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METHOD AND APPARATUS FOR FABRICATING TUBULAR UNITS

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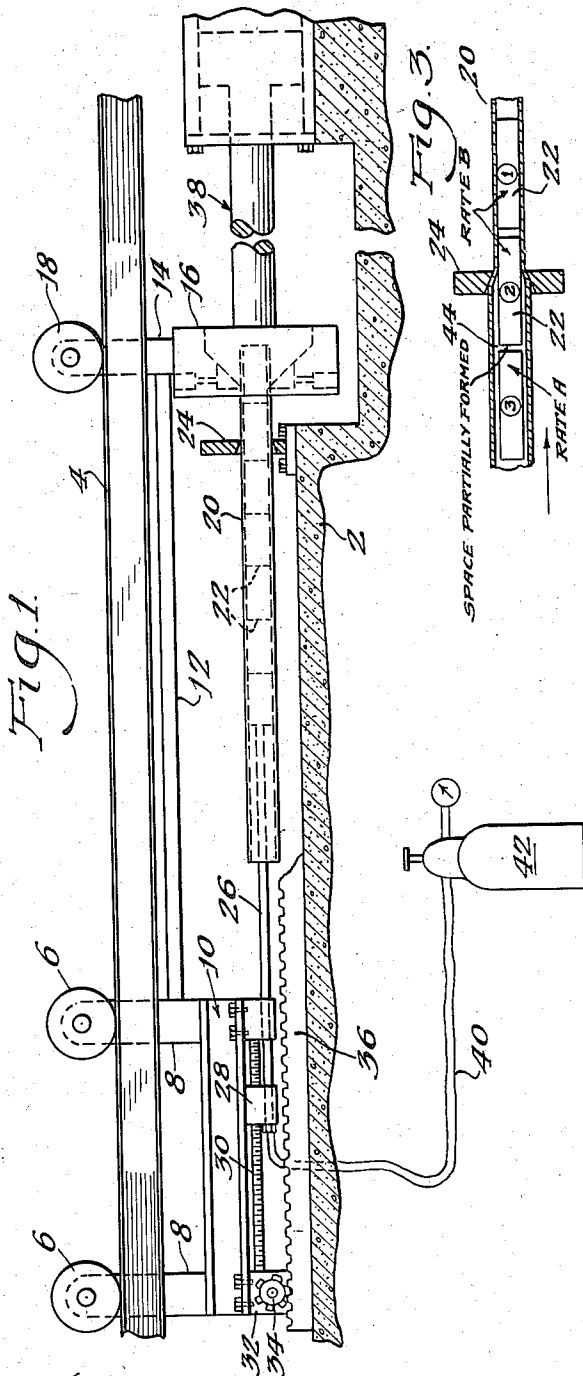


Fig. 1.

Witness:
Walter F. Schlegel, Jr.

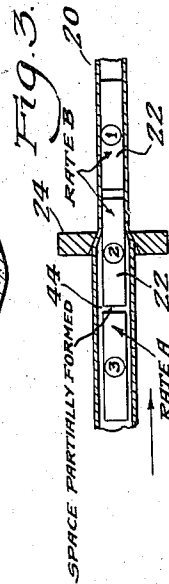


Fig. 3.

Fig. 2.

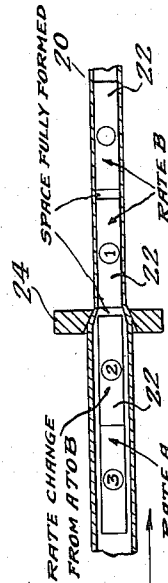
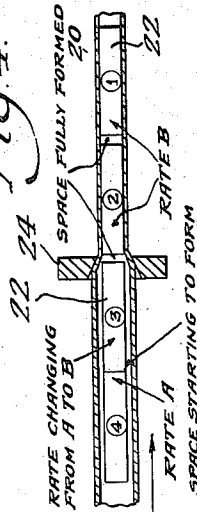


Fig. 4.



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METHOD AND APPARATUS FOR FABRICATING TUBULAR UNITS

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6 Claims. (Cl. 29—517)

This invention relates to a novel method and means for fabricating a unit containing a plurality of substantially equidistantly spaced elements within a tube.

More specifically, the invention comprises a novel method and apparatus for drawing a ductile tube to contract the same around a plurality of cylindrical substantially non-compressible members while equidistantly spacing said members a predetermined distance from each other within the tube.

