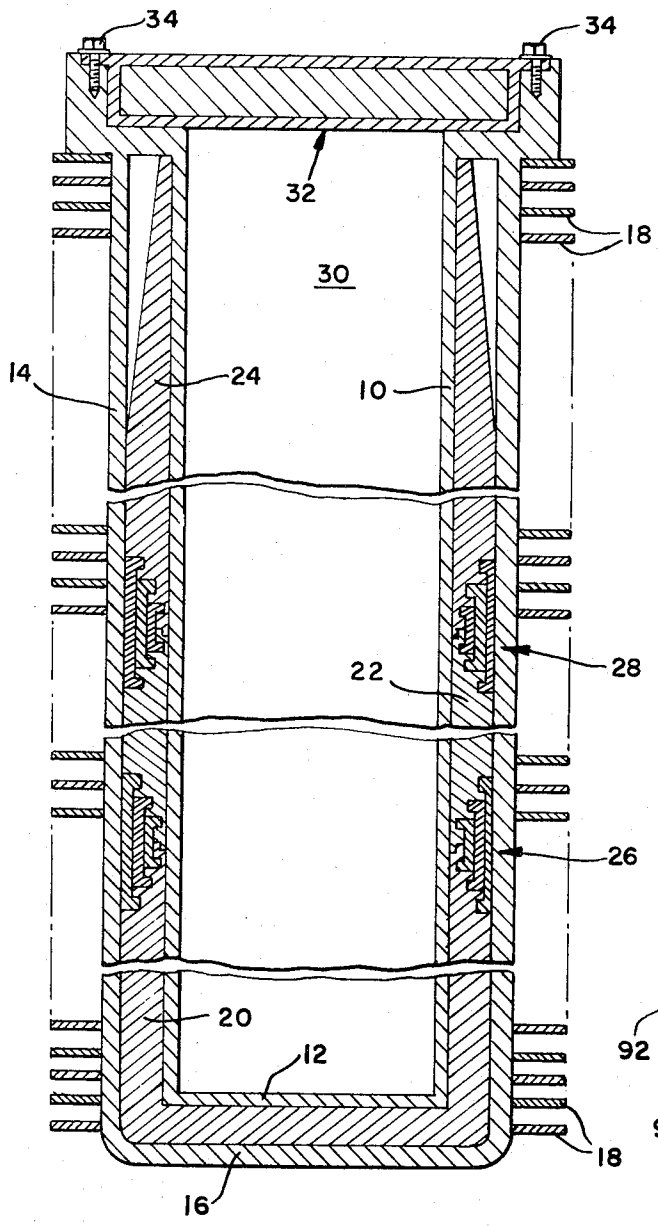

FIG. 2.

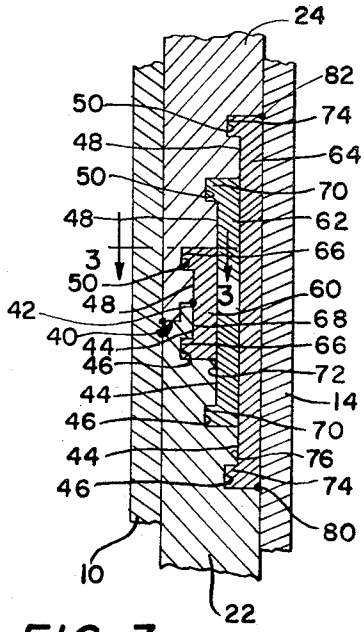

FIG. 3.

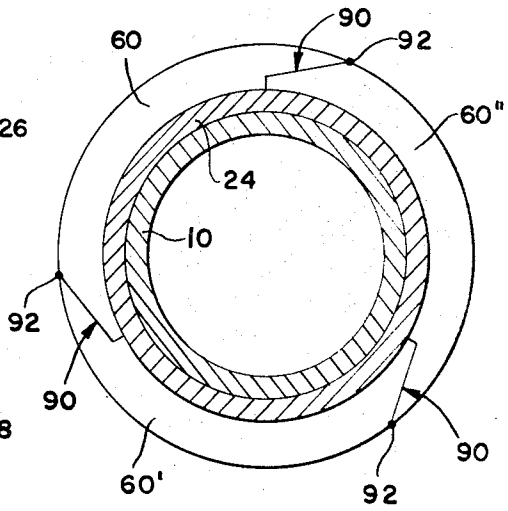

FIG. 4.

