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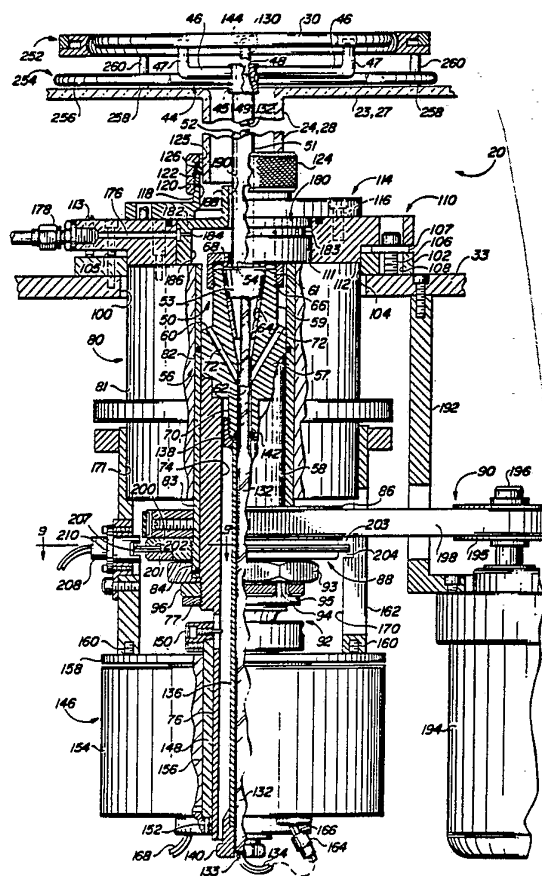
(54) Title: ROTATABLE SUBSTRATE SUPPORTING MECHANISM WITH TEMPERATURE SENSING DEVICE FOR USE IN CHEMICAL VAPOR DEPOSITION EQUIPMENT

(57) Abstract

A rotatable substrate supporting mechanism (20) for use in a chemical vapor deposition reaction chamber of the type used in producing semi-conductor devices is provided with a susceptor (30) forsupporting a single substrate (32), or wafer, for rotation about an axis normal to the center of the wafer. The mechanism is provided with a temperature sensing system (130) for producing signals indicative of sensed temperatures taken at the center of the susceptor and at various points about the periphery thereof. A gas purging system (176, 111 ,178) is provided for inhibiting the flow of reactant gas in unwanted areas of the reaction chamber and in the supporting system itself. Rotational driving of the mechanism is accomplished by a variable speed motor (194) under control of a circuit (212) which stops and starts the rotation at controlled speeds and stops the rotation at a homeposition for enhancing the handling of the wafers.



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ROTATABLE SUBSTRATE SUPPORTING MECHANISM WITH TEMPERATURE SENSING DEVICE FOR USE IN CHEMICAL VAPOR DEPOSITION EQUIPMENT

5 ## BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates in general to deposition equipment of the type used for chemical vapor
10 deposition of materials on substrates, and more particularly to a rotatable substrate supporting mechanism with temperature sensing device for use in the deposition chambers of such equipment.

15 ### Discussion of the Related Art

In the electronics art, it has long been a practice to employ chemical vapor deposition equipment for depositing various materials, on substrates at high temperatures as part of the
20 process of manufacturing semi-conductor devices. Basically, chemical vapor deposition equipment includes a reaction chamber which is heated to a desired reaction temperature and is configured for the controlled flow of the material carrier gas
25 therethrough. A base, which is commonly referred to in the art as a "susceptor", is located in the reaction chamber for supporting the substrates upon which the material is to be deposited by the well known chemical vapor deposition process.
30 Prior art susceptors are typically of two basic types with the first being a single planar surface for use in a horizontal attitude and the second being

an upstanding barrel shaped multi-surface structure. In either case, these susceptors are configured to support a multiplicity of relatively small substrates, i.e. in the neighborhood of 2 to 5 inches
5 in diameter, for simultaneously depositing materials on the multiplicity of substrates. While simultaneous deposition of materials on a multiplicity of substrates is desirable from a manufacturing standpoint, it has some drawbacks from
10 a quality standpoint.

