Aug. 18, 1959 L. A. OHLINGER 2,900,315

SHEATHED TUBE AND APPARATUS AND METHOD OF PRODUCTION THEREOF

Filed Dec. 15, 1952

FIG. 1.

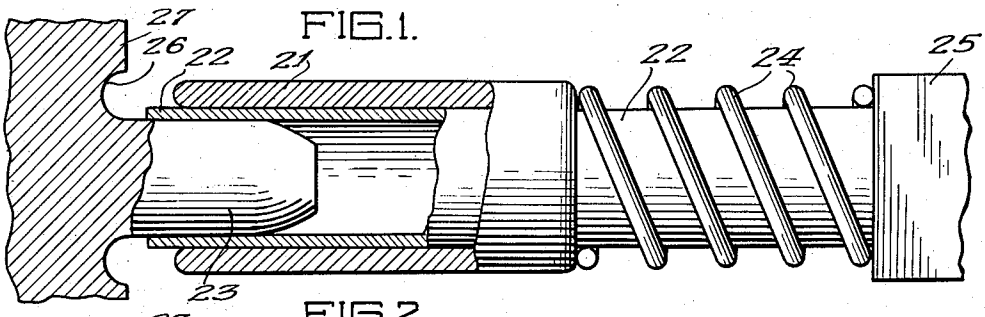


FIG. 2.

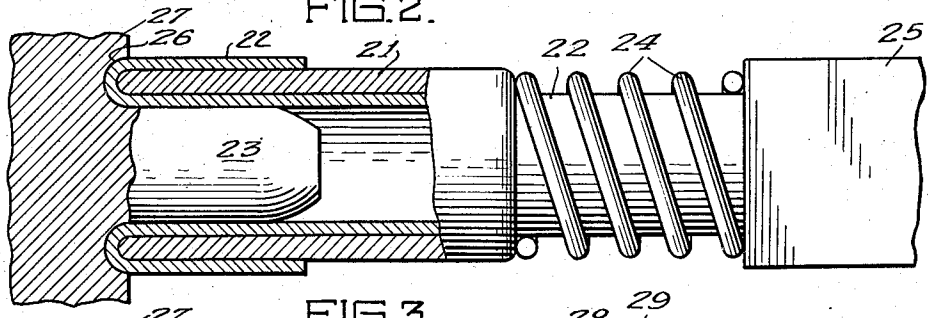


FIG. 3.

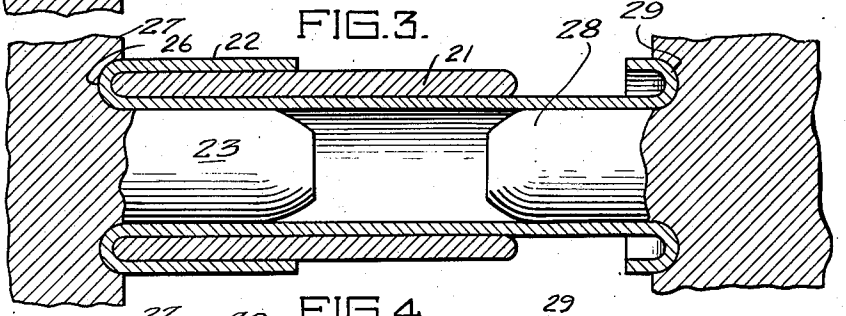


FIG. 4.

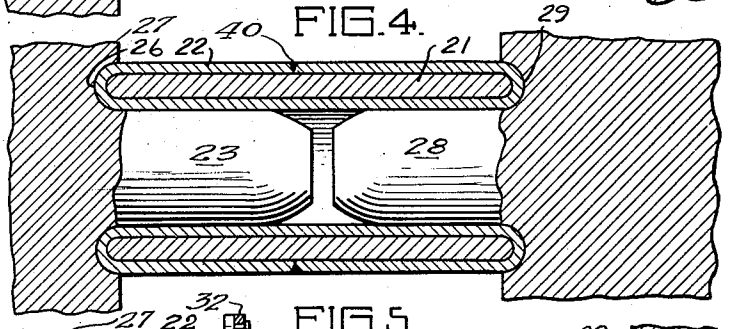
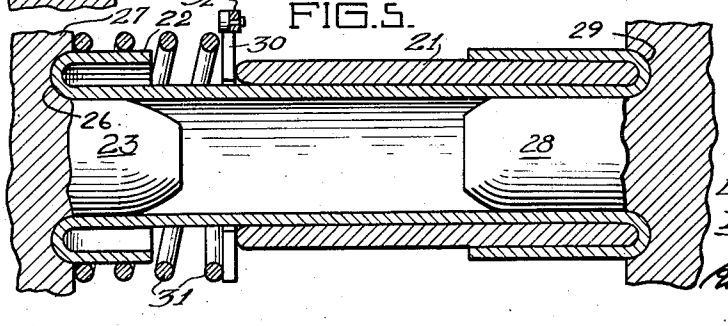


FIG. 5.



