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**Self-centering tool holder.**

(57)

A tool holder for a remotely operated and positioned tool which permits lateral and pivotal motion of the tool for self-centering capability.

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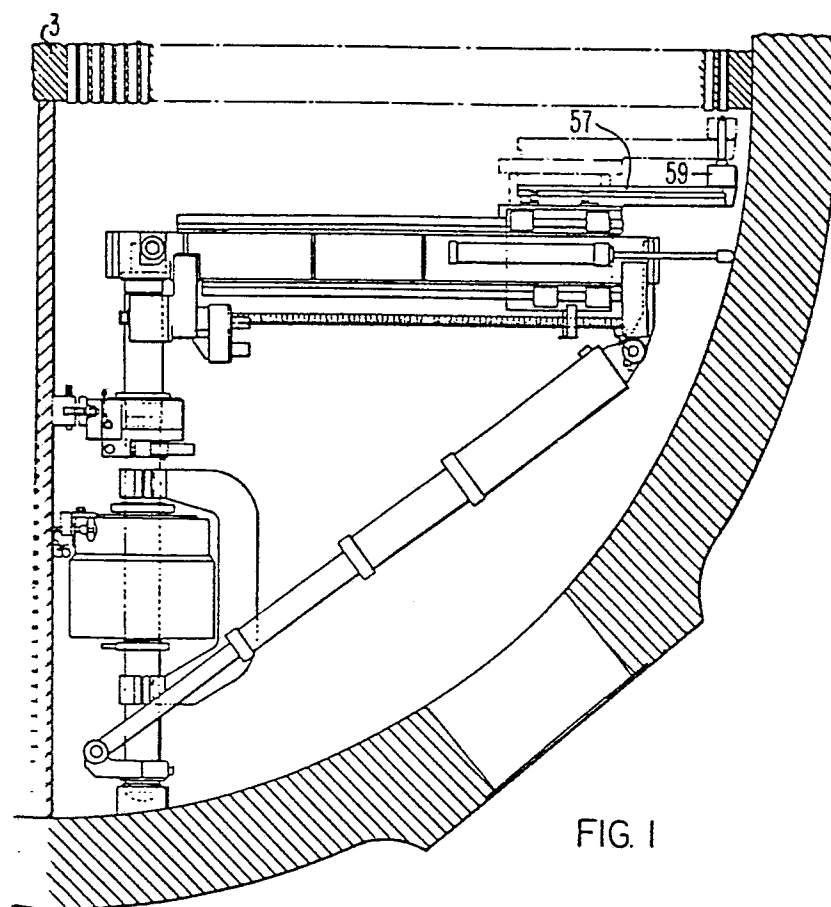


FIG. 1

## SELF-CENTERING TOOL HOLDER

This invention relates to a tool holding chuck and more particularly to a chuck mounted on a remotely operated tool-positioning arm and having limited self-centering and self-aligning capability.

5 Quick release tool holding chucks are well known in the prior art. Such chucks are generally solidly mounted in apparatus to provide definite, repeatable positioning of the tool. In the environment in which the chuck of the instant invention is to be used, namely  
10 within an irradiated nuclear steam generator, manual guidance and position adjustment is not possible. Therefore, the tools which are particularly adapted to perform various operations in a remote detubing/retubing procedure, are mounted on an apparatus such as discussed in  
15 U.S. Patent 4,205,940, in which they are automatically positioned from a remote control facility as therein discussed. For the most part the tool positioning is sufficiently accurate. However, as shown in the above-identified application, the tool is mounted on the distal  
20 end of an arm that magnifies any angular mis-positioning of the arm. Also, the weight of the arm and the working force applied by the tool at the end may cause a deflection in the support structure.

Thus, it is the principal object of the present  
25 invention to provide a mechanism for quickly connecting and releasing a tool which permits the tool to follow an existing opening, as in drilling out the tube, that is to

permit the tool to assume the proper placement and alignment to minimize stress on the various parts.