The present invention relates more particularly to a novel method and apparatus for fabricating composite reactive units containing fissionable material and adapted for utilization as a source of fuel for a self-sustaining nuclear fission chain reaction. Units of this type consist of cylindrical slugs containing uranium or other fissionable material tightly fitted within an aluminum tube or cartridge, spacing being provided between the slugs to accommodate thermal expansion and flexibility of the unit. Preferably the tube is filled with an inert gas, such as helium, which fills the spaces between the slugs to facilitate heat conductivity from the slugs to the aluminum tube or jacket at the spaces between the slugs, and to displace the atmosphere which might otherwise react with the uranium slugs to form uranium oxide and nitride, thereby creating a vacuum between the slugs and causing the latter to swell from the new compounds formed. The slugs are preferably from 2 to 8 inches long with spaces therebetween of from $\frac{1}{16}$ of an inch to $\frac{1}{4}$ of an inch, and preferably the slugs have a diameter of about 1.4 inches with a ground finish on the cylindrical perimeter thereof to accommodate a tight fit within the aluminum tube, which preferably has an outer diameter of about 1.5 inches.

The first attempts to fabricate a unit, such as above described, by drawing the aluminum tube or jacket onto a series of slugs by drawing the assembly through a single die, resulted in non-uniform spacing between the slugs with variances of up to several inches. Frequently in the same tube, slug spacing was found to vary over 100 percent.

The present invention comprehends a novel method and means for producing uniform spacing between the slugs and for filling the spaces with an inert gas, such as helium, while drawing the aluminum tube into tight thermal contact with the slugs.

The foregoing and other objects and advantages of the invention will become apparent from a consideration of the following specification and the accompanying drawings, wherein:

Fig. 1 is a somewhat diagrammatic illustration of an apparatus embodying the invention, the apparatus being shown partly in side elevation and partly in section; and

Figs. 2 to 4, inclusive, are diagrams showing the passage of the tube and slugs through the die to produce the desired spacing, Fig. 2 showing a slug entering the die, Fig. 3 showing the same slug partially drawn through

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the die, and Fig. 4 showing the same slug after having passed through the die.

Describing the invention in detail and referring first to Fig. 1, the novel apparatus disclosed therein comprises a foundation or drawbench 2 and a rail or track 4 thereabove affording support for a pair of wheels 6, the axles of which are journaled in upstanding pedestals 8 of a frame or carriage 10, said carriage being connected by a rod 12 to a similar pedestal 14 supporting a pulling head 16 from a wheel 18 on the track 4.

The pulling head 16 grips one end of an aluminum tube 20, such as above described, filled with a plurality of cylindrical uranium slugs 22. The tube 20 is drawn through a die 24 to contract the tube around the slugs into tight thermal contact therewith, the slugs 22 being pushed through the die by a hollow pusher rod 26 connected to a travelling nut 28 threadedly engaged with a rotatable shaft 30 actuated by a gear box 32 mounted on the carriage 10. The gear box is operatively connected to a gear 34 which is meshed with a rack 36 on the drawbench 2. Thus, as the pulling head 16 is moved on the advance or pulling stroke thereof by an associated conventional hydraulic motor 38, the tube 20 is drawn through the die, and the travelling nut 28 moves to the left, as seen in Fig. 1, relative to the carriage 10 so that the hollow pusher rod 26 moves to the right at a slower rate of speed than that at which the pulling head 16 moves, thus causing the pusher rod 26 to fall back or lag with respect to the head 16 to accommodate spacing of the slugs 22 within the tube 20 as the latter is drawn into tight thermal contact with the slugs.

The pusher rod 26 is connected by a flexible tube 40 to a source 42 of inert gas, such as helium. Thus, the spaces between the slugs are filled with helium for the above-mentioned purposes.

As above noted, the advance movement of the pusher rod 26 to the right, as shown in Fig. 1, is preferably at a predetermined slower rate than that of the head 16, thus accommodating equidistant spacing of the non-compressible elements 22 within the tube 20. If desired, the travelling nut 28 may be rendered inoperative, as for example, by disconnecting the gear 34 from the gear box 32 thus causing the pusher rod 26 to move on its advance stroke to the right, as seen in Fig. 1, at the same rate as the pulling head 16. This would substantially eliminate spacing between the slugs although slight spacing would be present due to stretching of the tube 20 at the right of the die 24.

