

Feb. 16, 1965

W. S. CASHEN ET AL

3,169,588

SAMPLING APPARATUS

Filed Nov. 7, 1960

3 Sheets-Sheet 1

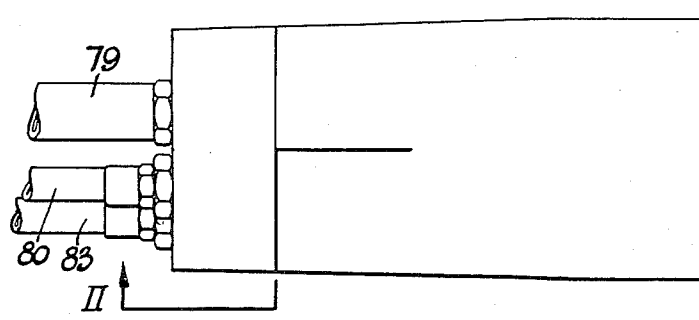


FIG. 1.A.

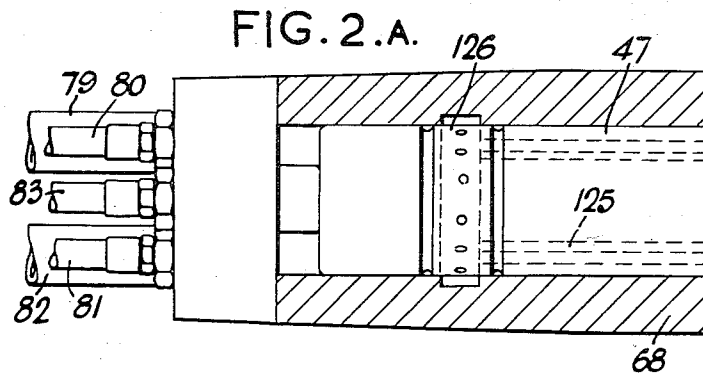


FIG. 2.A.

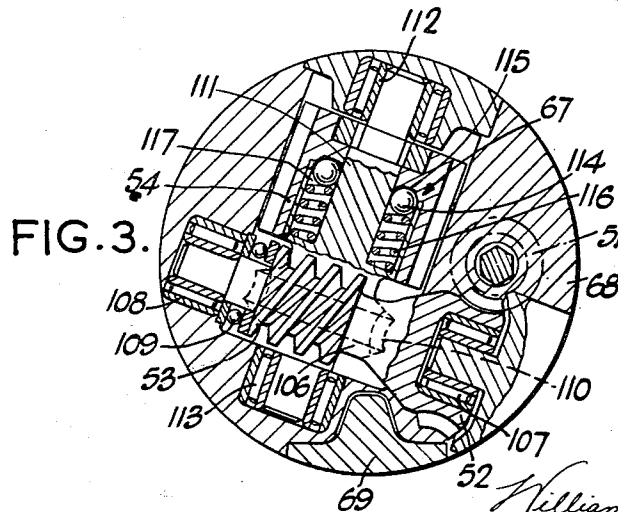


FIG. 3.

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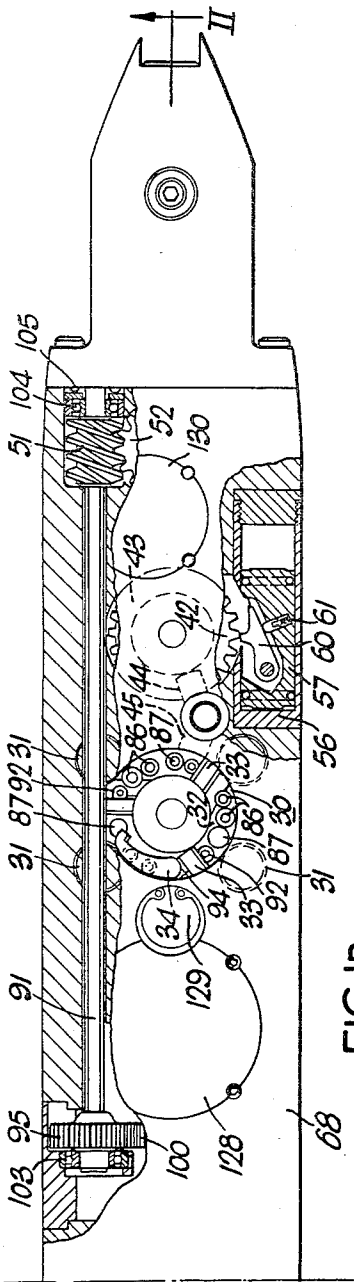


FIG. 1B.