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SHEATHED TUBE AND APPARATUS AND METHOD OF PRODUCTION THEREOF

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Application December 15, 1952, Serial No. 326,035

7 Claims. (Cl. 204—193.2)

This invention relates to a tubular article having a sheath thereon and is particularly concerned with tubes which are suitable for use in a neutron reactor.

In the bombardment of uranium or other fissionable material in neutronic reactors such as described in an application of Enrico Fermi and Leo Szilard, Serial No. 568,904, filed December 19, 1944, now Patent No. 2,708,656, or an application of Gale Young, Serial No. 552,730, filed September 5, 1944, now Patent No. 2,774,730, substantial heat is evolved. Accordingly it is frequently advantageous to use tubular uranium bodies and to pass a coolant such as water in heat exchange relationship therewith. In such a case it is found essential to provide the uranium with a sheath in order to prevent attacking of the uranium or similar body by the coolant and also to restrain passage of fission products from the uranium into the coolant. Such sheaths are preferably nonfissioning metals of low neutron capture cross section which resist the corrosion of water. Sheet aluminum has been found suitable for this protective covering because of its resistance to corrosion and because it parasitically absorbs relatively few neutrons. However, because of the difficulty of securing watertight and air-tight welds in aluminum, it is desirable that the number of welds per tube be reduced to a minimum. The problem is particularly acute since failure of a weld during use of the sheathed uranium may result in an extremely dangerous condition which may cause serious damage.

One of the objects of this invention is to provide a tube covered both inside and outside with a sealed protective covering in good heat exchange relation with the tube, with a minimum of welds.

A second object of the invention is to provide a method and apparatus for covering a tube on both the inside and outside surfaces with a deformable metal.

A further object of the invention is to provide a tube of uranium covered with a sealed unitary sheet aluminum sheath on both the inside and outside surfaces with a minimum of welds.

Other objects and advantages of the invention will be pointed out in the detailed description thereof which follows or will be apparent from said description.

In accordance with the present invention an improved method of sheathing a tube has been provided. Sheathed tubes in which the sheath possesses a minimum of welds are secured by enclosing the tube in a continuous tubular double walled sheath having a seam only on the outer side of the tube. Such tubes possess a minimum of welds or seams and when the sheath is made of a material which has a low neutron capture cross section such as aluminum or beryllium, the tube is suitable for use as an active fissionable component of a neutronic reactor.

In a preferred embodiment of the invention a deformable tube of material such as sheet aluminum is placed on the mandrel of a press and the rigid tube of material to be coated, such as uranium, is placed in coaxial relationship around the first tube. An annular deforming die is positioned at one end of the mandrel and a reciprocable pusher block at the other end. The pusher block is then moved toward the deforming die while pressing on one end of the deformable tube so that the other end of the deformable tube is forced against the annular deforming die, flaring the end of the deformable tube slightly outwardly and then bending the metal in the deformable tube wall back over the rigid tube throughout its circumference with a smooth end curve, through an arc of approximately 180° so that what was the inner surface of the deformable tube before deformation is now the outer surface of the assembly, and what was the outer surface of the deformable tube before deformation is now contiguous to the outer surface of the rigid tube. The movement of the pressure block is continued, with the deformable tube being moved relative to the rigid tube until approximately half of the outer surface of the rigid tube is covered by the material of the deformable tube. The pusher block is then removed from the press, and while the assembly is still supported on the first mandrel, a second mandrel and deforming die similar to those described above are positioned in the press so that the unbent end of the deformable tube is around the mandrel. The second mandrel and die are then moved toward the first mandrel and die, deforming the heretofore unbent end of the tube through an arc of 180° to cover the exposed outside surface of the rigid tube. The movement of the mandrel is continued until the two ends of the deformable tube meet on the outside of the rigid tube. The ends of the deformable tube are then welded with a single circular weld, so that the rigid tube is now entirely covered both inside and out, and sealed with a one piece covering having only one weld. To insure good heat exchange at the ends of the rigid tube, the arc of curvature of the deforming die and the arc of curvature of the end of the wall of the rigid tube are concentric when spaced the thickness of the deformable tube wall.