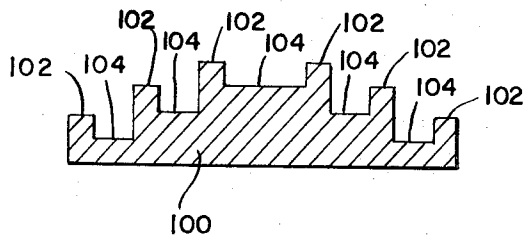

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FIG. 5.

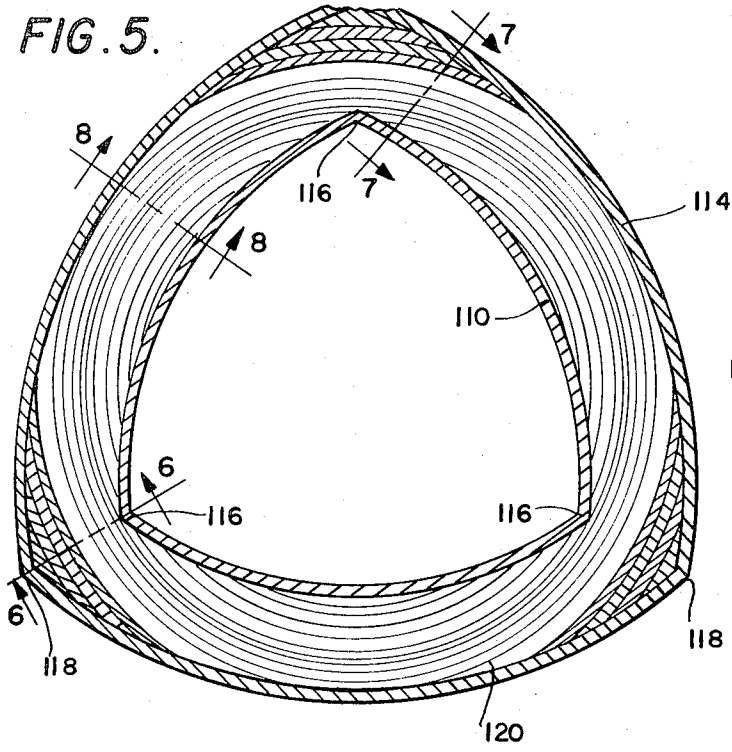


FIG. 6.

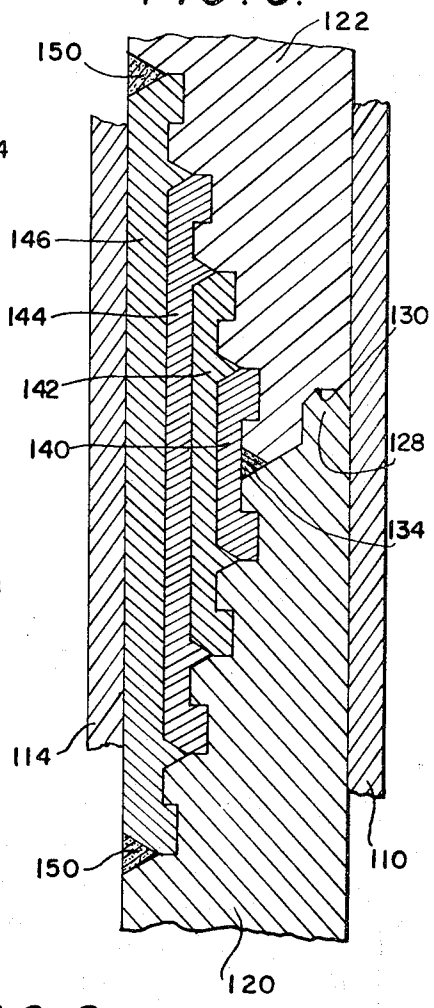


FIG. 7.