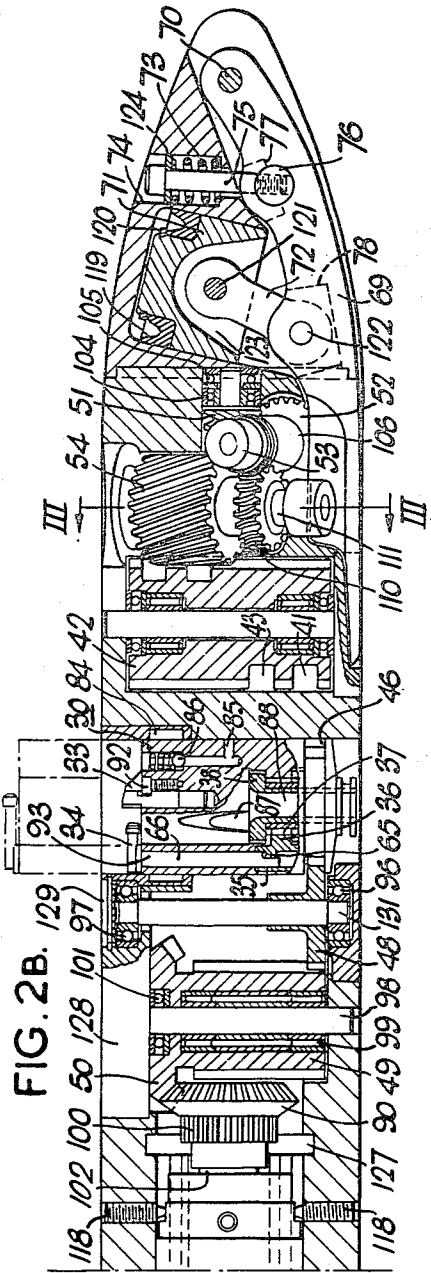


FIG. 2B.

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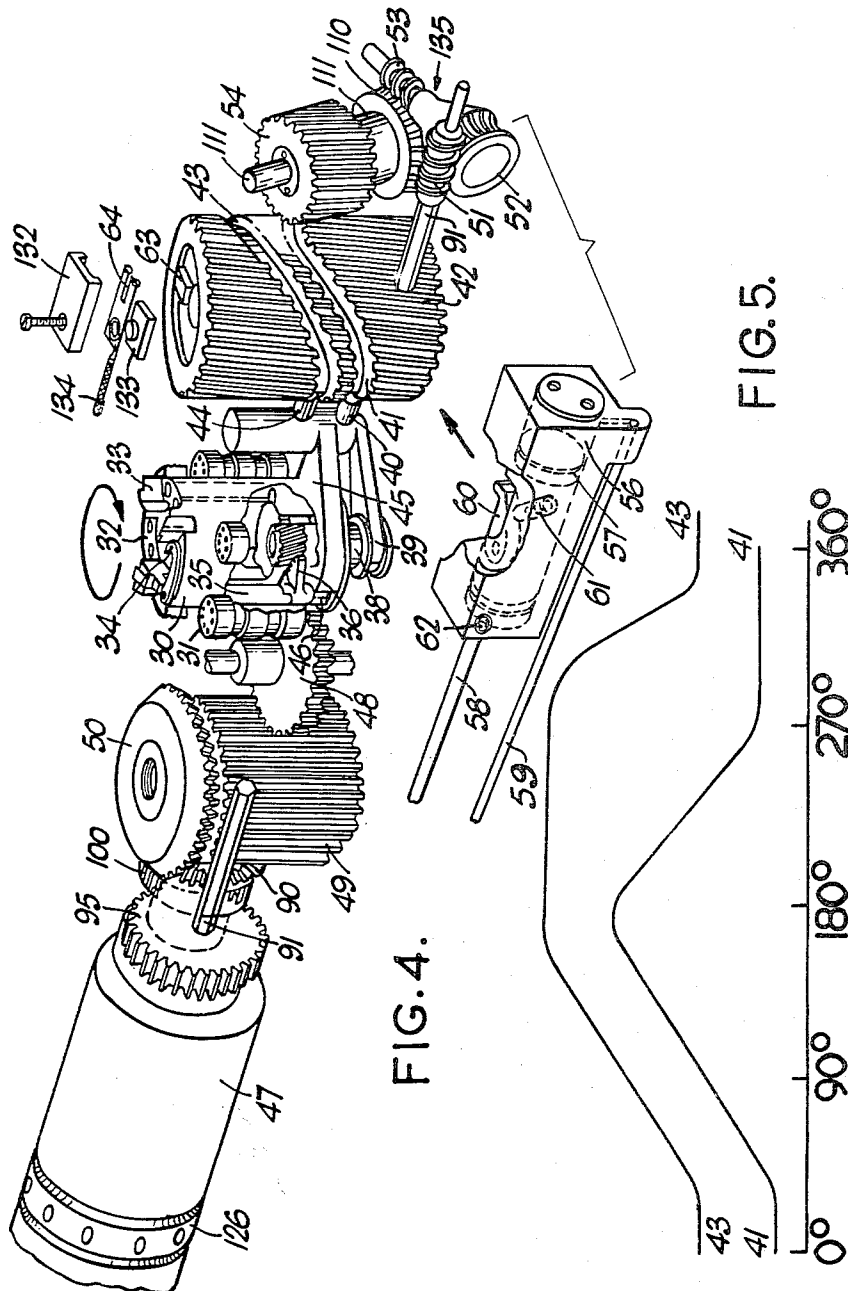
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3,169,588