The first problem associated with multi-substrate processing relates to the carrier gas which contains the atoms of the deposition materials. As the gas, which may be referred to as a reactant
15 gas, flows over the surfaces of the substrate and the susceptor, deposition of the materials results in changes in the concentration of the deposition materials in the carrier gas. Consequently, as the reactant gas flows across or over the length of these
20 relatively large susceptors, across each individual substrate and across a multiplicity of such substrates, different rates of growth of the deposited layer of material have been found. A second problem is that of temperature control which
25 is critical at the elevated temperatures needed for proper deposition. It is difficult, if not impossible, to control the temperature within the critical tolerances at all the desired locations within the relatively large reaction chambers. This
30 results in different deposition layer thicknesses from one substrate to another, and can even produce varying thickness within the individual substrates.

Still another problem is contamination which can result from various factors such as the handling techniques used to load and unload the substrates, the introduction of the carrier gas into the reaction chamber, and indeed from the reaction chamber itself. The carrier gas not only deposits the deposition material on the substrate, but also deposition takes place on the walls of the reaction chamber. In the relatively large reaction chambers required for multi-substrate processing, the unwanted deposits on the walls of the reaction chambers can be inadvertently incorporated into the growing layers being deposited on the substrates.

These problems and drawbacks, as well as other factors, all contribute to significant problems as the semi-conductor devices and the uses to which they are put become more sophisticated. As a result, many changes and improvements have been made in the equipment that is used to simultaneously process a multiplicity of substrates. For example, some equipment manufacturers are now using automated loading and off-loading devices to eliminate, or at least substantially reduce contamination resulting from human handling. Further, the second type of susceptor discussed above, i.e. the upstanding barrel shaped structure, is being rotated in some instances about its vertical axis to rotate the multiplicity of substrates about that same axis within the reaction chamber. Such barrel rotation is being done for averaging purposes, that is, temperature averaging and reactant gas flow averaging. Obviously these and other things which are being done to improve the

simultaneous multi-substrate processing techniques have helped. However, there are practical limits which many feel will ultimately make the simultaneous multi-substrate processing techniques unacceptable or at least undesirable. One of the limitations is that of the equipment being adaptable for handling larger diameter substrates. The economics of larger diameter substrates are causing many manufactures of semi-conductor devices to use larger substrates. However, increasing the size of the substrate is causing some problems with regard to temperature differentials across the substrate, decreasing concentrations of the deposition material as it is carried across the substrate, and the like.

Therefore, steps are being taken now by some equipment manufacturers to make suitable single substrate processing equipment which is significantly simpler in so far as controlling the various factors involved in chemical vapor deposition. Single substrate chemical vapor deposition equipment becomes inherently more desirable than multi-substrate equipment as the manufacturers of semi-conductor devices change to larger substrates, i.e. 6 to 8 inches in diameter or even larger. One important consideration is the cost at risk when processing one substrate as opposed to the simultaneous multi-substrate processing. That is, if something goes wrong, the monetary loss is far less with one substrate that it is with a plurality of substrates.

The susceptors being used in single substrate processing equipment consist essentially of some sort of platform, or base, for supporting the substrate

and contribute nothing further to the chemical vapor deposition equipment.

Therefore, a need exists for a new and improved susceptor for use in single substrate chemical vapor 5 deposition equipment which enhances the process and thereby helps in eliminating, or at least reducing, the problems and shortcomings of the prior art.

SUMMARY OF THE INVENTION

10 In accordance with the present invention, a new and useful rotatable substrate supporting mechanism is disclosed for use in single substrate chemical vapor deposition equipment. The rotatable substrate supporting mechanism includes a circular susceptor, 15 or platform, for receiving a single circular substrate and supporting the substrate in the reactant gas flow path through the reaction chamber. The susceptor is provided with an axially depending driveshaft which is suitably coupled to a variable 20 speed drive means for rotation of the susceptor, and thus the substrate, about a vertical rotation axis. By rotating the substrate about this axis, which is normal with respect to the center of the substrate, an averaging of the deposited material growth rates 25 results thus overcoming the problem in concentration depletion of the deposition materials as the reactant gas flows past the substrate. Rotation of the susceptor also produces an averaging of the temperature gradient which results in a significant 30 reduction in the temperature differences both in the susceptor and in the substrate being supported thereon.