In order that the invention may be more readily understood and fully comprehended, reference may be had to the accompanying diagrammatic drawings of a preferred embodiment in which:

Fig. 1 is a view partly in longitudinal section and partly in side elevation of a portion of the apparatus including a mandrel, a deforming die, and a pusher block in position to start the bending operation with the deformable tube mounted on the mandrel and the rigid tube surrounding said deformable tube;

Fig. 2 is a view similar to Fig. 1 of the apparatus in the second position with one end of the deformable tube bent back in an arc and partially covering the exterior of the rigid tube.

Fig. 3 is a view similar to Fig. 1 of the mandrel and bending die with the second mandrel and die replacing the pusher block and the second end of the deformable tube partially deformed.

Fig. 4 is a view similar to Fig. 1 of the apparatus with the rigid tube entirely covered and the ends welded together.

Fig. 5 is a view partially in cross-section and partly in side elevation of a second embodiment of the apparatus that may be substituted for the apparatus shown in Figs. 3 and 4.

Referring first to Fig. 1, a rigid metal tube **21**, for example of uranium, the walls of said tube being rounded at the ends, is shown ready for covering by a deformable tube **22** of material such as sheet aluminum. The sheet aluminum may be of any desired gauge; 0.35" has proven satisfactory. The aluminum tube **22** has an outside diameter slightly less than the inside diameter of

the uranium tube 21 and is slightly longer than the sum of twice the length, and twice the thickness of the uranium tube 21.

As shown in Fig. 1, the aluminum tube 22 is first placed on a mandrel 23 of a press (not shown), tube 22 having a close sliding fit over the mandrel. Secondly, the uranium tube generally having a length greater than the diameter thereof, 21, is placed over the aluminum tube 22 near one end of aluminum tube 22. A helical spring 24 is then positioned around aluminum tube 22 so that one end of said spring rests against the end of uranium tube 21 away from the mandrel 23. A pusher block 25, reciprocable by hydraulic pressure or other means, is then placed against the end of aluminum tube 22 away from mandrel 23 and also against the spring 24. Preferably the helical spring 24 is of such a length that when fully extended between the one end of tube 21 and pusher block 25, the opposite end of tube 21 will be a distance less than the wall thickness of tube 21 from that end of tube 22 nearest the mandrel 23.

A deforming die 26 in the form of an annular groove with a semi-circular cross section preferably having a radius of curvature about one half of the sum of the thickness of the uranium tube 21 plus twice the thickness of tube 22 and concentric with the curve of the end of the uranium tube is formed in the supporting member 27 of the mandrel 23. When the tubes 21 and 22 are assembled in the press, pusher block 25 is moved to the left, as shown in Fig. 2, forcing aluminum tube 22 against deforming die 26 so that the end of tube 22 is bent through an arc of 180° back on itself over the entire circumference. The sheet aluminum used must be ductile enough to withstand the deformation and stretching necessary for this operation. As the aluminum tube 22 is moved to the left by pusher block 25, uranium tube 21 is moved to the left by the pressure exerted from pusher block 25 through spring 24. The uranium tube 21 continues to move until it strikes the inside of the bent over portion of aluminum tube 22. At this point, the movement of the uranium tube 21 is halted, but it is held in this position by spring 24 that is compressed by pusher block 25. Pusher block 25 continues its movement to the left pushing aluminum tube 22 before it so that the aluminum tube slides inside uranium tube 21, into deforming die 26, around the concentrically curved end of tube 21, and back along the exterior of uranium tube 21 until approximately half the exterior of the uranium tube is covered, as shown in Fig. 2. Pusher block 25 and spring 24 are then removed from the apparatus and a mandrel 28 provided with a die 29 similar to mandrel 23 and die 26 is placed in the press in the position formerly occupied by pusher block 25. Die 29 is then moved toward die 26 so that the unbent end of aluminum tube 22 is forced against deforming die 29 so that it too is bent back in an arc around the rounded end of tube 21, as shown in Fig. 3. The movement of die 29 towards 26 is continued until the aluminum tube 22 entirely covers uranium tube 21 and the two ends of aluminum tube 22 meet in the position shown in Fig. 4. These two ends are then welded together by means well known in the art, providing a completely covered uranium tube with a single welded seam 40. The covered uranium tube may now be removed from the mandrels 23 and 28 and is ready for use. If better heat exchange contact between uranium tube 21 and the covering aluminum tube 22 is desired, a mandrel larger than mandrel 23 may be forced through the interior of the jacketed tube, thereby pressing the inner portion of the aluminum tube tightly against the interior of the uranium tube. Also the outer portion of the aluminum tube may be pressed tightly against the exterior of the uranium tube by passing the assembly between rollers.