With this object in view, the present invention resides in a tool holding apparatus for use with a tool support and positioning mechanism comprising a base member rotatably mounted on said support mechanism and defining a first surface generally perpendicular to the axis of rotation of said member, a tool holding member including means for releasably engaging a tool within a tool receiving cavity open at one end and having a second surface at the opposite end generally perpendicular to the axis of said cavity and in spaced facing relationship with said first surface with said members being generally coaxial, and an intermediate member disposed between said spaced first and second surfaces and defining generally parallel end surfaces, with one of said end surfaces in adjacent facing relationship with said first surface and the other of said end surfaces in adjacent facing relationship with said second surface, said base member and said intermediate member defining first engaging means for rotational generally coaxial driving engagement therebetween, said first engaging means further permitting relative translational movement therebetween in a first plane, characterized in that said tool holding member and said intermediate member define second engaging means for rotational generally coaxial driving engagement therebetween, said second engaging means further permitting relative translational movement therebetween along a second plane in a direction generally perpendicular to that of movement in said first plane, first support means are provided for supporting said intermediate member on said base member with said first surface, and said one surface in spaced relationship and providing a fulcrum therebetween permitting pivotal movement of said one surface in one axially extending plane, second support means are provided for supporting said tool holder member on said intermediate member with said second and said other surfaces in spaced

relationship and providing a fulcrum therebetween permitting pivotal movement of said second surface in another axially extending plane perpendicular to said one plane, and interconnecting means extend between said tool holding  
5 member and said base member for preventing axial disengagement of said first and second engaging means, said tool holding member translational motion with respect to the axis of rotation of said base member and pivotal movement with respect to said base member.

10           The invention will become more readily apparent from the following description of a preferred embodiment thereof shown, by way of example only, in the accompanying drawings, in which:

Figure 1 is a partial sectional view of a nuclear  
15 ar steam generator head with remotely operated tool holding and placement apparatus disposed therein for repairing the tube and tubesheet of the generator;

Fig. 2 is an enlarged cross-sectional view of a portion of the free end of the tool holding arm showing  
20 the tool holder of the present invention;

Fig. 3 is a view similar to Fig. 2 with the tool holder rotated 90° from the position of Fig. 2; and,

Fig. 4 is an exploded isometric of the quick release tool holder of the present invention.

25           Referring to Figure 1, the particular remotely controlled apparatus disposed in the channel head of a nuclear steam generator and which supports the tool holder of the present invention is shown. Such apparatus is more fully described and claimed in U.S. Patent 4,205,940,  
30 which is herein incorporated by reference for the description of this particular structure. However, it is sufficient to note the tool holding chuck (59 therein) is supported on the distal end of a removably mounted cantilevered tool holder arm (57 therein) supporting a tool  
35 generally in axial alignment with tubes extending through a tubesheet (3 therein) of the nuclear steam generator. It is apparent that proper disposition of the tool so as

to initially be disposed in axial alignment with each individual tube to be worked on and also in continued axial alignment as the tool is elevated within the tube are necessary for minimal stress on the tool and the attendant support structure. However, it is also apparent that due to manufacturing tolerances and the inherent deflections in the cantilevered tool support arm, exact axial alignment and subsequent axial travel of the tool are not assured. Thus, the tool holder 59 of the present invention permits, whenever such misalignment occurs, a self-centering of the tool as guided by the tool pilot as it enters the tube.

Thus referring to Figs. 2 through 4, the tool chuck 59 is clearly shown as mounted on the distal end of the tool holding arm 57 of such an apparatus shown in Fig. 1. The chuck 59 is formed of an assembly of parts comprising a rotatably driven base member 14 having a shank portion 16 vertically supported in a pair of bearings 18 in the arm 57 and a drive gear is keyed thereto for rotating the base member 14 from a gear drive arrangement described in the above-referenced copending application.

The upper end of base member 14 projects above the arm 57 and defines an enlarged cylindrical head 20 having a generally planar upper face 22 defining a groove or channel 24 (see Fig. 3) extending diametrically thereacross. A pair of diametrically opposed roller members 26 are supported within appropriate openings 28 in the head 20 via horizontal axial roller shafts 30 received within a horizontal bore 32 in the head 20 perpendicular to the channel 24. The rollers 26 extend upwardly through the surface 22 of the head 20 so that the peripheral rolling surface of the rollers 26 projects above the general plane of the upper surface, as is seen, and provides a rolling direction parallel to the channel 24.

The head 20 is also externally threaded as at 34 for threaded engagement of an upstanding internally threaded annular collar member 36, to be described later, and an internally threaded lock nut 38.

An intermediate cylindrical plate member 40 having a generally planar lower surface 42 rests on the opposed rollers 26 so that the plate 40 is elevated somewhat from the surface 22 of the base member 14 and thus free to teeter or wobble thereon with the roller members 26 forming the fulcrum. The lower surface 42 of the plate 40 defines a downwardly projecting diametrically extending tongue or rib 44 slidably received in the channel 24 of the spindle member 14 to provide an indexed engagement therebetween which guides any translational movement of the plate 40 permitted by the rolling supports 26 so that both rotational and translational movement permitted thereby is in a common vertical plane on the surface 22.