While the rotatability of the susceptor will inherently improve the temperature characteristics in comparison to a fixed non-rotatable susceptor, the substrate supporting mechanism of the present invention is preferably configured to provide a sophisticated temperature sensing system which can be used to produce accurate temperature control in the vicinity of the susceptor. The temperature sensing system includes a first temperature sensor means which in the preferred embodiment, extends axially and upwardly through the axial driveshaft of the susceptor for sensing the temperature at the center of the susceptor. A fixed concentric ring is located in close surrounding relationship with the rotatable susceptor and at least one, and preferably more, additional temperature sensing means are providing at circumferentially spaced increments in the fixed ring, and these additional temperature sensing means will sense the temperatures at various points about the rotatable susceptor. Each of the temperature sensing means produces a signal indicative of the sensed temperature, and those signals may be coupled to a suitable control system which operates in conjunction with the heating system of the reaction chamber for temperature control purposes.

Due to the rotation capability of the susceptor and the placement of the first temperature sensing means within the axial driveshaft of the susceptor, the driveshaft must be tubular and the susceptor must be provided with clearance relative to the reaction chamber. Therefore, the mechanism of the present invention is provided with a purging system by which

a purge gas is introduced under elevated pressure into the tubular shaft which is configured so that the purging gas will emerge from the driveshaft below the susceptor. In this way, the purge gas will inhibit the flow of reactant gas into the area below the susceptor and into the tubular shaft and thereby prevent deposited material contamination in those areas. In addition, the purging gas will inhibit the formation of hot spots in the mechanism.

In addition to the above, the mechanism of the present invention is provided with means for vertical adjustment whereby the susceptor, and thus the substrate carried thereon, can be set at an optimum position in the reactant gas flow path of the reaction chamber. Also, the mechanism is provided with a drive control system by which the rotational speed of the susceptor may be adjusted to a desired speed and by which the susceptor's rotation is stopped at the same point each time for substrate handling purposes.

Accordingly, it is an object of the present invention to provide a new and improved substrate supporting mechanism for use in single substrate chemical vapor deposition equipment.

Another object of the present invention is to provide a new and improved substrate supporting mechanism having a susceptor, or platform, upon which a single substrate is supported in the reactant gas flow path in a heated reaction chamber with the susceptor being rotatable for rotating the substrate about an axis which is normal to the center of the substrate for temperature and growth rate averaging

purposes.

Another object of the present invention is to provide a new and improved substrate supporting mechanism of the above described character which includes a temperature sensing means for sensing the temperature at various points in and about the rotatable susceptor and producing signals indicative of the sensed temperatures with the produced signals being usable for temperature control purposes which interacts with the equipment heating system to provide a flat temperature profile across the substrate.

Another object of the present invention is to provide a new and improved substrate supporting mechanism of the above described character which further includes a purging system by which a purge gas under elevated pressure is introduced into the mechanism to prevent the flow of the reactant gas into the mechanism itself and into the area below the rotatable susceptor.

Still another object of the present invention is to provide a new and improved substrate supporting mechanism of the above described type wherein the substrate supporting susceptor is adjustable along its rotational axis for optimum locating of the substrate in the reactant gas flow path through the reaction chamber.

Yet another object of the present invention is to provide the above described substrate supporting mechanism with a drive control system by which the rotating speed of the susceptor may be adjustably set to a desired rotation rate and by which the

susceptor's rotation is stopped at the same location each time for improved substrate handling purposes.

The foregoing and other objects of the present invention as well as the invention itself, may be more fully understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of the substrate supporting mechanism of the present invention with the mechanism shown as being used in a type of reaction chamber which is commonly referred to as a horizontal flow reaction chamber.