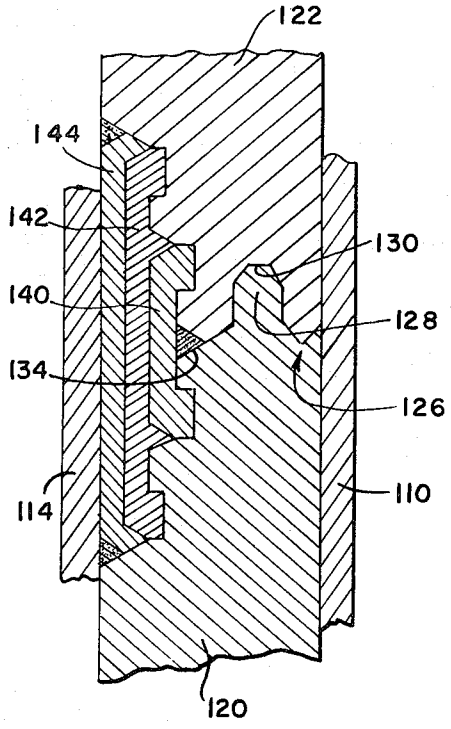
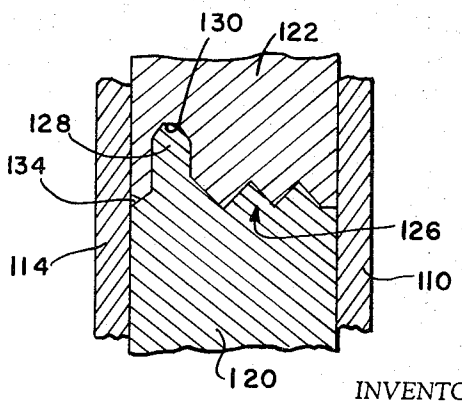


FIG. 8.



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RADIATION SHIELDING MEANS JOINT

BACKGROUND OF THE INVENTION

The present invention relates to a joint between radiation shielding members as employed, for example, in shipping containers for spent fuel elements utilized in nuclear reactors and the like. Such shipping containers may be utilized for shipping any type of radioactive material and are especially adapted to ship irradiated nuclear fuel elements, such containers normally being mounted on railroad cars, trailers and the like for transport from one location to another.

The utilization of uranium shielding in shipping containers provides a considerable weight savings and accordingly substantially improves the economy of shipping fuel elements. A particular problem involved with such shipping containers is the fact that the uranium shielding is generally provided in the form of castings. The amount of shielding required in a shipping container usually exceeds the casting capacity, and accordingly it is necessary to join several castings in such shipping containers.

The radiation shielding members must be joined in such a manner that adequate radiation protection is provided both under normal and accident conditons. The joint must therefore by of very high integrity so that in the event the shipping container is accidentally damaged, the castings comprising the radiation shielding members will not separate at the interfaces between the cast sections and allow radiation streaming.

The present invention is directed to a joint between radiation shielding members which provides adequate strength and shielding integrity while also affording a high degree of manufacturing convenience. The rigid metal shielding comprising a plurality of joined castings must be able to take severe impact loading developing tension, compression and shear stresses of considerable magnitude. The joints between the castings must accommodate such loadings in all directions.

In the past, uranium castings have been interconnected with one another by welding which involves substantial circumferential welding of the uranium castings. Such welding is quite expensive and time consuming and in many cases does not provide satisfactory results.

It is accordingly a principle objective of the present invention to reduce the amount of welding to a minimum while providing the desired degree of strength and rigidity to the joints between the castings.

SUMMARY OF THE INVENTION

In the present invention, the pair of radiation shielding members to be joined are interconnected with one another by a mechanical interlock, only a minimum amount of welding being involved so as to seal the members with respect to one another. The welding in the joint means of the present invention does not substantially contribute to the strength and integrity of the joint, but serves as a sealing means to prevent the entry of gases or liquids into the joint.

The pair of radiation shielding members to be joined have peripherally extending ribs and grooves in the end portions thereof which serve as mechanical interlock portions. The joint means comprises one or more joint members having peripherally extending ribs and grooves which cooperate with the ribs and grooves formed on the shielding members to provide a mechanical interlock. These joint members extend peripherally of the shielding members and are disposed in surrounding relationship to the end portions thereof. A plurality of radially disposed circumferentially extending joint members are employed, the joint members preferably being seal welded in position.

In one form of the invention, the shielding members may be of non-circular cross-sectional configuration so as to define a plurality of apexes. These non-circular shielding members are provided with arcuate ribs and grooves which receive arcuate joint members at the apexes, the joint members being discontinuous about the periphery of the radiation shielding members. These joint members are also preferably seal welded in position.

