April 23, 1968 L. RACHOR 3,379,076

APPARATUS FOR FORMING HOLLOWS IN SPHERICAL FUEL ELEMENTS

Original Filed Sept. 4, 1964

Fig. 2

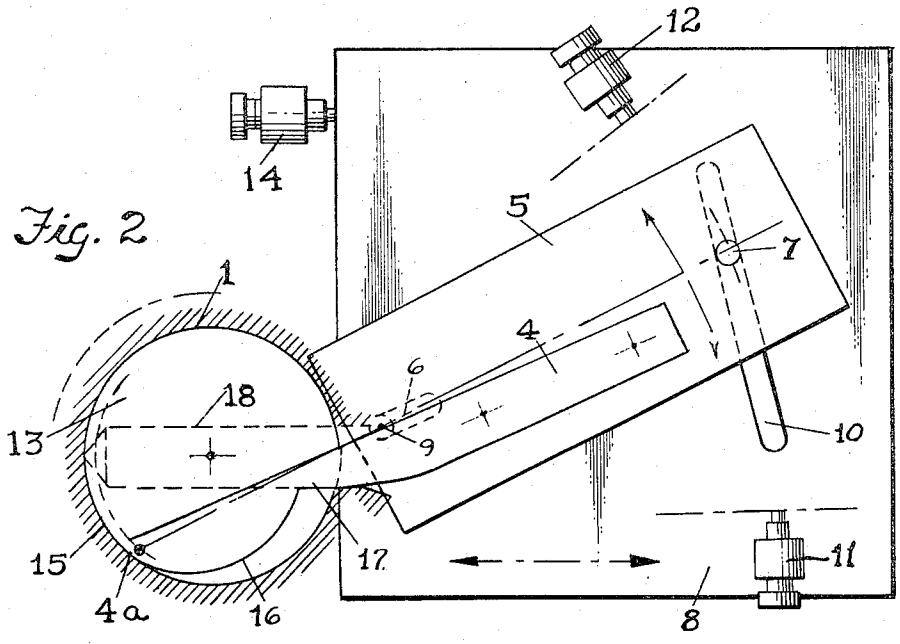
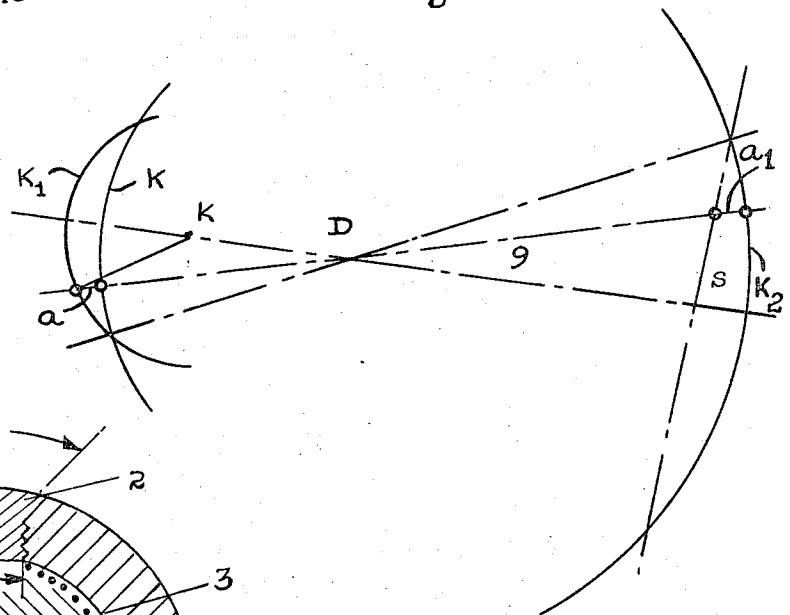



Fig. 3



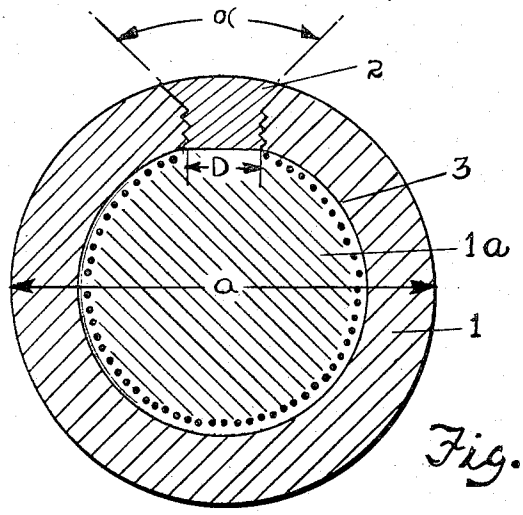




Fig. 1

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# APPARATUS FOR FORMING HOLLOWS IN SPHERICAL FUEL ELEMENTS

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Original application Sept. 4, 1964, Ser. No. 394,404, now Patent No. 3,284,314. Divided and this application Jan. 26, 1966, Ser. No. 523,172
Claims priority, application Germany, Sept. 13, 1963, N 23,747
3 Claims. (Cl. 77—3)

## ABSTRACT OF THE DISCLOSURE

A device for forming spherical hollows in nuclear fuel elements consists of a part mounted for movement in two straight-line guides at angles to each other and a chisel with a curved edge is mounted by one end on said member to move in an arc such that it cuts a spherical hole in the sphere as the sphere is rotated about its axis.