The upper surface 46 of the plate 40 is likewise generally planar except for a pair of diametrically extending and opposed upwardly projecting tongues or ribs 48 angularly off-set from the lower rib 44  $90^\circ$ . A pair of diametrically opposed rollers 50 (similar to the rollers 26 in the base member 14 and more clearly shown in Fig. 3) are supported in the plate 40 and have a peripheral surface projecting slightly the planar surface 46 of the plate. The rotational axis of the rollers 50 is likewise angularly offset from the axis of rollers 26 in the base member 14 by  $90^\circ$ .

It should be noted that the outer diameter of the plate 40 is somewhat less than the inner diameter of the collar 36 to provide an annular gap therebetween.

The tool-holding portion comprises a generally cup-like upper cylinder member 52 having an open upper end formed by a central cavity 53 and a planar lower surface 54 resting on the rollers 50 of the plate 40. The lower surface 54 defines a diametrically extending groove or channel 56 for receiving the ribs 48 of the plate 40 for indexed angular orientation of the cylinder member on the plate. This permits the cylinder member 52 to teeter or wobble about the rollers 50 in a vertical plane  $90^\circ$  off-set from the wobble plane of the plate 40 and the rollers

50 also permit the cylinder member 52 translational motion, as guided by the rib 48 and channel 56 engagement, in a vertical plane  $90^\circ$  off-set from the travel permitted by the plate 40 on the base member 14 with both such  
5 pivotal movement and translational movement on surface 46 being generally perpendicular to the respective movement on surface 22.

The cylinder member 52 has an annular exterior flange 58 at its base with the upper surface 60 thereof  
10 angled outwardly downwardly. The upper end 62 of the collar member 36 has an internal complimentary annular shoulder 64 angled inwardly upwardly overlapping the flange 62 of the cylinder member 52. It is noted that the internal diameter of the collar 36 is likewise greater  
15 than the outer diameter of the cylinder member 52 to define a like annular gap therebetween.

To assemble the above-identified parts, it is apparent that the plate member 40 is axially aligned on the base member 14 with the respective ribs and channels  
20 properly engaged and the upper cylinder member 52 is likewise axially aligned on the plate 40 with the respective ribs 48 and channels 56 engaged. The lock nut 38 is threaded into a lowered position on the spindle head 20 and the collar 36 is threaded onto the spindle until  
25 initial abutment between the complimentary engaging surfaces 60, 64 of the cylinder member 52 and the collar 36. (After this initial abutment the collar 36 is then slightly backed-off to permit generally free movement of the plate 40 and cylinder member 52 without interference of  
30 the complimentary surfaces 60, 64). And the lock nut is then tightened against the collar to maintain such assembly.

In the preferred embodiment the tool holder of the present invention includes an insert 68 that closely  
35 fits within the cavity 53 of the cup-like member 52 and which is securely attached to the shank 70 of the tool supported in the tool holder. The insert 68 includes a



set-screw 71 projecting through the sidewall thereof and into the bore for engagement of the tool shank 70 to prevent relative rotation of the tool within the insert, and a second set-screw 72 forming a vertically adjustable  
5 base for the insert to preset the depth of the insertion of the tool within the insert. By this structure all tools can be pre-assembled with an insert to a uniform position before the tool and insert assembly is mounted within the member 52.

10           The cylindrical member 52 has a quick-release capability for engaging the insert 68 and to this end includes an upper annular camming ring 76 in close sliding engagement with the exterior of the member 52 and defining an upper surface 78 abutting a retaining ring 80 mounted  
15 in an annular groove adjacent the top of the member 52 and further defining a lower depending leg portion 84 having an internal diameter in sliding engagement with the member 52. Between the upper surface 78 and the leg portion 84 the ring defines a generally concave surface 86 providing  
20 an annular space and including downwardly inwardly tapered area 88 extending to the sliding engaging leg portion 84.

          The cylindrical member 52 defines an elongated horizontal aperture 90 through the cylindrical wall in alignment with the lower portion 84 of the ring 76. A  
25 locking pin 92 is slidably housed within the slot 90 and extends into the inner area of the member 52 to engage a complimentary engaging groove 94 in the insert 68 for locking engagement between the member 52 and the insert. A key 96 retains the locking pin 92 from sliding completely through the aperture 90 when the insert 68 is removed.  
30

          A tensile coil spring 98 encircles the cylindrical member 52 with the opposite ends thereof received in appropriate facing notches 100 and 102 in the collar member 36 and the ring member 76 respectively, and the  
35 normal biasing force of the spring retains the ring 76 in its upward position wherein the leg portion 84 prevents the locking pin 92 from sliding outwardly and thus locks

the tool insert 68 within the cavity 90 of the cylindrical member 52. However, manually forcing the ring 76 downwardly moves the concave portion 86 thereof into alignment with the pin 92 and thus upward manual force on the tool insert 68 will cam the locking pin 92 outwardly into the annular space 86 and out of the way of further withdrawal of the insert permitting quick release of the tool and insert from the cylinder member 52.