FIG. 2 is a view similar to FIG. 1 but showing the substrate supporting mechanism of the present invention as being used in a type of reaction chamber that is commonly referred to as an axial flow reaction chamber.

FIG. 3 is an enlarged elevational view which is partially broken away to show the various features of the substrate supporting mechanism.

FIG. 4 is an enlarged top view of the substrate supporting susceptor and showing the concentric relationship of a fixed ring structure which is part of the temperature sensing system of the mechanism.

FIG. 5 is an enlarged fragmentary sectional view taken along the line 5-5 of FIG. 4.

FIG. 6 is an exploded perspective view showing the mounting structures and arrangement of the susceptor and the fixed ring of the temperature

sensing system of the mechanism of the present invention.

FIG. 7 is a top view of a particular form of susceptor which is provided with an especially configured top surface upon which a substrate is supportable.

FIG. 8 is a view similar to FIG. 7 but which shows an alternate top surface configuration provided on the susceptor.

FIG. 9 is a fragmentary sectional view taken along the line 9-9 of FIG. 3.

FIG. 10 is a fragmentary view similar to FIG. 3 and showing a modification of the substrate supporting mechanism of the present invention.

FIG. 11 is a fragmentary sectional view taken along the line 11-11 of FIG. 10.

FIG. 12 is a fragmentary sectional view taken along the line 12-12 of FIG. 10.

FIG. 13 is a schematic drawing of the drive control system of the substrate supporting mechanism of the present invention.

FIG. 14 is a fragmentary view similar to FIG. 3 and showing an alternate temperature sensor embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In that chemical vapor deposition per se is well known in the art, only a brief description thereof will be presented herein for completeness of this disclosure and to ensure full understanding of the present invention. Briefly, a reactant gas, which

contains gaseous forms of the atoms of the material to be deposited, is introduced into what is referred to as a reaction chamber in a manner which causes the reactant gas to flow through the reaction chamber in a path which is determined by reaction chamber configuration, gas injection location and the like. Reaction chambers are heated to relatively high temperatures, which are determined by the various factors of the particular process to be accomplished. By virtue of gas movement, temperature and chemical reaction, the material carried by the gas will be deposited and adhere to whatever is located in the gas flow path and will provide a deposition layer thereon. This general chemical vapor deposition technique is widely used in the electronics art for manufacturing semi-conductor devices.

Referring more particularly to the drawings, Figures 1 and 2 show the rotatable substrate supporting mechanism of the present invention which is indicated in its entirety by the reference numeral 20. Figure 1 shows the mechanism 20 as being used in conjunction with a reaction chamber 22 of the type sometimes referred to as a horizontal flow reaction chamber, and Figure 2 shows the mechanism 20 as being used in conjunction with an axial flow reaction chamber 26. As is known, both horizontal flow and axial flow reaction chambers have been devised in various configurations and the particular chambers 22 and 26, which are only partially shown, are intended to be typical representations of such reaction chambers.

It will be noted however, that the reaction

chamber 22 has a planar bottom surface 23 with a tubular shaft 24 depending integrally therefrom, and similarly, the reaction chamber 26 has a planar bottom surface 27 from which a tubular shaft 28 integrally depends. As will hereinafter be described in detail, the rotatable substrate supporting mechanism is coupled to the depending end of either of the tubular shafts 24 or 28 and portions of the mechanism 20 extend upwardly through the axial bores of the shafts into the interior of the reaction chamber 22 and/or 26, to provide, among other things, a platform, or susceptor 30 upon which a substrate 32 is demountably supportable. The substrate 32 is placed on the susceptor 30 prior to commencement of the chemical vapor deposition process and is off-loaded when the desired deposition film, or layer has been formed thereon and the process has been completed.

