April 11, 1961 R. S. CHALLENDER ET AL 2,978,790

APPARATUS FOR HANDLING NUCLEAR REACTOR FUEL ELEMENTS

Filed July 30, 1957

3 Sheets-Sheet 1

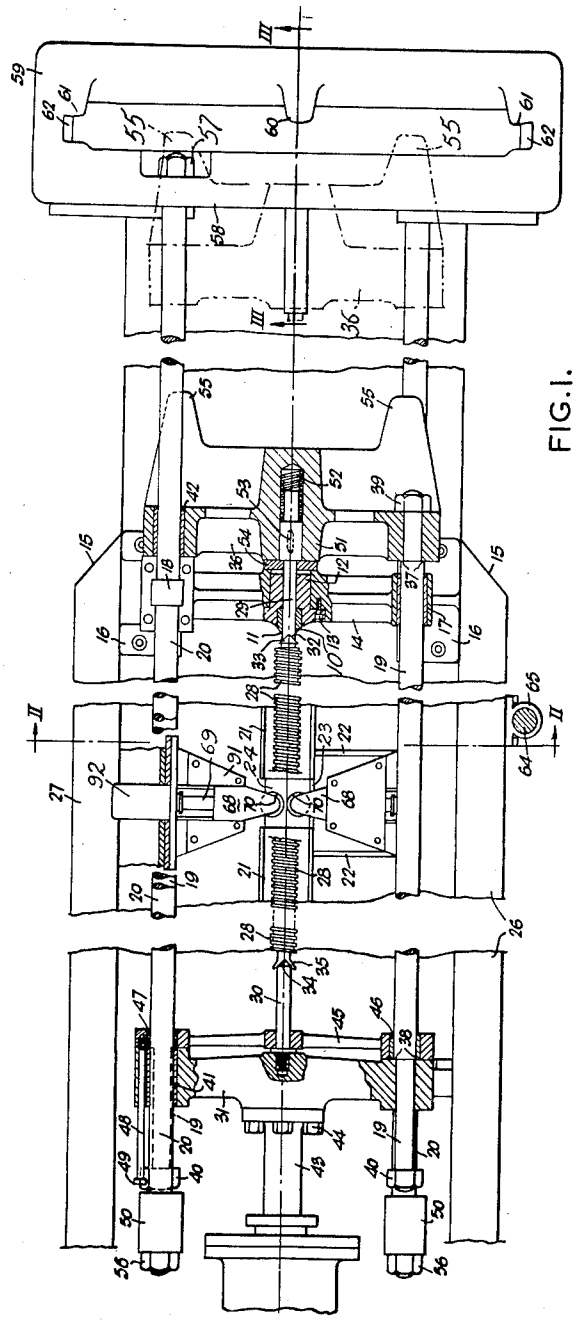

FIG. 1.