An annular outer skirt 104 is attached to the ring 76 to enclose the spring 98 and provide a generally smooth outer surface for manual engagement, and also a guard to keep cutting chips from entering the internal mechanism.

The tool holder of the present invention also includes cooling fluid delivery to the tool and to this end the base member 14, plate 40, cylindrical member 52, and set screw 72, all have an axial oversized bore 106 for receiving therethrough a tube 108 containing both a lubricant delivery line (not shown) and a pressurized air delivery line (not shown) so that at the terminal end of the tube 108, which mates with an axial bore in the tool, pressurized cooling fluid is delivered thereto for flowing through the tool and out appropriate apertures through the side of the tool. A bearing member 16 is retained in the bottom of the member 52 so as to be between the rotatable member 52 and the stationary tube 108 so that any movement of the member 52, whether the permitted translational movement or the rocking or teetering movement provided by these members being supported on the rollers, is transmitted to the flexible tube 108 to similarly move or flex it such that the tube 108 does not come into contact with any rotating part that would otherwise eventually wear the tube away.

Thus, it is seen that on those occasions where the upwardly projecting tool, as mounted within the holder of the present invention, is not exactly axially aligned with the opening in the tubesheet, initial insertion of

the tool within such opening will cause the tool holder to move by virtue of its ability to move in any direction parallel to the surface 22 and 46 (in a first vertical plane and in a second vertical plane perpendicular to the first plane such that any required resultant movement within the permitted limits can be obtained through these two right-angle planes of movement). Also, on occasions where the axis of rotation of the base member 52 is not in alignment with the axial direction of the opening receiving the tool, the tool holder, through its ability to also pivot or teeter in two vertical planes off-set 90° and about surface 22 can also permit the axis of the tool to be in alignment with the axis of the opening and angularly off-set from the axis of the drive so that any stress on the tool, tool holder or drive mechanism due to slight misalignment is minimized.

What we claim is:

1. Tool holding apparatus for use with a tool support and positioning mechanism comprising a base member (14) rotatably mounted on said support mechanism (57) and defining a first surface (22) generally perpendicular to the axis of rotation of said member, a tool holding member (59) including means for releasably engaging a tool (70) within a tool receiving cavity (53) open at one end and having a second surface at the opposite end generally perpendicular to the axis of said cavity and in spaced facing relationship with said first surface with said members being generally coaxial, and an intermediate member (40) disposed between said spaced first and second surfaces and defining generally parallel end surfaces (42, 46), with one of said end surfaces in adjacent facing relationship with said first surface (22) and the other of said end surfaces in adjacent facing relationship with said second surface (54), said base member (20) and said intermediate member (40) defining first engaging means (24, 44) for rotational generally coaxial driving engagement therebetween, said first engaging means (24, 44) further permitting relative translational movement therebetween in a first plane, characterized in that said tool holding member (52) and said intermediate member define second engaging means (48, 56) for rotational generally coaxial driving engagement therebetween, said second engaging means (48, 56) further permitting relative translational movement therebetween along a second plane in a

direction generally perpendicular to that of movement in said first plane, first support means (26) are provided for supporting said intermediate member (40) on said base member (20) with said first surface (22), and said one surface (42) in spaced relationship and providing a fulcrum therebetween permitting pivotal movement of said one surface in one axially extending plane, second support means (50) are provided for supporting said tool holder member (52) on said intermediate member (40) with said second and said other surfaces in spaced relationship and providing a fulcrum therebetween permitting pivotal movement of said second surface in another axially extending plane perpendicular to said one plane, and interconnecting means (36) extend between said tool holding member (52) and said base member for preventing axial disengagement of said first and second engaging means, said tool holding member (52) translational motion with respect to the axis of rotation of said base member and pivotal movement with respect to said base member.

2. An apparatus according to claim 1, characterized in that each said first and second engaging means comprises engaging tongue-and-groove structure on said facing adjacent surfaces.