The rotatable substrate supporting mechanism 20 is carried in a manner which will be described in detail below, on a suitable support plate 33 which is disposed below the reaction chamber 22 and/or 26. The plate 33 is provided with a plurality of bushing mounts 34 (one shown) each of which is slideably movable along a different one of a plurality of fixed vertical rod 35 (one shown). The plate 33, and thus the entire mechanism 20, is vertically adjustable relative to the reaction chamber 22 and/or 26 by a vertical elevating means 36. The vertical elevating means 36 includes a worm gear nut 37 carried on the support plate 33 for movement along an elongated rotatable worm gear 38. The worm gear 38 is

journaled for rotation about its longitudinal axis in a drive housing 39 that is fixedly carried on a suitable support means 40. The housing 39 contains a suitable gear train such as the illustrated worm gear 41 which is rotatable by means of the hand wheel 42, and the worm gear 41 is in driving meshed engagement with a spur gear 43 (FIG. 1) that is mounted on the lower end of the elongated worm gear 38. Thus, manual rotation of the hand wheel 42 in the appropriate direction will, by virtue of the gears 41 and 43, cause the worm gear 38 to be rotatably driven. Such driving of the worm gear 38 will cause the worm gear nut 37 to travel along the worm gear 38 and thereby raise or lower the support plate 33 as determined by the direction of rotation of the hand wheel 42.

The above described vertically adjustable elevating means 36 is a coarse adjustment for positioning the susceptor 30 at an optimum position within the reaction chamber 22 and/or 26 and a fine adjustment device is also provided as will hereinafter be described.

The susceptor 30 is of circular substantially planar configuration and is demountably carried and rotatably driven by a spider structure 44 having a central hub 45 from which at least three arms 46 extend radially. Each of the arms 46 is bent or otherwise formed at its distal end to provide an upstanding peg 47 upon which the susceptor 30 is supported. The hub 45 of the spider 44 is provided with a truncated conical bore 48 in which the tapered upper end 49 of a driveshaft assembly 50 is disposed.

The driveshaft assembly 50 is a multi-piece assembly including an elongated rotation shaft 51 at the uppermost end of the assembly. The rotation shaft 51, having the tapered upper end 49 as mentioned above, is provided with an axial bore 52 for reasons which will become apparent as this description progresses. The rotation shaft 51 has an enlarged tapered lower end 53 of inverted frusto-conical configuration with an enlarged diameter upwardly facing annular shoulder 54 in axially spaced relationship with the lower open end of the shaft.

As is customary in the art, the reaction chambers 22 and 26 are fabricated of a suitable transparent material, such as fused quartz, for the transmission of heating radiation from a suitable heat source (not shown). Since the depending tubular shafts 24 and 28 depend integrally from their respective reaction chambers 22 and 26, they too are formed of the same transparent material. For the same heat transmission reason, the above described spider structure 44 and the rotation shaft 51 are also formed of transparent material.

The driveshaft assembly 50 further includes a spindle 56 having an upper body portion 57 and a lower body portion 58 which may be formed as a single unitary structure or may be formed as two separate pieces for ease of fabrication and joined together such as by welding in the manner indicated in the drawing. In either case, the upper body portion 57 is of generally cylindrical configuration with a reduced diameter upper end 59 which forms an upwardly facing annular shoulder 60 on the upper body

portion 57. The reduced diameter upper end 59 is provided with external threads as indicated at 61 and an axial bore 62 is formed through the upper body portion 57. The axial bore has a tapered socket 64 at its upper end in which the enlarged tapered lower end 53 of the rotation shaft 51 is seated. A suitable hold-down nut 66 is threadingly carried on the upper end of the body portion 57 and a wave washer 68, or other suitable biasing means, is contained within the hold-down nut 66 to wedgingly hold the tapered lower end 53 of the rotation shaft 51 in the socket 64 of the spindle body portion 57. The hold-down nut 66 is provided with a suitable aperture through which the rotation shaft extends.

For reasons which will hereinafter be described in detail, the upper body portion 57 of the spindle 56 is further provided with a depending externally threaded boss 70 and a plurality (two shown) of passages 72 which extend downwardly from the annular shoulder 60 into intersecting relationship with the axial bore 62 at a location spaced below the tapered socket 64 portion of the axial bore.

