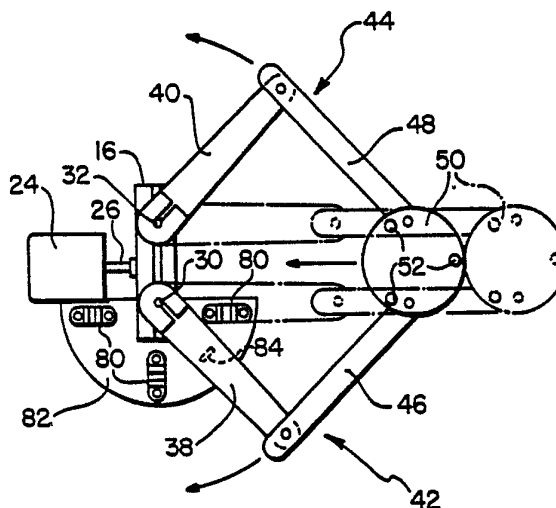




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(54) Title: ARTICLE TRANSFER APPARATUS



(57) Abstract

Article transfer apparatus which provides a straight line transfer of an article carried thereby over a distance equal to twice the length of the overall compound arm and in an accurate, straight line movement without requiring the use of guide rails and without the generation of undesirable dirt by the meshing of any gears in superposition with other articles. The article transfer apparatus comprises a pair of compound arms and an article support. Each of the compound arms is arranged for rotation in opposite directions about a first end thereof and carries the article support at a second end thereof. Each of the compound arms comprises a first arm arranged to be drivably rotated about a first end thereof, and a second arm having a first end rotatably mounted at the second end of the first arm. Each of the second arms is connected at the second end thereof to the article support. A drive pulley is stationarily disposed at the first end of the first arm and a driven pulley is drivably connected to the first end of the second arm. A belt is provided for drivably connecting the driven pulley with the drive pulley with a speed ratio of 2:1 and whereby both move relatively in the same direction. A motor is arranged for driving the compound arms.

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ARTICLE TRANSFER APPARATUSField of the Invention

The present invention relates to an improvement in apparatus arranged to move plate-like or wafer elements, such as semiconductor wafers utilized in the manufacture of semiconductor devices, and which must be transferred from one work station to another. Because of the need for maintaining cleanliness during the manufacturing processes for producing semiconductor wafers, and the need for enhancing the productivity of the operation, it is necessary to use an automated apparatus for handling the semiconductors and for transferring them from one work station to another. Cassettes have been used for handling a plurality of wafers for transferring the wafers from one operation to another. Previous methods of moving wafers to and from cassettes, for example belt drives, have proven to generate unacceptable amounts of contaminants; and therefore, the need has developed for other wafer-handling devices. With the above cassettes, the wafers must be moved into and out of the cassette by a mechanical transfer device which is sufficiently thin at the wafer-bearing end that it can enter into the relatively narrow space between adjacent wafers. It must then deposit or remove one wafer to or from the cassette without contacting or otherwise damaging either that wafer or those adjacent to it. Moreover, it is important that the apparatus not include any mechanism which can generate particulate contaminants which can be deposited on any of the wafer surfaces. Because of the necessity for carefully locating wafers in proper position at the

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wafer work station, it is also a requirement that the transfer device be able to accurately engage a wafer and to accurately locate and transfer it.

Background Art

5 One transfer device manufactured by Brooks Automation utilizes a pair of compound arms which are operated from one end by a motor and are connected at the opposite end to a wafer-holding spatula. This device has the disadvantage that the
10 distance over which it can transfer a wafer is limited to only the extended length of its arms. Further, this device relies upon intermeshing gears at the spatula end of the arms to synchronize the operation of the arms and to provide the desired
15 linear motion. It has been found that intermeshing gears at the spatula end of wafer transfer devices generate undesirable particulate material which can contaminate the surface of the wafers because of wear of the intermeshing gears. This is
20 particularly undesirable because it occurs directly over the wafers adjacent the one being handled.