April 11, 1961 R. S. CHALLENDER ET AL 2,978,790

APPARATUS FOR HANDLING NUCLEAR REACTOR FUEL ELEMENTS

Filed July 30, 1957 3 Sheets-Sheet 2

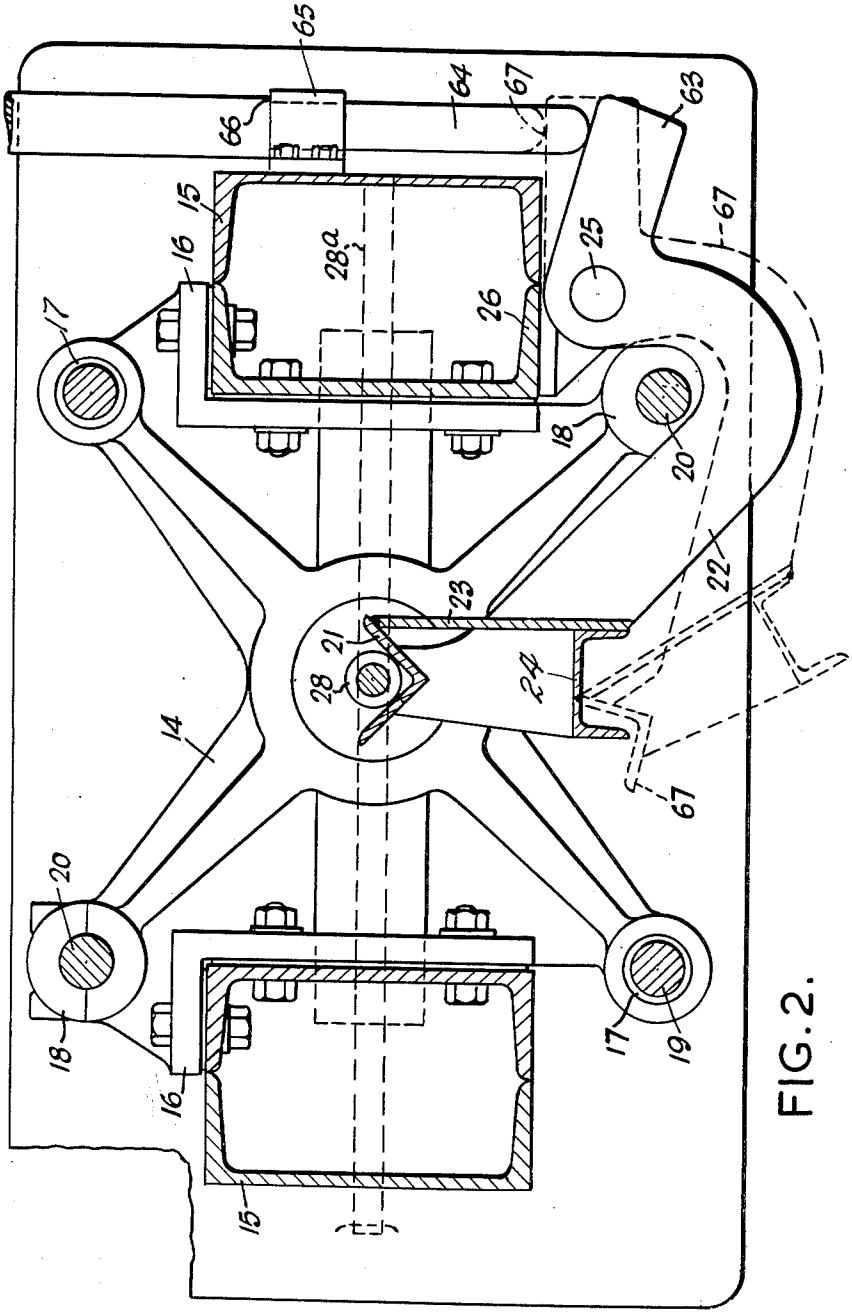

FIG. 2.