This latter modified construction enables circular machining cuts to be made in the faces of the shielding members even though their shape is non-circular thereby considerably simplifying manufacture of the shielding members and yet at the same time enabling an effective joint to be provided.

The joint members of the present invention each include a plurality of pieces extending peripherally of the joint, the joint members providing direct tension and compression surfaces for transmitting axial loads between the shielding members. If it is desired to transfer transverse shear loads across the joint, the plurality of parts of the joint members may be welded together to provide a continuous peripherally extending joint member.

In the form of the invention employing non-circular shielding members, the shielding members include radially inwardly of the joint means an annular shear interconnection for transmitting transverse shear loads. The shielding members may also include stepped surfaces inwardly of the joint means to prevent radiation beaming.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical longitudinal section through a shipping container employing joints according to the present invention;

FIG. 2 is an enlarged view of a portion of the structure shown in FIG. 1;

FIG. 3 is a sectional view taken substantially along line 3—3 of FIG. 2 looking in the direction of the arrows;

FIG. 4 is a sectional view illustrating a modified form of the invention;

FIG. 5 is a sectional view through still another form of the invention;

FIG. 6 is a sectional view on an enlarged scale taken substantially along line 6—6 of FIG. 5 looking in the direction of the arrows;

FIG. 7 is a sectional view on an enlarged scale taken substantially along the line 7—7 of FIG. 5 looking in the direction of the arrows; and

FIG. 8 is a sectional view taken substantially along line 8—8 of FIG. 5 looking in the direction of the arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein like reference characters designate corresponding parts throughout the several views, a first form of the invention is illustrated in FIGS. 1 and 2. As seen in FIG. 1, a shipping

container includes an inner shell means **10** having a bottom **12** and an outer shell means **14** having a bottom **16**, the shell means being formed of a suitable material such as stainless steel or the like. A plurality of spaced annular horizontally disposed cooling fins **18** are secured to the outer surface of the outer shell means **14**. Radiation shielding means is provided between the inner and outer shell means and as illustrated includes three uranium castings **20, 22** and **24** which are cast separately from one another and which are joined in the finished construction by a pair of joints indicated generally by reference numerals **26** and **28.** In this construction, each of the castings is of generally cylindrical configuration, the castings being joined end to end with one another with the joints extending circumferentially around the radiation shielding means.

A central radioactive material receiving cavity **30** is provided within the shipping container, and the open end of the shipping container is closed off by a conventional closure means or head **32** held in place with respect to the associated body means by a plurality of cap screws **34** extending through suitable holes provided in the closure means and being threaded into correspondingly threaded holes provided in the body means.

Referring now to FIG. **2** of the drawings, an enlarged view of joint **28** is illustrated. The ends of the adjacent shielding members **22** and **24** are provided with stepped surfaces providing a stepped interface **40** to prevent radiation beaming between the shielding members and also to provide a shear interconnection therebetween. The shielding members are preferably seal welded at **42** along the inner periphery of the abutting end surfaces of the two shielding members.

Casting **22** is provided with mechanical interlock portions in the form of a plurality of peripherally extending ribs **44** and a plurality of peripherally extending grooves **46** formed adjacent the ribs thereof. In a similar manner, casting **24** is provided with mechanical interlock portions in the form of a plurality of peripherally extending ribs **48** and a plurality of peripherally extending grooves **50.**

The joint means in this form of the invention includes a plurality of joint members **60, 62** and **64,** these joint members each comprising a plurality of peripherally extending parts as hereinafter described. The joint members are disposed radially outwardly of one another. Each of the joint members is of less thickness than the radiation members and the joint members overlap one another in a longitudinal direction.

Joint member **60** is provided with a pair of peripherally extending ribs **66** which are received within grooves **46** and **50** of the two shielding members. A peripherally extending groove **68** of joint member **60** receives ribs **44** and **48** of the two shielding members.

Shielding member **62** is provided with a pair of peripherally extending ribs **70** received within grooves **46** and **50** of the two shielding members. A peripherally extending groove **72** formed in joint member **62** receives a pair of ribs **44** and **48** of the two shielding members as well as joint member **60.**

Joint member **64** includes a pair of peripherally extending ribs **74** received within grooves **46** and **50** of the two shielding members. A peripherally extending groove **76** formed in joint member **64** receives a pair of ribs **44** and **48** as well as joint member **62.**

Outer joint member **64** is preferably seal welded along lines **80** and **82** at the outer opposite peripherally extending edges thereof to shielding members **22** and **24** respectively. Outer joint member **64** is formed as a plurality of peripherally extending parts as hereinafter described, and each of these parts is also seal welded along the longitudinally extending edges thereof at the joints therebetween. These welded portions provide an effective seal to prevent the entry of gas or liquids into the joint.