The lower body portion 58 of the spindle 56 is of elongated cylindrical configuration and defines an axial bore 74 which has an inside diameter that is considerably larger than the axial bore 62 formed through the spindle's upper body portion 57 and is larger than the outside diameter of the depending boss 70 thereof for reasons which will be explained below. The lower body portion 58 is provided with a reduced diameter lower end 76 and has external threads 77 formed thereon immediately above the point

which the diameter of the lower body portion 58 is reduced.

A bearing means, in the preferred form of rotary seal 80, is provided with a non-rotating portion 81, 5 which is mounted in a manner which will hereinafter be described, and has an elongated rotatable sleeve 82 journaled for rotation therein, with the sleeve being axially disposed in the bearing means with a dependingly extending lower end 83 having external 10 threads 84 on the lowermost part of depending end 83. The driveshaft assembly 50 is disposed so as to extend coaxially through the rotatable sleeve 82 in a manner whereby the sleeve 82 and the driveshaft assembly 50 rotate as a single entity.

15 Thus, the bearing means 80 is employed in the substrate supporting mechanism 20 to support and rotatably journal the driveshaft assembly and to prevent gas leakage for reasons which will become apparent as this description progresses. The bearing 20 means in the form described is commercially available from the Ferrofludics Corporation of 40 Simon Street, Nashua, New Hampshire 03061 and is identified as Model Number HS-1500-F-W.

A driven pulley 86 is attached, such as by means 25 of the set screw shown, to the dependingly extending lower end 83 of the sleeve 82 and a position indicator wheel 88 is threadingly mounted immediately below the pulley on the threads 84 provided on the lowermost end of the sleeve 82. Both the driven 30 pulley 86 and the position indicator wheel 88 form a part of a drive means 90 which will hereinafter be described in detail.

A special cage nut 92 having an internally threaded upper portion 93 which is threadingly carried on the threads 84 of the sleeve 82 and an internally threaded lower portion 94 which is
5 threadingly carried on the threads 77 of the spindle 56. The upper and lower portions 93 and 94 of the cage nut 92 are interconnected in axially spaced relationship by at least two diametrically opposed ribs 95 (one shown) which provided openings for
10 access to an adjustment nut 96 which is captively retained between the upper and lower portions 93 and 94 of the cage nut 92. As shown, the adjustment nut 96 is threadingly mounted on the threaded end 77 of the spindle 56. Manual rotation of the adjustment
15 nut 96 will axially slideably move the entire driveshaft assembly 50 relative to the sleeve 82 of the rotary seal bearing means 80, and this is used to make the above mentioned fine vertical adjustments of the susceptor 30 in the reaction chamber 22 and/or
20 26.

The substrate supporting mechanism 20 is carried on the above mentioned support plate 33 which has an opening 100 formed therethrough. An adjustment plate 102 is mounted atop the support plate 33 and is
25 provided with an opening 104 which is substantially coaxial with respect to the opening 100 of the support plate. The adjustment plate 102 is connected to the support plate 33 by a suitable bolt 105 about which the plate 102 is pivotably movable for
30 adjustable location in a horizontal plane of the opening 104. The adjustment plate 102 is lockable in the desired position by a diametrically opposed bolt

106 and washer 107 with the bolt 106 passing downwardly through an enlarged aperture 108 of the plate 102 into threaded attachment with the support plate 33. A bearing mounting plate 110 having an opening 111 formed therethrough is positioned atop the adjustment plate 102 and is configured to provide an axially depending reduced diameter boss 112 which extends approximately half way down into the opening 104 of the adjustment plate 102. The non-rotating portion 81 of the bearing means 80 is bolted fast to the lower surface of the boss 112 so that it extends approximately half way up into the opening 104 of the adjustment plate 102. The bearing mounting plate 102 is mounted in place by the bolt 105 and others (not shown) which, as previously discussed, are used to fix the adjustment plate 102 on the support plate 33. In addition to supporting the bearing means, the bearing mounting plate 110 is adjustably tiltable by means of the adjustment screw 113 which depends from the seal mounting plate 110 into bearing engagement with the upper surface of the adjustment plate 102. From the above, it will be seen that the adjustment plate 102 and the bearing mounting plate 110 are independently adjustable and cooperatively interact to provide the properly aligned coaxial and vertical relationships of the bearing 80 and the driveshaft assembly 50.