April 11, 1961 R. S. CHALLENDER ET AL 2,978,790

APPARATUS FOR HANDLING NUCLEAR REACTOR FUEL ELEMENTS

Filed July 30, 1957 3 Sheets-Sheet 3

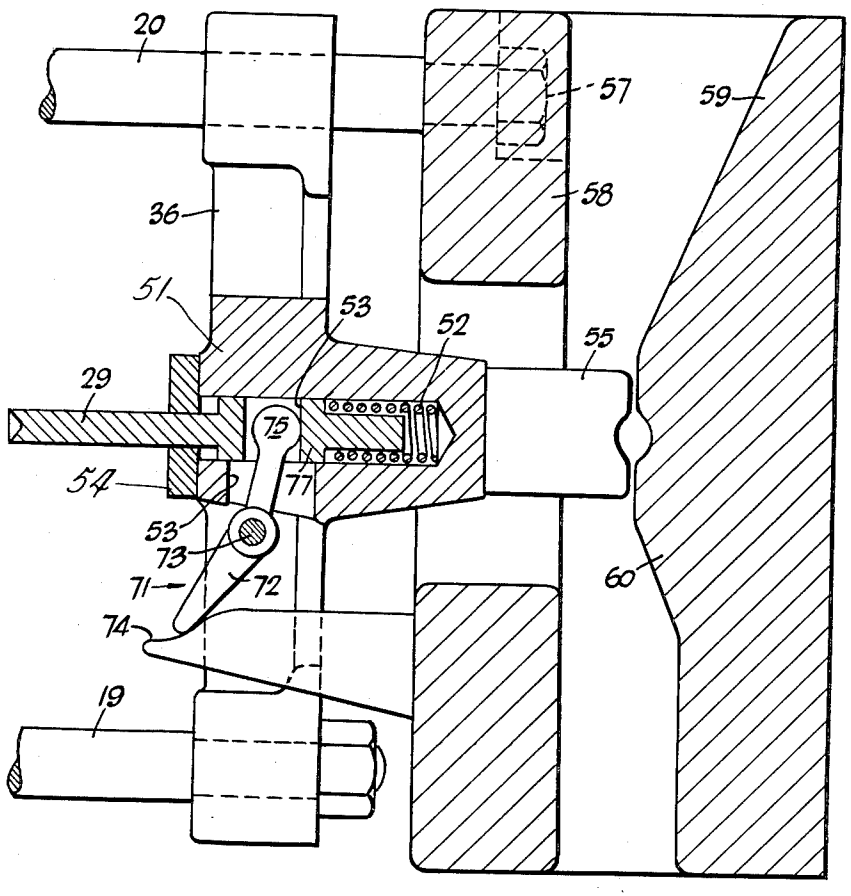

FIG. 3.

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APPARATUS FOR HANDLING NUCLEAR REACTOR FUEL ELEMENTS

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7 Claims. (Cl. 29—33)

This invention relates to apparatus for handling nuclear reactor fuel elements comprising a fuel member enclosed by a protective sheath. It is an object of the invention to provide apparatus for removing the sheath from such fuel elements by physical means.

Apparatus according to the invention comprises an annular die with a leading cutting edge, a support in front of the die to support a fuel element approximately coaxial with the die, locating means to locate with the fuel element to bring it truly coaxial with the die, means for advancing the fuel element relative to the die so as to pass the fuel member part of the element through the die whilst cutting away the sheath and means for applying a bow-restraining force to the fuel element during the initial cut of the die.

An embodiment of the invention will now be described with reference to the accompanying drawings wherein:

Fig. 1 is a plan view partly in section; the chain-dotted outline shows the right hand cross-head in the position it occupies at the end of the stroke;

Fig. 2 is a section on the line II—II of Fig. 1; and

Fig. 3 is a section on the line III—III of Fig. 1.

An annular die **10** with a leading cutting edge **11** is carried in a block **12** fixed by screws **13** and X-shaped cross head **14** secured to the twin box-girder frame **15** (Fig. 2) of the apparatus by flanges **16**. The cross head **14** has two bushes **17** associated with one leg of the X and two supports **18** associated with the other leg of the X: the bushes **17** carry sliding thrust rods **19** and the supports **18** carry fixed guide rods **20**.

In front of the die **10** there is a fuel element support cradle which comprises two V-shaped carriers **21** carried on arms **22** linked together by a plate **23** and channel-section bar **24**. The arms **22** pivot on a pin **25** carried by a part **26** of a box-girder of the frame **15** of the apparatus. One arm **22** has an extension piece **63** over which moves a push-rod **64** movable in a journal **65** secured to the box-girder **26**. The push-rod **64** has a step **66** which abuts the journal to limit the downward movement of the rod. The upward movement of the rod **64** and corresponding retracted position of the arm **22** etc., is shown by the dotted lines **67**. A transversely-finned fuel element **28**, resting in the V-carriers **21** is approximately coaxial with the die. The fuel element **28** is made truly coaxial by conical location with a nose support **29**, movable in the die **10** and carried in a cross-head **36**, and a tail support **30** carried in an X-shaped cross-head **31**. The nose support **29** has a conical indentation **32** to mate with the conical end cap **33** of the fuel element **28**. The tail support **30** has a conical pointed end **34** to mate with the end cap **35**.