Other transfer devices are exemplified by U.S. Patent Nos. 3,363,474 ad 3,401,568, and the references cited therein. These devices utilize a
25 single compound arm driven at one end by a drive motor and which actuate the outer arm by a gear and chain or belt linkage between the two arms so that an article transferring element at the outer end thereof is guided in a generally straight line.
30 However, it has been found with the devices illustrated in these patents, that the accuracy of travel is less than that required for the handling of semiconductor wafers as disclosed above. It has been found that the tolerances in the components
35 forming these prior art devices are such as to cause

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the outer end of the outer arm to deviate from a straight line so that neither the path nor the final location of an article transferred thereby is satisfactorily controlled. One solution to this problem has been to provide guide means or tracks for the outer end of the outer arm to follow as disclosed in the aforementioned Patent 3,363,474. However, the use of such guide rails or tracks is often undesirable and unacceptable in apparatus for handling semiconductor wafers.

SUMMARY OF THE INVENTION

Accordingly, it is proposed to provide an article transfer apparatus which provides a straight line transfer of an article carried thereby over a distance equal to twice the length of the overall compound arm and in an accurate, straight line movement without requiring the use of guide rails and without the generation of undesirable particulates by the meshing of any gears in superposition with other articles.

According to one aspect of the present invention, an article transfer apparatus is provided for moving an article, such as a semiconductor wafer, comprising a pair of compound arms and an article support means. Each of the compound arms is arranged for rotation in opposite directions about a first end thereof and carries the article support means at a second end thereof. Each of the compound arms comprises a first arm arranged to be drivingly rotated about a first end thereof, and a second arm having a first end rotatably mounted at the second end of the first arm. Each of the second arms is connected at the second end thereof to the article support means. Drive means is stationarily disposed at the first end of the first arm and driven means

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is drivingly connected to the first end of the second arm. Means is provided for drivingly connecting the driven means with the drive means with a speed ratio of 2:1 and whereby both move
5 relatively in the same direction. Motor means is arranged for driving the compound arms.

Further, the present invention provides a transfer apparatus for moving an article such as a semiconductor wafer along a given path comprising a
10 pair of compound arms arranged for rotation in opposite directions about respective parallel spaced axes at a first end and carrying at a second end a common article support means. Each of the compound arms comprises a first arm arranged to be drivingly
15 rotated about the respective axis at a first end thereof, and a second arm having a first end rotatably mounted at the second end of the first arm. The second arm is pivotally connected at the second end thereof to the article support means. A
20 drive means is stationarily disposed about the respective axis of the first arm and a driven means is movably mounted at the second end of the first arm and is drivingly connected to the first end of the second arm. Means is provided for drivingly
25 connecting the driven means with the drive means with a speed ratio of 2:1 whereby both move relatively in the same direction. Motor means is provided for driving the transfer means, and means is provided for connecting the motor means to the
30 first arms of the pair of compound arms coaxially along the respective axes and extending through the stationary drive means.

More specifically, the present invention includes a drive belt as the connecting means in the
35 arms and the drive means and the driven means are

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pulleys.

Various means for practicing the invention and other features and advantages thereof will be apparent from the following detailed description of illustrative preferred embodiments of the invention, reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective exploded view of the transfer apparatus according to the present invention; and

FIGS. 2 and 3 are planned views of the apparatus according to the present invention showing the sequential operation thereof.

DESCRIPTION OF A PREFERRED EMBODIMENT

The article transfer mechanism of the present invention is illustrated in a partially exploded perspective view in FIG. 1 and comprises a base member 10 having a pair of upright bearing shafts 12 and 14 on which the main frame portion 16 ride via bearing blocks 18, 20, and 22. A reversible stepper motor 24 is disposed on one side of the frame 16 and has an output shaft 26 carrying a worm gear 28 extending into the center of the frame. A pair of spaced, vertically parallel shafts 30 and 32 extend upwardly through the frame and are drivingly connected at the lower end to drive gears 34 and 36, respectively, which engage opposite sides of the worm gear 28. The upper end of the shafts extend above the top surface of the frame and are drivingly connected to the first ends of first arms 38 and 40 of compound arms 42 and 44. Journaled at the second end of the first arms are respective second arms 46 and 48, each of which are connected at the second end thereof to an article support means or spatula 50 which may be provided with three

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equispaced article engaging bosses 52.