SAMPLING APPARATUS

Filed Nov. 7, 1960

3 Sheets-Sheet 3



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3,169,588

SAMPLING APPARATUS

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Filed Nov. 7, 1960, Ser. No. 67,715

Claims priority, application Great Britain, Nov. 11, 1959,
38,337/59

4 Claims. (Cl. 175—51)

This invention relates to sampling apparatus and is primarily concerned with sampling apparatus for obtaining graphite specimens from the wall of fuel element or control rod channels in a graphite moderated nuclear reactor.

The problems of obtaining graphite specimens from a nuclear reactor are those of blind and remote operation of a sampling tool in very confined spaces whilst avoiding overheating during the taking of the sample and of being reasonably certain that no part of the tool can become jammed such that it is irretrievable from its remote position.

Sampling apparatus according to the invention comprises an elongate body of generally smooth contour, a trepanning head, with a cutting face having cutting blades, movable into and out from the body, a parting-off cutter mounted on said cutting face to lie behind said cutting blades during a trepanning cut, means for moving the parting-off cutter from behind the cutting blades at the end of the trepanning cut to provide a parting off cut, and means for feeding a coolant fluid into the body to pass over the cutting blades.

The invention will now be described with reference to the accompanying drawings wherein:

FIGURES 1A and 1B together form a plan view partly sectioned;

FIGURES 2A and 2B together form a sectional view on the line II—II of FIGURES 1A, 1B;

FIGURE 3 is a sectional view on the line III—III of FIGURE 2;

FIGURE 4 is an exploded view; and

FIGURE 5 is a developed view of a detail.

In FIGURES 1, 2 and 4 is shown a trepanning head 30 rotated by a compressed air motor 47 through gears 48, 49, 50, 90 and moved axially by engagement with a scroll cam 42 driven by the same motor 47 through double reduction worm gearing 135, shaft 91 and gears 95, 100. The trepanning head 30 is supported by roller steady bearings 31 and has a cutting face 32 to which cutter blades 33 are fixed by screws 92. A parting off cutter 34 is mounted on a pivot 93 in the wall of the head 30 so that the cutter lies behind the blades 33 and is held in the head by a bracket extension 94 on the nearest blade 33. The cutter 34 has an arcuate movement about the pivot 93 and is actuated through a sleeve 35 provided with a flat 65 to suit the stem 66 of the parting off cutter 34. The sleeve 35 carries a small quadrant gear 36 which meshes with a helical gear 37 cut in the upper end of a bronze sleeve 38. The sleeve 38, free to slide axially in the center of the trepanning head 30, engages a small selection fork 39 (FIGURE 4) which is attached to a peg type cam follower 40 engaging an endless track 41 in the scroll cam 42. Besides the track 41 the cam 42 has a second endless track 43. This second track 43 is cut above the track 41 and is engaged by a peg-type follower 44 to which is attached a selector fork 45 fitting in an annular groove 46 at the base of the trepanning head 30. A developed view of both tracks is shown in FIGURE 5.