3. An apparatus according to claim 1 or 2, characterized in that each said first and second support means (26, 50) each comprises a pair of diametrically opposed rollers disposed within diametrically opposed cavities in said base and intermediate members (20 and 40), and an arcuate portion of the surface of said rollers (26, 50) projects above the surfaces of said base and intermediate members (20, 40) providing said fulcrum support, and that said tongue-and-groove structures (24, 44; 48, 56) between said facing adjacent surfaces extend perpendicularly to the axis of said rollers (26, 50) separating said respective surfaces so that the rollers (26, 50) provide a rolling support in the direction of guided translational movement permitted by said tongue-and-groove structures (24, 44; 48, 56).

4. Apparatus according to claim 3, characterized in that said base member (20), said intermediate member (40) and said tool holding member (52) are generally cylindrical, and said tool holding member (52) defines an outer annular shoulder (58) adjacent said second surface (46), with the outer diameter of both said shoulder (58) and said intermediate member (40) being less than the outer diameter of said base member (20) and wherein, said interconnecting means comprises a collar (36) threaded to said base member (20) and having an upper inner annular lip (62) overlying said shoulder (58) to retain said tool holding member (52) and said intermediate member (40) on said base member (20), said collar (36) providing an annular space between it and the outer peripheral walls of both said tool holding member (52) and said intermediate member (40) to permit at least limited translational movement of said members (40, 52) within said collar (36).

5. Apparatus according to claim 4, characterized in that said lip and shoulder (62, 58) define complementary engaging surfaces which are angled outwardly downwardly, that is toward the base member (20), to permit relative pivotal movement of said shoulder (58) with respect to said lip (62).

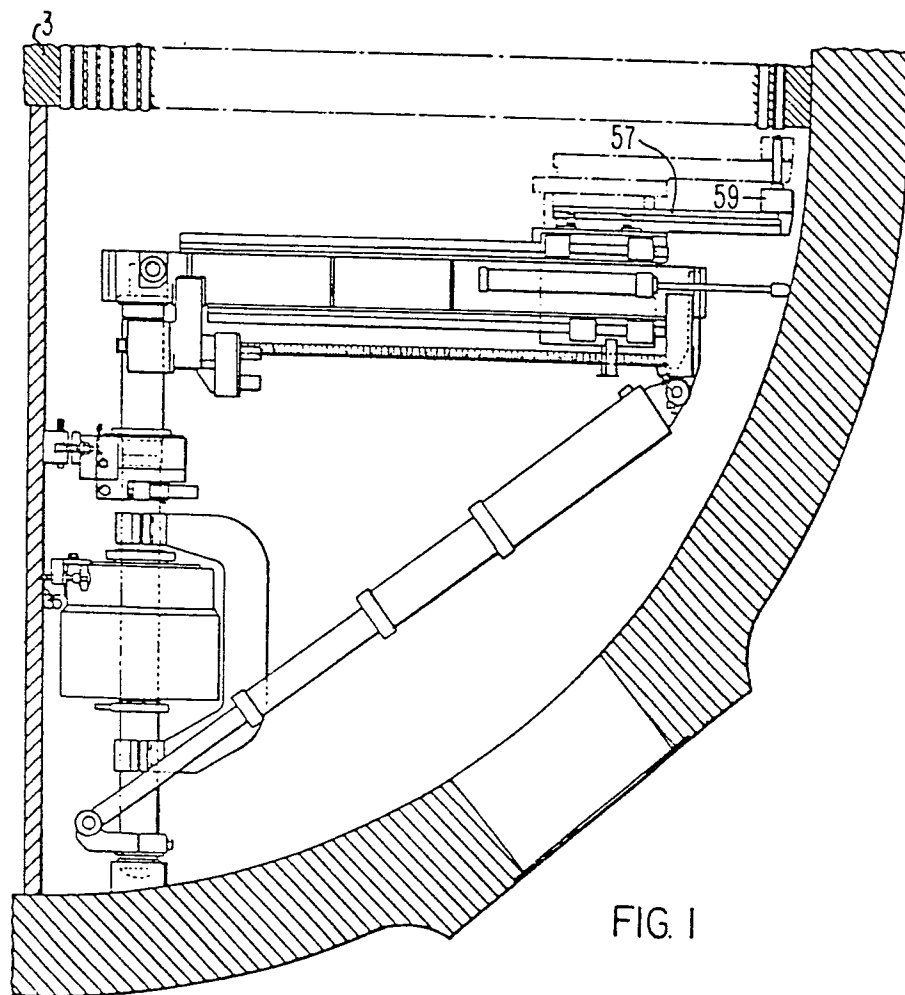
6. Apparatus according to any of claims 1 to 5, characterized in that said tool holder (52) has an axial, tool receiving cavity (53), an aperture (90) extending through the wall of said cylinder (52) and into said cavity (53) and a pin member (92), generally conforming to said aperture (90) slidably received therein and having a length greater than the thickness of said wall (52), a slidable ring member (84) encircling said cylindrical member (52) and overlying said pin member (92) and defining a camming surface (88) for camming said pin (92) from a free position projecting from the exterior of said cylinder (52) to a tool locking position projecting into said cavity (53), and a blocking surface for preventing the pin (92) from moving out of said locking position and,