Each of the first arms 38 and 40 are provided with a recess in the lower surface thereof which is arranged to receive the drive means for the
5 second arm. While both compound arms 42 and 44 are provided with such a drive means, only the one illustrated for arm 44 will be described. The drive means for arm 44 includes a first drive pulley 54 which is disposed about shaft 30 and is provided
10 with a bearing 56 which permits the shaft to rotate freely with respect to the pulley 54. The lower surface of the pulley 54 is provided with a diametrically extending rib 58 which protrudes from the lower surface thereof and which engages a groove
15 60 provided in the upper surface of frame 16. The rib and groove cooperate to hold the pulley 54 stationary while the shaft 30 and arm 38 are rotated. A driven pulley 62 is drivingly mounted on a shaft 64 which is arranged to rotate in the second
20 end of the first arm 38. Suitable bearings 66 and 68 are provided there at for this purpose. The upper end of shaft 64 is drivingly connected to the first end of second arm 46. A drive belt 70 connects the drive pulley 54 with the driven pulley
25 62. A cover plate 72 is provided to the underside of arm 38 and is connected thereto with fastener members 74 to enclose the pulley and belt assembly. As illustrated, the drive pulley 54 has a diameter twice that of driven pulley 62 whereby the speed
30 ratio of the driven pulley with respect to the drive pulley is 2:1, with both pulleys moving relatively in the same direction with respect to the first arm 38. This configuration provides a movement of the second arms, 46 and 48, respectively, which are
35 opposite to the movement of the first arms 38 and 40

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and at a speed twice that of the first arms moving the spatula 50 along an accurate linear path.

A lifting motor 76 is provided, which is also preferably a reversible stepper motor, the output shaft of which is connected through an eccentric 78 to the lower portion of the frame element 16. Upon rotation of the motor 76 the complete transfer mechanism is lifted by a predetermined amount which may be controlled by the eccentric and by the amount of rotation of the motor shaft.

The transfer mechanism is also provided with a plurality of sensors 80 mounted on a support plate 82 located beneath one of the compound arms 44, the first arm of which, 40, is provided with a sensor-activating blade 84 on the lower surface thereof. This blade cooperates with the sensors 80 to generate a signal when the transfer mechanism is in one of the three respective positions corresponding to the placement of the sensors. This signal can be used to calibrate the stepper motor for control of the stepper motor and to supply the necessary feedback to assure the accurate positioning of the article-carrying spatula 50.

As noted above, the main drive motor 24 is preferably a reversible stepper drive motor which can be accurately controlled by counting the number of revolutions, or portions thereof, of the motor output shaft to accurately determine the position of the transfer arms and to accurately control the disposition of the arms with respect to the overall mechanism and the placement of the article carried thereby. The motor is reversible to drive the arms and the spatula in opposite directions to provide two-way transfer capabilities.