The crossheads **31** and **36** are associated with one another by the thrust-rods **19** which have shouldered ends **37**, **38** where they bear against the cross-heads. In the case of end **37**, nuts **39** fix the cross-head **36** firmly against the shoulder. In the case of end **38** the cross-head **36** has a degree of free movement between the shoulder and nuts **40**. The cross-heads are movable on the

guide rods **20** and are provided with bushes **41**, **42** for this purpose. Crosshead **31** is coupled with a hydraulic ram **43** by bolts **44**.

Between the two cross-heads **36**, **31** and around the tail support **30** there is a minor cross-head **45** slidable on busbar **46** on the guide rods **19** and on busbar **47** on the thrust rods **20**. The minor cross-head **45** is also slidable about the tail support **30**. A spacing rod **48** is screwed into the cross head **45** and it has a head **49** which contacts a lug **50**, which is one of two lugs supporting the guide rods **20** at the ram end of the apparatus.

The cross-head **36** carries the nose support **29** in a central boss **51** and the support **29** is spring loaded by a compression spring **52** and has an advancing slot **53**. The support **29** is retained in the boss **51** by a retaining plate **54**. Two impact heads **55** extend from the cross-head **36**.

The ends of the rods **20** are secured by nuts **56**, **57**: the nuts **56** tightened against the lugs **50** and the nuts **57** tightened against bridges **58** in an impact block **59**.

The block **59** has a centre projection **60**, two end projections **61** and end ledges **62** in which a fuel member can be located prior to being struck by the impact heads **55** and broken into pieces of suitable size and shape for feeding to an extraction plant dissolver. The chain-dotted outline of the cross-head **36** in Figure 1 illustrates that the fuel member is broken into four pieces by the action of the impact heads **55** in conjunction with the center projection **60**.

Diametrically opposite one another, are two retractable anti-bowing struts **68** hydraulically operated by rams **69** and fitted with rollers **70**. The retractable struts **68** are conventional. They slide in guides **91** and are operated by rams **69** driven from cylinders **92**. The concave rollers **70** fitted to the ends of the struts **68** are shaped so as to grip a fuel element in the machine when the struts **68** are advanced and they rotate about their vertical axis to allow the fuel element to be pushed past them by the ram **43**.

In Fig. 3 the ram is shown at the end of its stroke after release of the stripped fuel element **28** by means of a trip mechanism **71** which comprises a lever **72** pivoted on a pin **73** secured to the crosshead **36** and a cam **74** fixed to one of the bridges **58**. The lever **72** has a ball end **75** which is located in the slot **53** in the head **77** of the nose support **29**.

In operation, the cross head **31** is drawn back against the nuts **40** leaving the crosshead **36** in the position shown in Fig. 1. A previously stripped fuel member is placed in the block **59** so as to rest on the ledges **62**. The fuel element **28** to be stripped is placed in the V-carriers **21** (which have been raised to the position shown in the drawing by depression of the rod **64**) and the crosshead **31** carrying the tail support **30** is advanced to take up the fuel element **28** between the support **30** and the nose support **29** so as to be coaxial with the die. The spring **52** compensates for any slight variations in fuel element length. The carriers **21** are retracted and the anti-bowing struts **68** are advanced so that the rollers **70** crush the fins and hold the fuel element **28**. The movement of the struts **68** is limited by stops so that the fuel element, at least at the point of contact with the rollers **70**, is brought into a straight line with supports **29** and **30**. The ram **43** is further advanced to bring the fuel element end cap **33** into the die **11**. The die cuts through the cap **33** (a heavy cut in which bowing of the fuel element would occur if not restrained by the struts **68**), the struts **68** are retracted and the ram **43** pushes the rest of the fuel element **28** through the die **11** (a light operation not creating bowing tendencies).