means (98) for biasing said ring (84) into said pin locking position

7. Apparatus according to claim 6, characterized in that said pin (92) includes a stop means (96) preventing said pin (92) from sliding completely through said aperture (90) into said cavity (53).

8. Apparatus according to any of claims 1 to 7, characterized by coolant fluid delivery means (108) extending through an axial aperture (106) in base member (20) to deliver pressurized cooling fluid to a tool (70) retained therein.

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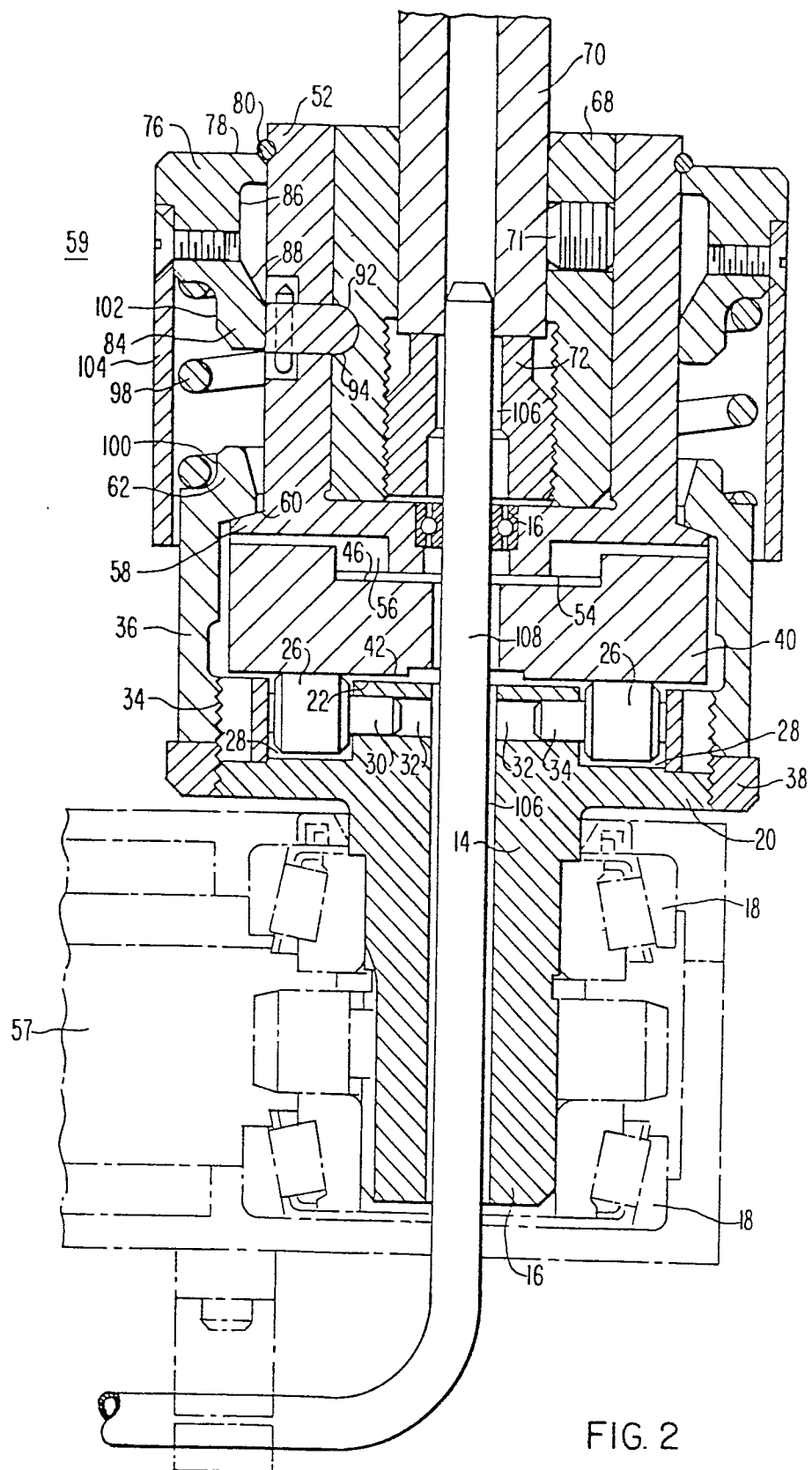
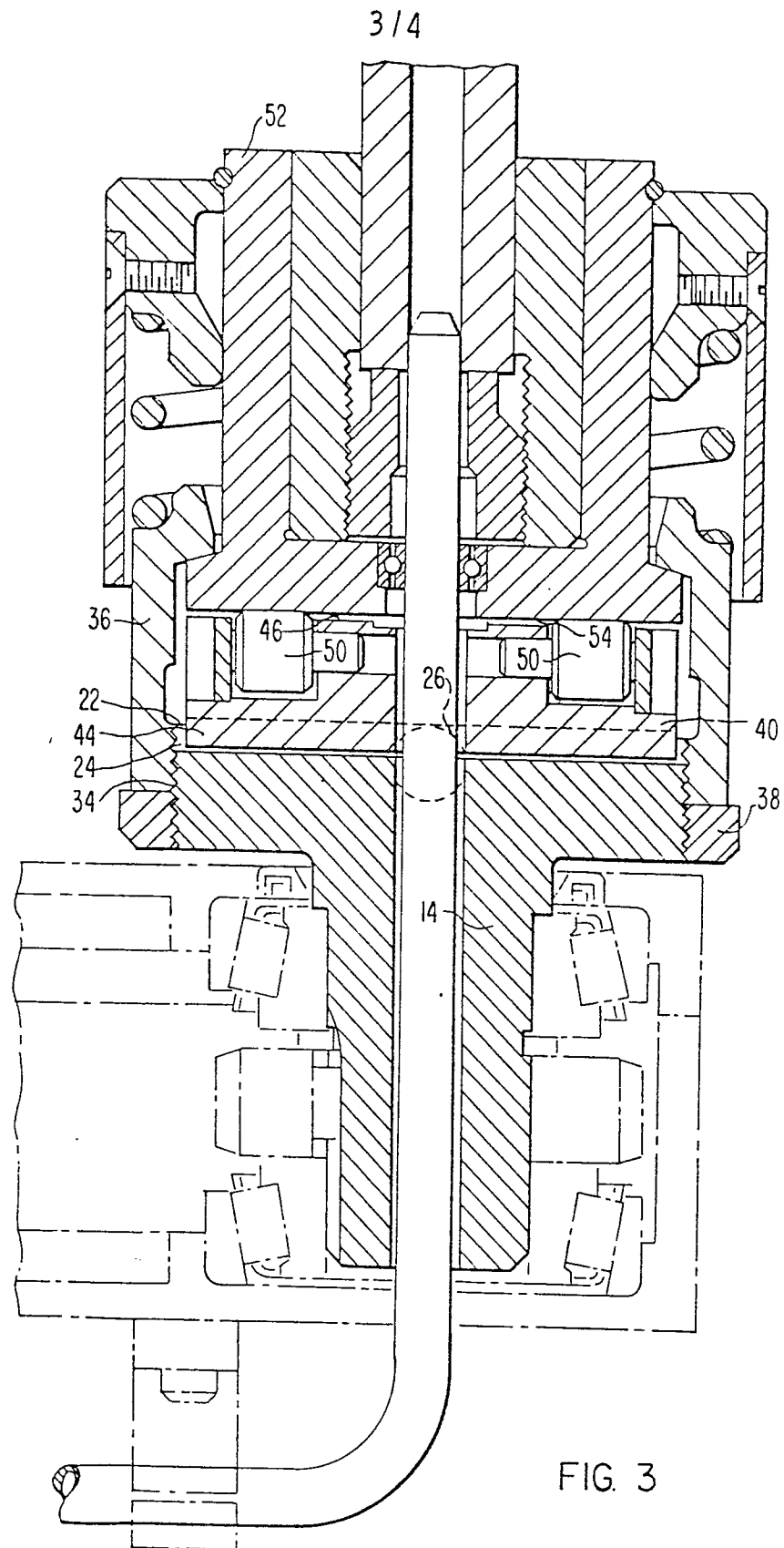