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Referring now to FIGS. 2 and 3 for a schematic illustration of the sequential operation of the transfer apparatus, the spatula may start in the right-most extended position as illustrated in phantom in FIG. 2. As the motor 24 drives the worm gear 28, gears 34 and 36 are rotated in opposite directions. This in turn drives shafts 30 and 32 and the first arms 38 and 40, respectively, connected thereto in opposite directions. Thus, as the drive motor 24 rotates counter-clockwise, looking at the end of the worm gear 28, the gear 34 moves clockwise while gear 36 is driven counter-clockwise. Thus, first arms 38 and 40 are driven clockwise and counter-clockwise, respectively, while the second arms, 46 and 48, revolve in directions opposite to that of the motion of the respective first arms. This moves the spatula 50 in a straight line to the position indicated in full in FIG. 2. When the first arms 38 and 40 have rotated 90° from the starting position, the position indicated in full in FIG. 3 is reached, with the spatula disposed above the center of frame 16. As the first arms, 38 and 40, continue their motion in the aforesaid directions, the spatula 50 passes over the center of the base and, as the first arms reach a position 180° from the original position, the spatula reaches the left-most position, illustrated in phantom in FIG. 3. It will thus be apparent that the transfer apparatus of the present invention provides a travel distance for the article moved equal to twice the combined length of the first and second arms. Inasmuch as the motor 24 is reversible the arms may also be driven in the opposite direction from that just described. Moreover, since the drive motor is

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of the stepper type, the arms can be accurately stopped at any desired position controlled by the stepper mechanism and control circuit.

The operation of the first and second arms may be understood by referring back to FIG. 1 and noting that as arm 38 rotates in a clockwise direction, the drive pulley 54 is held stationary by the engagement of rib 58 in slot 60. The net effect of this construction is that the drive pulley 54, though stationary, effectively rotates counter-clockwise with respect to the movement of arm 38. Thus, the belt 70 drives the driven pulley 62 and the shaft 64 and arm 46 connected thereto in a counter-clockwise direction. Moreover, since the sizes of the pulleys bear a ratio of 2:1, with the drive pulley being the larger, the driven pulley is driven at a speed twice the speed of the relative motion of the drive pulley with respect to the first arm 38. Thus, as the first arm rotates 180° about its axis, the first end of the second arm 46 effectively rotates 360° about its moving axis.

The operation of the transfer mechanism of the present invention results in a smooth uniform linear travel of an article carried by the spatula 50 along a carefully and accurately controlled path. Moreover, the distance of movement provided is twice that of similar prior art devices utilizing compound arms without the disadvantage of meshing gears in the region of the wafer surfaces. This motion is possible so long as the relative lengths of the respective arms are maintained such that the sum of the length of the first arms plus the distance between the drive shafts 30 and 32 is substantially equal to the sum of the length of the second arms plus the distance between the connection

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point of the second ends of the second arms at the spatula. This relationship permits the wafer to travel smoothly over center of the mechanism without binding or other adverse effects.

5 It will be noted that the second arms 46 and 48 are simple bar members, having no complex mechanism therein and are made of relatively thin, flat materials. Likewise the connection between the second ends of arms 46 and 48 and the spatula 50 is
10 a simple pivot requiring only a very simple bearing. The resulting construction has an overall thickness which is very small, permitting the spatula and the ends of the arms to enter between adjacent wafers carried in a standard wafer cassette
15 without contacting either of the adjacent wafers. The lifting motor provided by the transfer mechanism can accurately control the elevation of the mechanism whereby it can be accurately inserted into the space between adjacent wafers within a cassette
20 and the entire mechanism lifted by the small amount, e.g., 0.030 to 0.10 inches necessary to lift the desired wafer from the cassette slot so that it may be removed.

INDUSTRIAL APPLICABILITY

25 It will thus be seen that the present invention provides an article transfer apparatus which simply and reliably transports an article over an accurate and predetermined path. Because of the interaction of the two compound arms, being driven
30 in opposite directions by a common drive source, with the second end thereof connected to a common article conveying element, any deviation of the travel path that might result from manufacturing tolerances, or from wear over the life of the
35 apparatus is effectively cancelled by the opposing

-11-

forces of the two, oppositely moving compound arms. .
This is accomplished without the requirement of the
prior art devices of a guide member or guide rail to
accurately control the path of the article being
5 transferred.

Alternative embodiments of the present
invention may include gears and drive chains for the
drive and driven members in the first arms as well
as a gear train provided that the drive and driven
10 members are driven relatively in the same direction
with respect to the direction of movement of the
first arms. This is possible because these
mechanisms, though not as clean as the belt drive,
do not pass over any wafer surfaces which might be
15 contaminated thereby.