This application is a division of application Ser. No. 394,404, filed Sep. 4, 1964 and now Patent No. 3,284,314.

The earlier application describes in detail a fuel material for nuclear reactors composed of hollow spheres which consists of a body of electro-graphite of good heat conductivity and mechanical strength which may be closed by plugs, which can be screwed in. A hollow is formed by the shell, which is preferably spherical or nearly spherical. The nuclear fuel material of the mixture of nuclear and breeder material is positioned in the hollow in a relatively thin layer on its wall.

The present invention relates to an apparatus for use in making such spheres which is fast, inexpensive and simple.

Further objects and advantages of the invention will appear more fully from the following description, especially when taken in conjunction with the accompanying drawings which form a part thereof.

In the drawings:

FIG. 1 shows in cross-section a sphere of the type to be produced;

FIG. 2 shows a machine embodying the invention; and

FIG. 3 is a geometrical diagram for explanatory purposes.

The shell **1** to be produced is formed of graphite and has a central hollow, on the inner wall of which is formed a layer **3** in which the fuel material, advantageously in the form of coated particles, and preferably mixed with graphite, is embedded.

The outer diameter of a sphere is, for example, 60 mm. and the diameter of the hollow is 36 mm., whereas the coated particles have a diameter of about 0.4 to 0.7 mm. and are covered with a coating about 0.1 mm. thick of a material impervious to gases.

The shell has a filling opening which is closed by a plug **2**. The cross-section of the filling opening in which the plug **2** is secured is substantially smaller than a cross-section of the hollow.

The head of the plug which closes the filling opening is of conical shape, the length of the conical part being desirably from 30% to 50% of the length of the plug.

FIG. 2 shows an arrangement which is well adapted to produce on a turning machine such fuel elements, particularly for the formation in the sphere of a hollow.

The arrangement includes a chisel with a rounded point **4***a* by which a part of the inner contour of the hollow is formed through movement of the point in a circular arc, the radius of which corresponds with that of the



hollow, while the remainder of the end portion of the work tool is constituted by a circularly profiled cutting edge. The working movement of the chisel generally consists of a movement around a point in the area of the filling opening of the ball, which can be quite small if the tool is of sufficient rigidity.

Referring again to FIG. 2, a chisel **4** is fastened on and spaced above a carrier part **5**. This carries a guiding groove **6** and a bolt **7**. It is carried by a base **8** with a guiding bolt **9** and a guiding groove **10**.

The carrier part is turnable about the bolt **9** engaged in guide **6**, while bolt **7** slides in the groove **10**. The carrier **5** is suitably secured to the base plate **8**.

The chisel includes a further edge **17** at an angle to its longitudinal axes.

The swinging of the carrier **5** is limited by stops **11** and **12**.

In operation, a cylindrical bore is first formed in the shell **1** as indicated by dotted lines at **18**. With the bolt **7** in the bottom of the slot **10**, the carrier **8** is moved forwards (to the left in FIG. 2) until it engages stop **14**, so that the chisel enters the bore **18**. The ball **1** is then rotated by a suitable mechanism around the axis of the bore **18**, and carrier **5** is gradually shifted counter-clockwise.

During a part of the movement, the tip of the chisel swings in the circular arc **15** and thereafter the chisel is withdrawn longitudinally so that the edge **16** forms the remainder of the spherical interior. The edge **17** follows the contour of the filling opening.

FIGURE 3 shows the geometrical basis of this movement. A turning of the straight line *g* about the point D only would result in the ark *k*. For achieving the arc $k_1$ around the center K of the sphere, a longitudinal displacement of the straight line G by the amount *a* is necessary. This longitudinal movement is made possible in a very simple way by guiding a suitable point of the straight line *g* in a straight line S perpendicular to the line DK at a suitable distance from D. The distance $a_1$ on the straight line *g* between the secant *s* and the arc $k_2$ corresponds with sufficient exactness to the distance *a* between the areas *k* and $k_1$.

While I have described herein one embodiment of my invention, I wish it to be understood that I do not intend to limit myself thereby except within the scope of the claims hereto or hereinafter appended.

I claim:

**1.** Apparatus for producing a fuel element composed of a hollow sphere having a filling opening, comprising a chisel having a cutting edge including a rounded tip, and means mounting said chisel for simultaneous rocking and longitudinal movement to cause said tip during part of such movement to move in an arc having a radius equal to the radius of the hollow, said tip having its cutting edge curved about an axis perpendicular to the direction of such longitudinal movement, and said chisel being supported by said mounting means only at the end remote from said tip.

**2.** In a claim as claimed in claim **1**, said chisel edge having a section adjacent to the tip curved about a radius equal to the radius of the hollow.

**3.** In a claim as claimed in claim **1**, said mounting means including two straight-line guides.

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