Referring now to FIG. **3** of the drawings, joint member **60** comprises a plurality of parts shown as being three in number and identified by reference characters **60, 60'** and **60''.** The joint member may also be formed of only two parts or more than three parts if so desired. The various parts of the joint member are provided with non-radial interfaces indicated by reference characters **90** which prevent radiation beaming. The various parts of the joint member are preferably seal welded along lines **92** at the outer peripheral longitudinally extending abutting edges thereof. The parts of the joint member are also seal welded circumferentially along the peripherally extending edges thereof to the shielding members. This insures an effective seal.

Joint members **62** and **64** are also formed as a plurality of peripherally extending parts in the same manner as joint member **60,** and the plurality of peripherally extending parts of each of the joint members are provided with non-radial interfaces to prevent radiation beaming and are preferably seal welded to one another in the same manner as described in connection with joint member **60.**

Referring now to FIG. **4** of the drawings, a modification is illustrated wherein a single joint member is provided with the same cross-sectional configuration as combined joint members **60, 62** and **64.** Joint member **100** may be formed as a plurality of peripherally extending parts and is provided with a plurality of peripherally extending ribs **102** and a plurality of peripherally extending grooves **104.** In this form of the invention, the radiation shielding members may be formed in the same manner as members **22** and **24** previously described, and the ribs and grooves formed on joint member **100** are adapted to cooperate with the ribs and grooves formed in the ends of the shielding members to provide a mechanical interlock therewith. Here again, the joint member is preferably seal welded in operative position to provide an effective seal for the joint.

Referring now to FIGS. **5–8,** inclusive, a modified form of the invention is illustrated wherein the radiation shielding means is adapted to be employed within a shipping container of non-circular cross-sectional configuration. As seen in FIG. **5,** an inner shell means **110** is provided and an outer shell means **114** is provided, these two shell means being suitably spaced from one another to provide a space for receiving radiation shielding means. Each of the shell means includes three similar sides defining three spaced apexes **116** on the inner shell means and three correspondingly spaced apexes **118** on the outer shell means. The radiation shielding members disposed between the two shell means are considered to have apexes at those points on the shielding members lying directly between the apexes **116** and **118** of the adjacent shell means. Accordingly, the shielding members are considered to define three equally spaced apexes which receive joint members as hereinafter described.

The radiation shielding members in this case comprise a pair of uranium castings **120** and **122** having a

suitable cross-sectional configuration as shown in FIG. 5. At the radially inward portions of the shielding members, a stepped interface 126 is provided therebetween to prevent radiation beaming. This interface is provided by forming a series of discontinuous circular cuts on the inner surface of the two castings to provide a labyrinth type interface which prevents any substantial radiation leakage path. It will be noted that the maximum stepped interface is provided at the midpoint between apexes of the radiation shielding members as shown in FIG. 8, whereas no stepped interface is provided at the apex portion as seen in FIG. 6.

Radially outwardly of the stepped interface between the castings is a continuous annular shear interconnection between the two castings including rib 128 formed on casting 120 and a groove 130 formed in casting 122 which receives said rib. This shear interconnection mates the two castings and is designed to take transverse shear loads only.

When the castings are initially assembled, the shear connection is made, and a peripherally extending seal weld 134 is provided around the castings to provide an effective seal at one side of the joint.

The ends of the two shielding members 120 and 122 are provided with mechanical interlock portions in the form of ribs and grooves similar to those described in connection with the embodiments shown in FIGS. 1 and 2, and four joint members 140, 142, 144 and 146 are provided, these joint members having cooperating mechanical interlock portions in the form of peripherally extending ribs and grooves interengaged with the ribs and grooves on the two casting members as is clear from an inspection of FIG. 6. The mechanical interconnection between the joint members and the ends of the shielding members as seen in FIGS. 6 and 7 operates in the same manner as that described in connection with FIGS. 1 and 2. The outermost joint member 146 is seal welded at 150 along the exposed outer peripheral portions thereof. Joint member 144 is seal welded at 152 along the exposed outer peripheral portions thereof, and joint members 140 and 142 are seal welded along the exposed outer peripheral portions thereof to completely seal each joint against the entrance of liquids or gases thereinto.