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I Claim:

1. Transfer apparatus for moving an article comprising:

a pair of compound arms,
an article support means,

each of said compound arms arranged for rotation in opposite directions about a first end thereof and carrying said article support means at a second end thereof,

each of said compound arms comprising:

a first arm arranged to be drivingly rotated about a first end thereof,

a second arm having a first end rotatably mounted at a second end of said first arm,

said second arm being connected at the second end thereof to said article support means,

drive means stationarily disposed at the first end of said first arm and driven means drivingly connected to the first end of said second arm, and

means for drivingly connecting said driven means with said drive means with a speed ratio of 2:1 and whereby both move relatively in the same direction, and

motor means for driving said compound arms.

2. The invention according to Claim 1 wherein said first arms of said compound arms are rotatable about respective parallel spaced axes.

3. The invention according to Claim 2 including means for connecting said motor means to said first arms of said compound arms coaxially

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along said respective axes.

4. The invention according to Claim 2 wherein said drive means is stationarily disposed about said respective axis of each of said compound
5 arms.

5. The invention according to Claim 1 wherein said driven means is movably mounted at the second end of said first arm.

6. Transfer apparatus for moving an
10 article along a given path comprising:

a pair of compound arms arranged for rotation in opposite directions about respective parallel axes at a first end and carrying at a second end a common article support means,
15 each of said compound arms comprising:

a first arm arranged to be drivingly rotated about a respective axis at a first end thereof,

a second arm having a first end rotatably mounted at a second end of
20 said first arm,

said second arm being pivotally connected at the second end thereof to said article support means,

25 drive means stationarily disposed about said respective axis of said first arm and driven means movably mounted at the second end of said first arm and drivingly connected to
30 the first end of said second arm, and

means for drivingly connecting said driven means with said drive means with a speed ratio of 2:1 and whereby
35 both move relatively in the same direction,

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motor means for driving said transfer means, and

means for connecting said motor means to said first arms of said pair of compound arms coaxially along said respective axes and extending through said stationary drive means.

7. The invention according to Claim 6 wherein said connecting means in said arms includes a drive belt and said drive means and said driven means are pulleys.

8. The invention according to Claim 6 wherein said drive means, said driven means and said connecting means in said arms comprise a gear train.

9. The invention according to Claim 6 wherein said drive means and said driven means are gears and said connecting means in said arms is an endless chain.

10. The invention according to Claim 6 wherein said means for connecting said motor means to said first arms includes a shaft connected at one end to said first end of said first arm of each of said compound arms, and gear means at the second end of said shaft connected to said motor.

11. The invention according to Claim 10 wherein each of said shafts is coaxial with said respective axis of each of said compound arms.

12. The invention according to Claim 10 wherein said motor is provided with an output worm gear which is arranged to engage said gears on said shafts.

13. The invention according to Claim 12 wherein said gears engage opposite sides of said worm gear.

14. The invention according to Claim 6

-15-

including means for raising and lowering said apparatus.

15. The invention according to Claim 14 wherein said raising and lowering means includes a pair of guide rods, and cam means for moving said apparatus on said guide rods.