The sheath is peeled off and the fuel member part of the fuel element remains held by the supports **29** and **30** and the cut inner parts of the caps **33** and **34**. When

the lever 72 of the mechanism 71 strikes the cam 74 the ball end 75 is advanced ahead of the cross-head 36 together with the support 29 so that the fuel member is released and the cut inner parts of the caps 33, 34 fall off. The ram 43 proceeds and the impact heads 55 strike the fuel member in the block 59 to break it into four approximately equal pieces. The ram 43 is now drawn back and the relative friction of the sliding parts is such that the draw back to the positions shown in Fig. 1 is reached. Once the cross-head 36 abuts the cross-head 14, the ram draws back the cross-heads 31 and 45 towards the nuts 40. The head 49 of the pin 48 then strikes the lug 50 so that the cross-head 31 continues its journey alone to the nuts 40 and draws the support 30 through the cross-head 45 in so doing thus making sure that any parts of the fuel element adhering to the support 30 are detached. The fuel member which has been stripped of its sheath and released is picked up with tongs and placed in the block 59 in readiness for the next cycle and the pieces of the broken fuel member are fed to an extraction plant.

The operation is carried out under water so that the operators are shielded from dangerous radiations but able to see what they are doing. The principal parts of the apparatus are therefore constructed of material which is not corroded by the water. Rubbing parts are chromium plated carbon steel; other parts are mild steel, aluminium sprayed.

We claim:

1. Apparatus for separating a tubular casing from a body enclosed therewithin, comprising an annular die having an inside diameter no greater than the diameter of the body and a cutting edge at one end thereof, first means slidably mounted within and co-axial with the annular die for positioning the body, means mounted opposite the cutting edge of the die and to reciprocate relative to the die for moving the body relative to the die, and second means mounted on the reciprocating means co-axial with the first means and for positioning the body, whereby the reciprocating means forces the body through the die as it is suspended between the first and second positioning means to separate the casing therefrom.

2. Apparatus according to claim 1 wherein the reciprocating means is a ram assembly mounted to reciprocate in a path co-planar with the axis of the die, and the first and second positioning means are cylindrical members adapted to slide within the annular die, the first being normally mounted within the die and the second being

normally fixed in the ram assembly to lie co-axial with the first, the cylindrical members having opposing ends adapted to support the body.

3. Apparatus according to claim 1 further comprising retractable means mounted transverse to the axis of the die between the cutting edge and the reciprocating means and including rollers disposed adjacent the axis of the die for engaging the tubular casing and preventing bowing therein.

4. Apparatus according to claim 1 further comprising retractable means mounted transverse to the axis of the die between the cutting edge and the reciprocating means and including a carrier element disposed adjacent to and extending parallel to the axis of the die for aligning the body between the first and second positioning means for engagement therewith.

5. Apparatus according to claim 4 wherein the carrier element is a V-shaped member, the vertex thereof being disposed parallel to the axis of the die.

6. Apparatus according to claim 1 further comprising resilient means mounted on the reciprocating means and urging the first positioning means toward the second positioning means, means mounted on the reciprocating means and engaging the first positioning means for overcoming the bias of the resilient means, and means mounted in the path of the reciprocating means and disposed to engage and actuate the means for overcoming the bias of the resilient means, whereby the body is released from engagement with the first and second positioning means.

7. Apparatus according to claim 6 wherein the reciprocating means is a ram assembly mounted to reciprocate in a path co-planar with the axis of the die, the ram assembly including a member with a recess disposed opposite the other end of the die from the cutting edge, the resilient means being disposed in the recess, the first positioning means being a cylindrical member normally mounted within the annular die and having one end engaged with the resilient means in the recess, the means for overcoming the bias of the resilient means being a lever pivoted on the ram assembly member and engaging the cylindrical member, and the means for actuating the means for overcoming the bias of the resilient means being an element mounted in the path of the ram assembly and being disposed to engage the lever to release the body by advancing the cylindrical member ahead of the ram assembly.

No references cited.