The trepanning head 30 is driven from the motor 47 through the traveller gear 43 which is constantly in mesh with the head 30 and travels with it across the wide face

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gear 49. The gear 48 is mounted on a pillar 131 supported by bearings 96, 97. The gear 49 is mounted on a pillar 98 and runs on needle bearings 99. Integral with the gear 49 is the bevel gear 50 which is supported by thrust bearing 101 and engages the bevel gear 90 mounted on the shaft 102 of the motor 47. The drive for the cam 42 is provided, as mentioned above, from the motor 47 through the gear 100 which engages the gear 95 mounted at one end of the shaft 91. A worm 51 is carried at the other end of the shaft 91. The shaft 91 runs in bearings 103, 104 and is supported by a thrust bearing 105 at the end carrying the worm 51. The worm 51 engages a worm wheel 52 mounted on a shaft 106 which carries a worm 53. The shaft 106 runs on needle bearings 107, 108. A thrust bearing 109 is provided for the worm 53. The worm 53 engages a worm wheel 110 which is connected to a helical gear 54 which drives the cam 42. The worm wheel 110 and gear 54 are mounted on a shaft 111 which runs in needle bearings 112, 113. Within the gear 54 is a spring-loaded clutch 67 which allows slipping of the gear 54 on the shaft 111 when the gear 54 is driven in reverse by rotation of the cam 42 in a manner to be described below. It also allows slipping in the forward direction should axial movement of the trepanning head become stiff. The clutch is of the ball type having balls 114 loaded into depressions 115 in the gear 54 by springs 116 housed in recesses 117 in the shaft 111.

The motor 47 and all the other parts already referred to are housed in a casing 68, cover plates 128, 129, 130 being provided for gears 49, 48 and 54 respectively. Axial movement of the trepanning head 30 out from and back into the casing 69 is allowed for. Locating pins 118 are provided for the motor 47. Part of the casing 68 is in the form of a shoe 69 pivotable on a pin 70 and operated pneumatically through a piston 71 and lever 72 (pivoting about pins 121, 122) to press the shoe against the wall of a channel in a moderator structure and thereby cause the apparatus to operate in an inclined position. The piston 71 is provided with a sealing gland 119 held in position by a collar 120. Recesses 78, 123 are provided for the lever 72 in the shoe 69 and piston 71, respectively. A return spring 73 is provided in a recess 74. The spring is compressed by a collar 124 and bolt 75 screwed into a pin 76 in the shoe 69. A recess 77 in the shoe 69 allows relative movement of the shoe 69 and bolt 75.

In a recess in the side of the casing 68 is a cylinder 56 provided with a double headed piston 57. One side of the piston 57 is acted on by oil in a pipe 58. The other side of the piston is acted on by constant air pressure through a pipe 59. The center portion of the piston 57 is recessed and carries a pawl 60 in the recess loaded by a spring 61, which engages the gear teeth on the cam 42 as the piston is acted upon by oil in the pipe 58 but disengages on the return stroke of the piston. A bleed screw 62 is provided to remove entrained air. The pawl 60 is used to drive the cam 42 in reverse in the event of failure of the air motor or jamming, a large reverse torque on the cam 42 being made available by the oil operated piston 57.

Four flexible hoses 79, 80, 81, 82 are connected to the apparatus for the supply of compressed air. These hoses serve the motor 47, the shoe 69 and the air side of the cylinder 56, and also provide a coolant line to the cutter blades 33. Air supply to the cutter blades 33 is effected via an annulus 84 and air holes 85. Nine holes 85 are provided but only one is shown. The nine holes are arranged at three different levels so that three holes are in circuit with the annulus 84 at any one time. The lowest six of the holes 85 are provided with spring loaded non-return valves 86 to prevent swarf being blown back into the apparatus when these holes are not in use. Air

and swarf is removed through passages 87 and common exhaust 88. Air to the motor 47 is supplied through the hose 81 and exhausts through grooves 125 and exhaust manifold 126 via annulus 127. A hydraulic line 83 is provided to the pipe 58 connected with the cylinder 56.

The scroll cam 42 carries an electrical contact 63 which at the rest position of the cam makes contact with wiper 64 set in the casing 68 between insulating blocks 132, 133 (see FIGURE 4). An insulated flexible wire 134 (FIGURE 4) leads to the control position of the apparatus. A signal light at the control position indicates the return of the cam 42 to its rest position and hence completion of a trepanning and parting off operation.

The assembled apparatus is inserted in and withdrawn from a channel by steel tubing connected in lengths as required. Numbered marks on the tubing serve to locate the apparatus along the length of the channel. To ensure accuracy of location the tubing is connected by screwed joints which are pinned after assembly.