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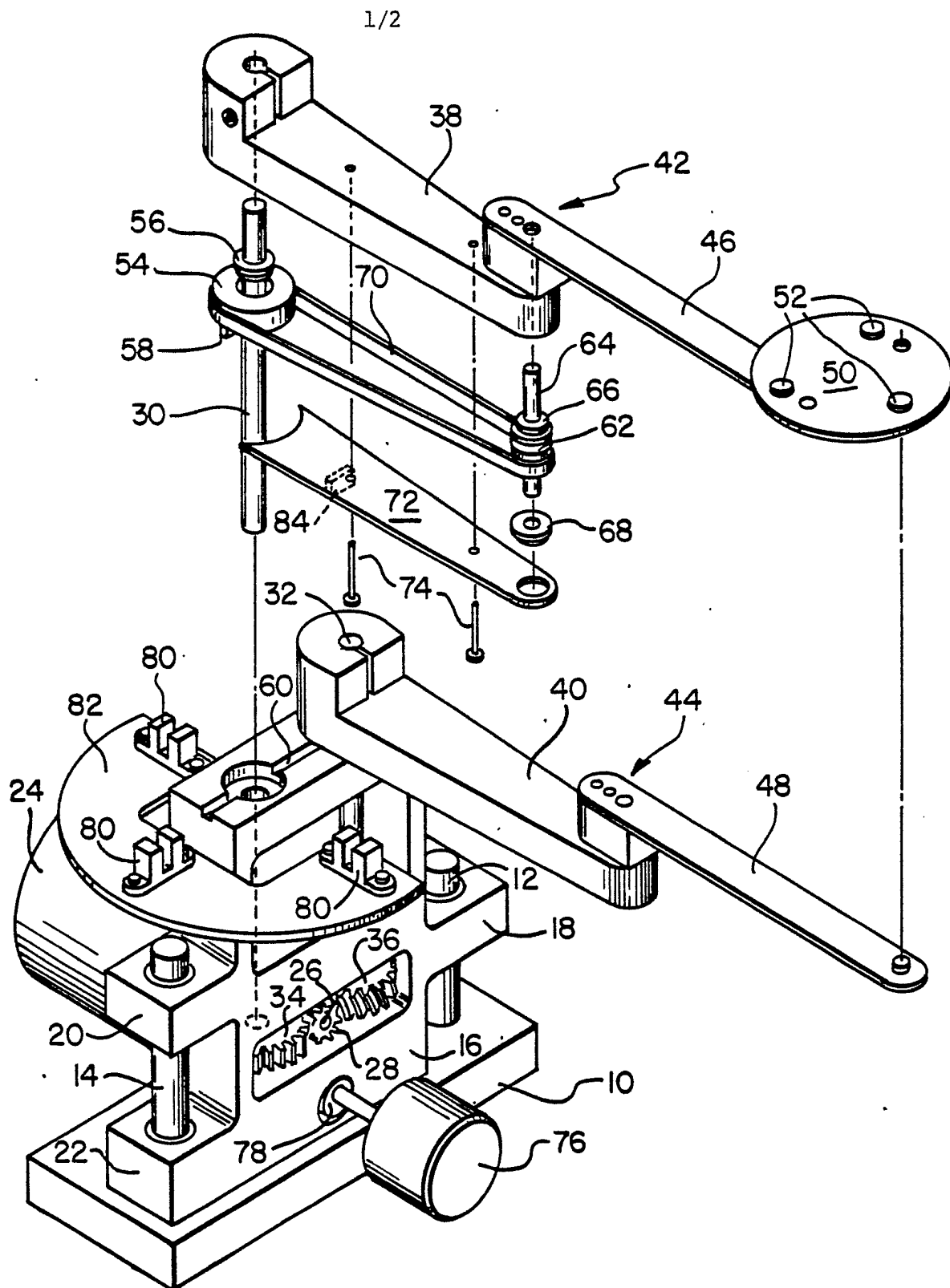
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FIG. 2