As seen in FIG. 6, four joint members are provided at each apex defined by the shielding members, each of these joint members having a thickness substantially less than the thickness of the shielding members. The joint members overlap one another in a longitudinal direction, and each of these joint members is formed of a plurality of peripherally extending parts in a manner similar to that described in connection with the previously described modifications of the invention. While four joint members have been shown, it is preferred to use a one-piece construction as shown in FIG. 4 at each apex defined by the shielding members.

As seen most clearly in FIG. 5, the joint members are provided only at the apex portions of the shielding members and the joint members fair out toward the center parts of each side of the shell means. Accordingly, the maximum thickness of the joint members as seen in FIG. 6 is at the apex portions of the shielding members, whereas no joint members are provided as seen in FIG. 8 at the mid portion of the sides of the shell means.

The joint members therefore geometrically cover only the outer part wall thickness of the shielding means at the apex portions of the shielding means. The joint members provide axial load continuity for the apex regions thus allowing the completed radiation shielding means assembly to act as a three-cornered beam in this form of the invention, the radial faces of the joint members carrying axial loads whereby the joint members serve as tension and compression members in the finished structure.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, and since the scope of the invention is defined by the appended claims, all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly cooperative equivalents are therefore intended to be embraced by those claims.

I claim:

1. A radiation shielding means joint comprising a pair of tubular radiation shielding members to be joined end to end, said tubular shielding members having opposed ends provided with mechanical interlock portions, and multi-part joint means adapted to connect the opposed ends of said shielding members said multi-part joint means comprising joint members interposed between opposed ends of said shielding members and extending peripherally in surrounding relationship thereto said joint members having cooperating mechanical interlock portions constructed and arranged to permanently engage the mechanical interlock portions on the corresponding ends of said opposed shielding members for permanently interlocking said pair of shielding members with one another for carrying axial tension and compression loads.

2. A joint as defined in claim 1 wherein said shielding members are tubular uranium castings disposed in end-to-end relationship with respect to one another.

3. A joint as defined in claim 1 wherein the opposed ends of said shielding members are provided with adjacent stepped surfaces to prevent radiation beaming.

4. A joint as defined in claim 1 wherein the mechanical interlock portions of said shielding members comprise peripherally extending ribs and grooves formed on the opposed ends of said shielding members, the cooperating mechanical interlock portions of said joint members also comprising peripherally extending ribs and grooves formed thereon.

5. A joint as defined in claim 4 wherein said joint members are welded at their outer edges to said shielding members.

6. A joint as defined in claim 1 wherein each part of said multi-part joint means comprises a plurality of joint members disposed radially outwardly of one another.

7. A joint as defined in claim 6 wherein said plurality of joint members overlap one another in a direction extending longitudinally of the shielding members, each of said joint members being of less thickness than the thickness of said radiation members.

8. A joint as defined in claim 1 wherein the periferally extending joint members of said multi-part joint means are provided with non-radial interfaces to prevent radiation beaming.

9. A joint as defined in claim 8 wherein said peripherally extending joints members are welded to one another at the exposed edges of said interfaces and at the

exposed interface between said joint members and said shielding members.

10. A joint as defined in claim **1** wherein said shielding members are non-circular and define a plurality of apexes, said multi-part joint means including a joint member disposed at each of said apexes.

11. A joint as defined in claim **10** including a plurality of joint members disposed at each apex.

12. A joint as defined in claim **10** wherein said joint members at each apex is welded to said radiation shielding members along the exposed outer peripheral portions thereof.

13. A joint as defined in claim **10** including an annular shear interconnection between opposed ends of said shielding members inwardly of said joint means.

14. A joint as defined in claim **13** wherein said shear interconnection includes a groove formed in the end of one of said shielding members and a rib formed in the opposed end of the other of said shielding members and received within said groove.

15. A joint in claim **13** wherein said shielding members are seal welded to one another outwardly of said shear interconnection.

16. A joint as defined in claim **13** wherein said shielding members are provided with stepped adjacent surfaces inwardly of said shear interconnection to prevent radiation beaming.

17. A joint as defined in claim **1** including an annular shear connection between said shielding members.

* * * * *