Referring now to Figs. 2-4, the spacing of the slugs in the tube is diagrammatically illustrated. Thus, in Fig. 2, slug No. 1, which has passed through the die, is clamped by the tube and is moving with the same in the direction of the arrow at rate B, which is approximately the pulling rate of the head 16 and the rate of movement of the tube 20 at the right or exit side of the die. Slug No. 2 which is moving at rate A, the rate of movement of the pusher rod 26, is just entering the die 34 in Fig. 2. In Fig. 3, slug No. 2 has partially passed through the die and is moving with the tube at rate B, causing a space to form at 44. This space is shown fully formed in Fig. 4, wherein slug No. 3 has entered the die and is about to move at rate B to produce a space between slug No. 3 and slug No. 4. It will be understood that the spacing between the slugs 22 is dependent upon the relative movement of the pulling head 16 and the pusher rod 26.

As above discussed in connection with Fig. 1, the carriage 10 and the pulling head 16 are connected as by a rod 12 so that the pusher rod 26, the head 16 and the tube 20 are moved by the hydraulic motor 38 toward the right, as seen in this figure. Thus, although the pusher rod 26 moves toward the right relative to the die 24, the pusher rod 26 is, in a sense, retracted from the

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tube 20 by relative motion with respect thereto, thus producing the before-mentioned spacing of the slugs, although the total retraction of the pusher rod 26 from the tube 20 may not be substantially greater than the elongation thereof by the drawing process. This retraction of the pusher rod 26 from the tube 20 may, if desired, be effected by connecting the carriage 10 to the die 24 and moving these parts to the left as by a hydraulic motor (not shown) while maintaining the head 16 in a stationary position. Under these conditions the rod 26 would also be retracted relative to the tube 20, but would be moved by nut 28 toward the die 24 to diminish the distance between the rod 26 and the die 24, thereby pushing the slugs 22 through the die. Thus, it will be understood that the rate at which the pusher rod 26 is retracted relative to the tube 20 will be less than the rate at which the tube 20 enters the die 24 regardless of whether the tube is pulled through the die or the die is pulled along the tube. In other words, as the tube is drawn by relative motion between the die and the tube, the distance between the die and the adjacent end of the pusher rod 26 is diminished to force the slugs through the die.

It will be understood that the above-described method and apparatus embodying the invention are merely by way of illustration and not limitation, inasmuch as various and other forms of the invention will be readily apparent to those skilled in the art without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. A method of fixing a plurality of members within a ductile tube in spaced relationship therein, comprising drawing said tube into tight engagement with said members while continuously retracting from said tube at a rate less than the drawing rate an element adapted to limit movement of said members outwardly from said tube during said drawing thereof.

2. A method of fixing a plurality of members within a ductile tube in spaced relationship therewithin, comprising inserting a group of said members in said tube in end-to-end abutting relationship with each other, positioning an element within said tube in abutment with the

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member at one end of the group, and drawing said tube into tight engagement with said members from the opposite end of said group while retracting said element from said tube at a rate less than the drawing rate.

3. A method of fabricating a unit wherein a ductile tube contains a plurality of rigid members spaced by pockets of fluid, comprising inserting a group of said members into said tube in end-to-end abutting relationship, positioning a rigid hollow element within said tube in abutment with the member at one end of said group, and then drawing said tube into tight engagement with said members from the opposite end of said group while retracting said element from said tube at a rate less than the drawing rate, and while directing said fluid into said tube through said element.

4. An apparatus for drawing a ductile tube into tight engagement with a plurality of members therein, comprising means for gripping the tube, die means for engaging the tube, means for moving at least one of said means with respect to the other to force said tube through said die means, means insertable within the tube for restricting movement of said members therein in the direction away from said die means, and means for spacing said members in said tube comprising means for withdrawing said restricting means from the tube as the latter passes through said die means.

5. A method which comprises inserting a tube member containing a plurality of substantially non-compressible elements into a die member and moving at least one of the members to draw the tube member into tight contact with said elements while pushing said elements toward said die member at a rate substantially less than the drawing rate.

6. A method which comprises drawing a ductile tube into tight contact with a plurality of substantially non-compressible members therein while pushing said members within said tube in the direction of movement thereof.

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