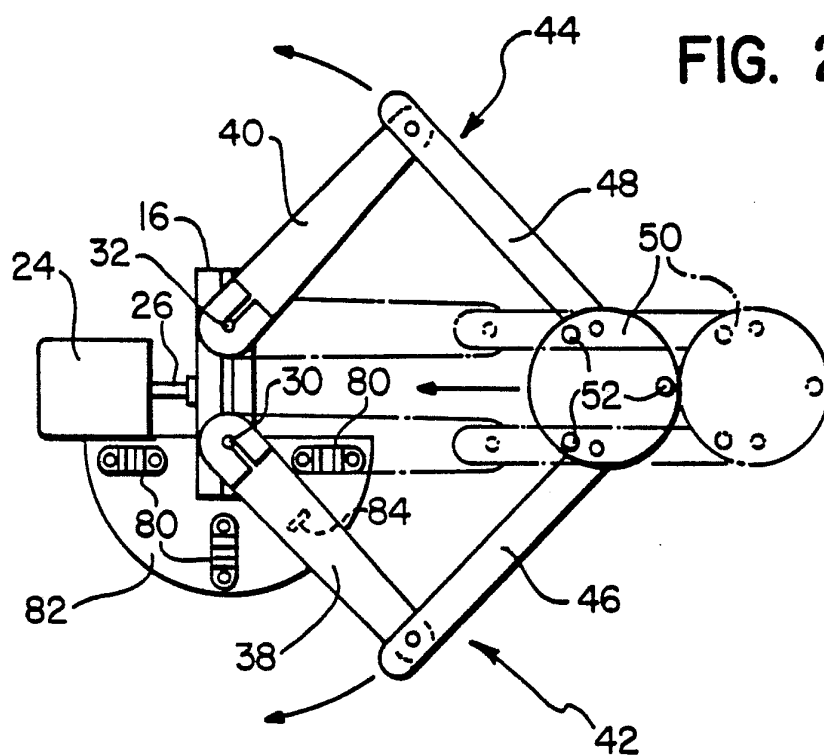
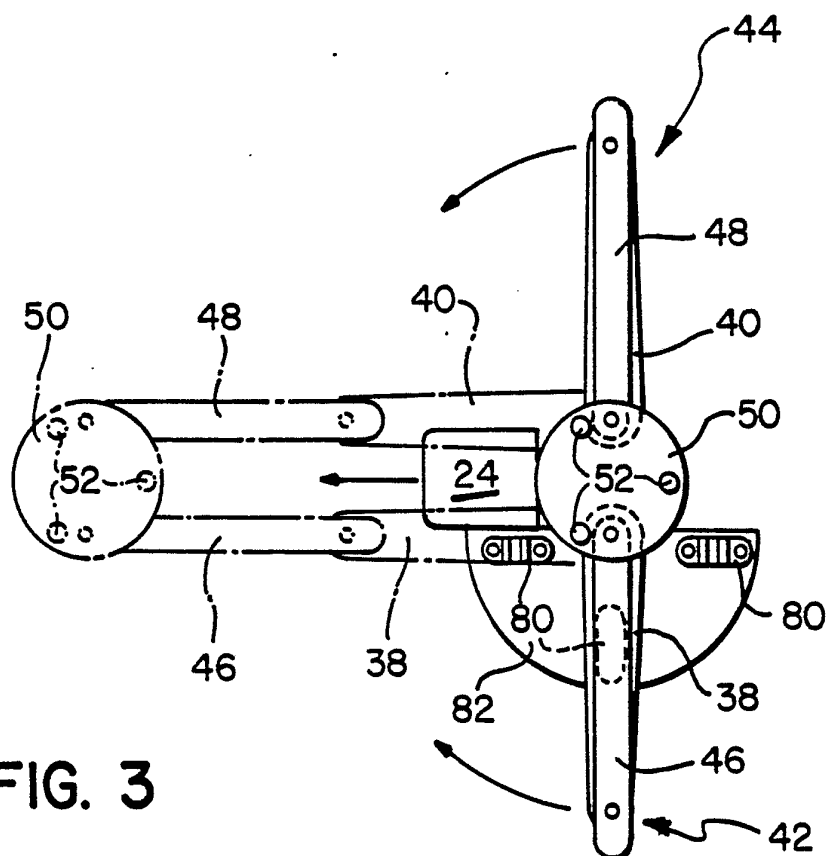