FIG. 2



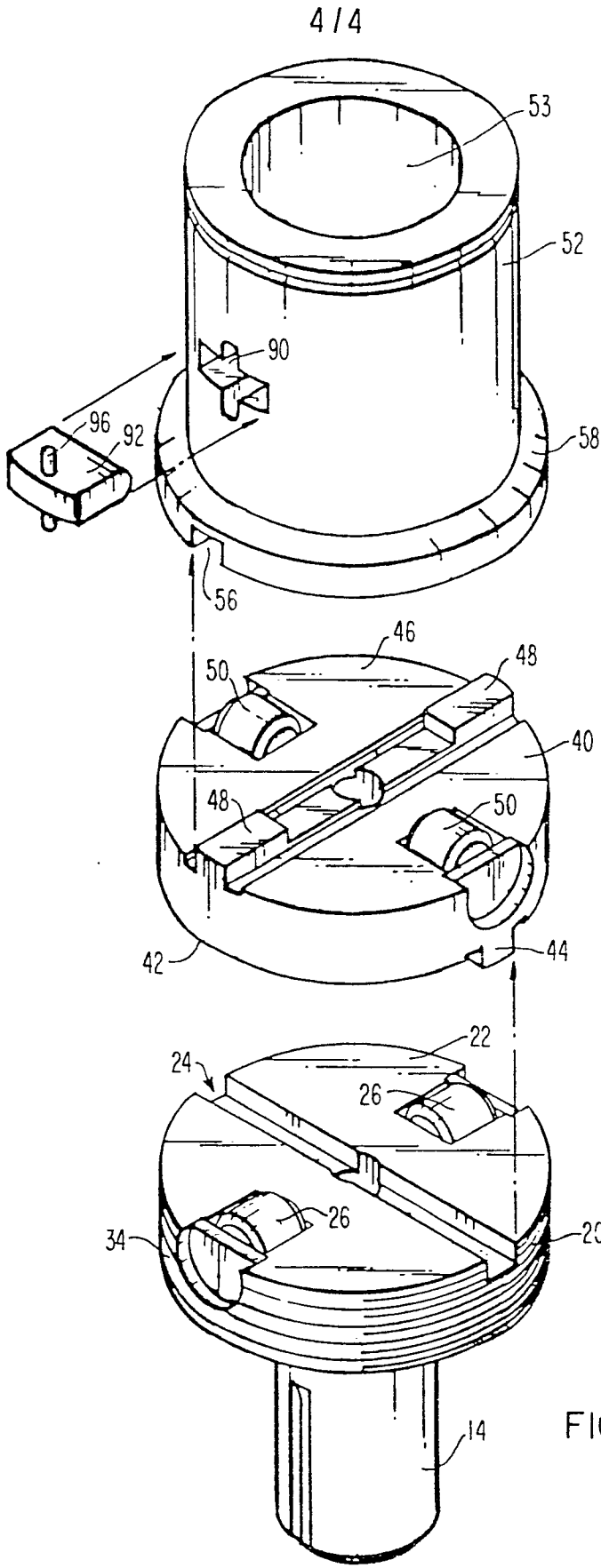


FIG. 4



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# EUROPEAN SEARCH REPORT

Application number  
EP 80 30 4392

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 7)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X,P	<p>EP - A - 0 006 339 (WESTINGHOUSE ELECTRIC CORP.)</p> <p>* Page 20, lines 3-29 *</p> <p>--</p>	1	B 25 J 5/00
	<p>GB - A - 2 005 760 (CHARBONNAGES DE FRANCE)</p> <p>* Claims 1-5 *</p> <p>--</p>	1-3	
A	<p>US - A - 4 018 346 (LESHEM et al.)</p> <p>* Column 10, lines 30-51 *</p> <p>--</p>	4,5	TECHNICAL FIELDS SEARCHED (Int. Cl. 7)
A,P	<p>EP - A - 0 007 491 (KRAFTWERK UNION)</p> <p>* Page 9, lines 15-24 *</p> <p>--</p>	6,7	<p>B 25 J 5/00</p> <p>F 22 B 37/00</p> <p>B 23 P 19/00</p> <p>21/00</p>
A	<p>FR - A - 2 351 242 (HAWERA PROEST)</p> <p>* Claims 1, 11-13 *</p> <p>&amp; US - A - 4 202 557</p> <p>----</p>	6,7	
			CATEGORY OF CITED DOCUMENTS
			<p>X: particularly relevant</p> <p>A: technological background</p> <p>O: non-written disclosure</p> <p>P: intermediate document</p> <p>T: theory or principle underlying the invention</p> <p>E: conflicting application</p> <p>D: document cited in the application</p> <p>L: citation for other reasons</p>
<p><input checked="" type="checkbox"/> The present search report has been drawn up for all claims</p>			<p>&amp;: member of the same patent family, corresponding document</p>
Place of search		Date of completion of the search	Examiner
The Hague		09-03-1981	LAMMINEUR