The apparatus is clamped in position in a channel in a graphite structure by operation of the pivoted shoe 69. Air pressure is then applied to the motor 47 so that the trepanning head 30 and cam 42 rotate. The cycle of movements is as follows:

Following a short dwell period the two cam followers 40, 44 move outwards together, the tracks 41, 43 in the cam 42 being parallel. Thus the parting off cutter 34 remains in a rest position while the trepanning head 30 rotates and also moves axially out from the casing 68 to cut into the adjacent graphite. At the conclusion of the trepanning cut the cam track 43 follows a horizontal path so that the head 30 does not cut further into the graphite. The track 41 diverges from the track 43 at this point so that the bronze sleeve 38 is drawn out from the bottom of the head 30 and the helical gear 37 causes the parting off cutter 34 to rotate. This results in the severing of the specimen at the upper end of the cutter 34 as the cutter moves toward the centre of the trepanning head 30 (which is still rotating). The upper track 43 now starts to drop towards the lower track 41 so that the trepanning head 30 is moved back into the casing 68 while the parting off cutter 34 rests at or near the centre to retain the trepanned sample of graphite inside the head 30. During the last part of the cycle the sleeve 38 re-enters the head 30 and the cutter 34 returns to its position behind the cutting blades. At the end of the cycle the contact 63 contacts the wiper 64 and the signal light at the control position indicates completion of the operation. The apparatus may now be removed from the channel and the graphite specimen extracted. It is found that the small pip left on the specimen by the parting off cutter 34 assists in this extraction. During removal of the apparatus from the channel the specimen is not held positively but it is a close fit in the head 30. By using this apparatus graphite samples 1 in. in diameter and 1 in. long have been obtained by cuts at an angle of 25° above horizontal from channels 3.55 in. in diameter.

Should it not be possible to complete the cutting cycle the head 30 may be retracted hydraulically by rotating the cam 42 in the direction reverse to its normal direction. An oil pump manually operated from the control position displaces oil in the pipe 58 so that the piston 57 is driven along the cylinder 56 and the pawl 69 engages a tooth on the cam 42 and rotates the cam a part of a revolution against the action of the spring loaded clutch 67 in the gear 54. On the return stroke of the piston 56 the pawl 60 is disengaged from the cam 42 and the procedure is then repeated until the head 30 is returned to its rest position when the apparatus may be withdrawn from the channel.

In an alternative arrangement of the apparatus the exhaust manifold 88 for graphite swarf and cutter blade coolant outside the reactor in which the apparatus is being used.

We claim:

1. Sampling apparatus comprising an elongate body of generally smooth contour, a hollow trepanning head with a cutting face having cutting blades, an opening for the trepanning head defined by the elongate body, means for feeding a coolant fluid into the body, means for conveying said coolant fluid to the trepanning head, passages in the trepanning head leading to the cutting face and communicating with said conveying means, a parting-off cutter mounted on said cutting face to lie behind said cutting blades during a trepanning cut, means for moving the parting-off cutter from behind the cutting blades at the end of the trepanning cut to provide a parting-off cut, a scroll cam having an endless track, a cam follower in the endless track, and means connecting the cam follower with the trepanning head so that axial movement of the trepanning head is governed by movement of the cam follower as dictated by the endless track on rotation of the cam, the endless track being shaped so that with unidirectional rotation of the cam the trepanning head executes a cycle of axial movement out from and back into the body, and means for rotating said trepanning head and said scroll cam.

2. Sampling apparatus according to claim 1 wherein the means for moving the parting-off cutter from behind the cutting blades at the end of the trepanning cut to provide a parting-off cut comprises a second endless track defined by the scroll cam and a second cam follower in said second track, the second follower being operatively connected to the parting-off cutter so that as the second follower moves in the second endless track the parting-off cutter executes a cycle of movement consisting of a rest period during the trepanning cut, a second rest period while the trepanning head is moved part way back into the body and the return of the parting-off cutter to its position behind the cutting head.

3. Sampling apparatus according to claim 1 further comprising a hydraulically operated pawl means for driving the cam in the direction reverse to its normal direction.

4. Sampling apparatus comprising an elongate body of generally smooth contour, a hollow trepanning head with a cutting face having cutting blades, an opening for the trepanning head defined by the elongate body, means for feeding a coolant fluid into the body, means for conveying said coolant fluid to the trepanning head, passages in the trepanning head leading to the cutting face and communicating with said conveying means, a driving motor, a first coupling from the motor to the trepanning head to rotate said head, a second coupling from the motor comprising a scroll cam defining a first endless track and a follower in said endless track coupled to said trepanning head to govern movement of the trepanning head out from and back into the body, a parting-off cutter pivotably mounted on the cutting face of the trepanning head to lie behind the cutter blades during the movement of the trepanning head out from the body, a second endless track defined by said scroll cam, and a follower in said second track coupled to said parting-off cutter to cause said parting-off cutter first, to pivot from its position behind the cutter blades when movement of the trepanning head out from the body has been completed and thereby to effect a parting-off cut, second, to rest at the end of the pivot movement while the trepanning head is moved part way back into the body, third, to return to its position behind the cutting blades.

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