In Fig. 5 is shown an attachment comprising a second helical spring 31 and a separable or hinged washer 30 provided with a hinge 32 that may be used in the step of the method shown in Fig. 3. When the aluminum tube 22 is forced against die 26 it may have a tendency to turn more than 180°. This is prevented in the step shown in Fig. 2 because the bent over end of the aluminum tube contacts the exterior of the uranium tube 21. However, as shown in Fig. 3 when the second end of the aluminum tube is deformed, the uranium tube is not in a position to contact the end of the bent over tube. This second end of the aluminum tube may be prevented from turning more than 180° by the use of the apparatus shown in Fig. 5. The deformation of the first end is halted slightly before one half of the uranium tube is covered. The uranium tube is then slid out of the bent over end of the aluminum tube towards the unbent end so that it occupies the same relative position to the second end as it did in the step shown in Fig. 1 to the first end. The hinged washer 30 is then placed around the aluminum tube 22 and the second helical spring 31 large enough to fit over the exterior of the bent over aluminum tube is slid over said bent over portion. Mandrel 28 is then moved toward mandrel 23 as explained above, and the spring 31 and split washer 30 keep the rounded end wall of the uranium tube 21 pressed against the interior of the portion of the aluminum tube being deformed, performing the same function as spring 24 did in the step shown in Figs. 1 and 2. When the two ends of the aluminum tube are almost together, the split washer 30 is removed and movement of mandrel 28 is continued until the two ends meet in the manner as described in the step shown in Fig. 4.

In accordance with a further modification a bonding agent may be interposed between the sheath and the tube to improve heat conductivity or for other purposes. For example an intermediate coating of zinc, tin or similar metal capable of inhibiting corrosion or promoting heat conductivity may be interposed between the sheath and the tube by applying a coating of the zinc or other metal to the tube or sheath or both prior to the sheathing operations herein described. After the sheath has been placed upon the tube the assemblage may be heated if desired in order to fuse the zinc or other metal and provide a highly effective heat conductive bond.

While I have described my invention as applied to the protection of uranium, thorium or other bodies to be subjected to neutron bombardment in a neutronic reactor it will be obvious that the invention can be applied to any tube to be immersed in a medium that might corrode the tube, providing of course that such medium does not substantially corrode the deformable material applied to the tube. Many changes and modifications in the described product, method and apparatus will be apparent to those skilled in the art. For this reason, the description is intended to be illustrative only and the invention is to be limited only by the following claims.

This applicaton is a continuation-in-part of my copending application, Serial No. 563,293, filed on November 13, 1944, now abandoned.

What is claimed is:

1. As an article of manufacture a uranium tube having a close fitting covering comprising a tube of aluminum covering the inner surface of said tube, both ends of said tube, and the entire outer surface of said tube, the ends of said aluminum tube being joined together.

2. The method of covering a tube having an inner and an outer surface comprising fitting a second tube of deformable material over one of said surfaces so that the second tube extends beyond an end of the first tube, and directing an end of said second tube through an arc of approximately 180° around the end of said first tube and over the other surface of said first tube until the ends of the second tube are joined to form a single seam.

3. The method of covering a tube having an inner and an outer surface comprising fitting a second tube of de-

formable material over one of said surfaces so that the second tube extends beyond an end of the first tube, directing the ends of said second tube around the ends of said first tube and over the entire other surface of said first tube, and joining the ends of said second tube together.

4. The method of providing a covering for a uranium tube having an inner and an outer surface comprising fitting said uranium tube over a sheet aluminum tube so that the aluminum tube extends beyond the ends of the uranium tube, and directing material forming the walls of the aluminum tube over the entire outer surface of said uranium tube.

5. An article of manufacture comprising an elongated tube and a continuous tubular double walled sheath comprising a reentrantly folded tube enclosing the first tube between the walls thereof, the ends of said folded tube being joined to form a single seam.

6. An article of manufacture comprising an elongated tube and a continuous tubular double walled sheath comprising a reentrantly folded tube enclosing the first tube between the walls thereof, the ends of said folded tubing being joined to form a single seam disposed on the exterior side of said first tube.

7. A tube capable of use as an active component in a neutronic reactor and comprising a fissionable metal tube and a tubular double walled metallic sheath comprising a reentrantly folded tube in close heat conducting relationship with the first tube, capable of restraining transfer of fission products therethrough, the first tube being enclosed between the walls of the sheath and the ends of said folded tube being joined.

No references cited.