FIG. 3



INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 87/01085

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC IPC ⁴ : H 01 L 21/00																													
II. FIELDS SEARCHED Minimum Documentation Searched ⁷ <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; border-bottom: 1px solid black; padding: 5px;">Classification System</td> <td style="border-bottom: 1px solid black; padding: 5px;">Classification Symbols</td> </tr> <tr> <td style="padding: 5px;">IPC⁴</td> <td style="padding: 5px;">H 01 L F 16 H</td> </tr> </table> Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *			Classification System	Classification Symbols	IPC ⁴	H 01 L F 16 H																							
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III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border-bottom: 1px solid black; padding: 5px;">Category *</th> <th style="width: 70%; border-bottom: 1px solid black; padding: 5px;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 20%; border-bottom: 1px solid black; padding: 5px;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">WO, A, 84/03196 (BROOKS) 16 August 1984 see page 4, line 16 - page 7, line 11; figures 1,2,4</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,4,6,10, 2,3,11,14</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="text-align: center; vertical-align: top; padding: 5px;">--</td> <td style="text-align: center; vertical-align: top; padding: 5px;"></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 3363474 (EVG) 16 January 1968 see column 2, lines 21-65; figure 1 cited in the application</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,4,6,10 5,7-9</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="text-align: center; vertical-align: top; padding: 5px;">--</td> <td style="text-align: center; vertical-align: top; padding: 5px;"></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">Solid State Technology, volume 28, no. 1, January 1985, (Port Washington, New York, US), "Equipment frontiers; Wafer handling robot", see page 74</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-7,10,11, 14,15</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="text-align: center; vertical-align: top; padding: 5px;">--</td> <td style="text-align: center; vertical-align: top; padding: 5px;"></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US, A, 3401568 (BLATT) 17 September 1968 see column 1, line 67 - column 3, line 4; figures 1,2 cited in the application</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-7,10,11</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">E</td> <td style="padding: 5px;">EP, A, 0187249 (TOKUDA) 16 July 1986 see page 13, line 34 - page 14, ./. </td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-8,10,11</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	Y	WO, A, 84/03196 (BROOKS) 16 August 1984 see page 4, line 16 - page 7, line 11; figures 1,2,4	1,4,6,10, 2,3,11,14	A	--		Y	US, A, 3363474 (EVG) 16 January 1968 see column 2, lines 21-65; figure 1 cited in the application	1,4,6,10 5,7-9	A	--		A	Solid State Technology, volume 28, no. 1, January 1985, (Port Washington, New York, US), "Equipment frontiers; Wafer handling robot", see page 74	1-7,10,11, 14,15	A	--		A	US, A, 3401568 (BLATT) 17 September 1968 see column 1, line 67 - column 3, line 4; figures 1,2 cited in the application	1-7,10,11	E	EP, A, 0187249 (TOKUDA) 16 July 1986 see page 13, line 34 - page 14, ./.	1-8,10,11
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E	EP, A, 0187249 (TOKUDA) 16 July 1986 see page 13, line 34 - page 14, ./.	1-8,10,11																											
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top; padding: 5px;"> * Special categories of cited documents: ¹⁴ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td style="width: 50%; vertical-align: top; padding: 5px;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "A" document member of the same patent family </td> </tr> </table>			* Special categories of cited documents: ¹⁴ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "A" document member of the same patent family																									
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IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="padding: 5px;">18th August 1987</td> <td style="text-align: right; padding: 5px;">24 SEP 1987</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;">International Searching Authority</td> <td style="border-bottom: 1px solid black; padding: 5px;">Signature of Authorized Officer</td> </tr> <tr> <td style="text-align: center; padding: 5px;">EUROPEAN PATENT OFFICE</td> <td style="text-align: center; padding: 5px;">L. ROSSI </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	18th August 1987	24 SEP 1987	International Searching Authority	Signature of Authorized Officer	EUROPEAN PATENT OFFICE	L. ROSSI																			
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
	line 3; page 16, line 15 - page 17, line 3; figures 3-6 -----	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO.

PCT/US 87/01085 (SA 17237)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 04/09/87

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