A coupling plate 114 is positioned atop the bearing mounting plate 110 and is free to float into aligning relationship with the bearing mounting plate 110 and the depending tubular shaft 24 and/or 28 of the reaction chambers 22 and 26 respectively. Once

the aligned relationship has been established, such as during initial assembly of the substrate supporting mechanism 20, the coupling plate 114 may be tightened down against any further additional movement such as by means of the illustrated bolt 116, and others (not shown). The coupling plate 114 is formed with an axially upwardly extending externally threaded boss 118, and an axial bore 120 is formed through the coupling plate. An O-ring seal 122 is provided at the upper end of the boss 118 so as to be in sealed circumscribing engagement with the peripheral surface of the depending tubular shaft 24 or 28. A clamping nut 124 having an axially opening 125 formed therethrough is threadingly carried on the boss 118 to exert a circumferentially compressive force on the O-ring seal 122 by virtue of a compressing ring 126 carried in the clamping nut.

A heat sensing means in the preferred form of a thermocouple 130 is mounted in the upper end of a sheath 132 formed of suitable heat resistant material. The sheath 132 is of elongated configuration and is open on the end 133 thereof which is opposite to the closed end in which the thermocouple 130 is contained, with the open end being provided for exiting of the thermocouple wires 134 from the sheath. The lower end portion of the sheath 132 is axially disposed in a tube 136 having a fitting means 138 on its upper end and having a nut 140 on its lower end. The tube 136 and its associated fitting 138 and nut 140, is used to install and hold the sheath 132 in the axial bore that is cooperatively formed by the bores of the

various components which make up the driveshaft assembly 50. As shown, the fitting means 138 is threadingly attached to the depending boss 70 of the upper body portion 57 of the spindle 56, and a suitable O-ring seal 142 is provided at the junction of the fitting means 138 and the boss 70 to prevent gas leakage downwardly through the tube 136 as will hereinafter be described. The lower end, that is, the nut 140 extends below the open bottom end of the spindle 56 and is used simply as a tool for attaching the upper end fitting of the tube to the boss 70.

As shown, the upper closed end of the sheath 132 extends from the bore 52 of the rotation shaft 51 upwardly into a blind central cavity 144 formed in the lower surface of the susceptor 30. In this way, the thermocouple 130 will sense the temperature at the center of the susceptor 30 and produce an electric signal indicative of the sensed temperature in the manner well known in the art. The thermocouple 130 forms part of a temperature sensing system of the substrate supporting mechanism 20 as will hereinafter be described in detail.

In that the sheath 132 is axially carried in the driveshaft assembly 50 as described above, it will rotate along with the driveshaft assembly. For this reason, a slip-ring means 146 is provided on the lower end of the substrate supporting mechanism 20. The slip-ring means 146 is commercially available from the IEC Corporation, 3100 Longhorn Boulevard, Austin Texas 78759, and is a sealed unit identified as Model No. IECFCS. The slip-ring means 146 has an axial sleeve 148 therein which is coupled by means of

a clamping nut 150 to the reduced diameter lower end 76 of the spindle 52 for rotation therewith. The lower reduced diameter end 76 of the spindle 56 extends axially through the sleeve 148 of the slip-
5 ring means 146, and the lower end of the sleeve 148 is coupled, such as by a pin 152 to the rotatable outer portion 154 of the slip-ring means. The slip-ring means 146 has a fixed core 156 which is coaxially disposed between the inner sleeve 148 and
10 the rotatable portion 154. The core 156 is fixed against rotation by means of a flange 158 that is suitably attached to the upper end of the core 156 and is also attached by bolts 160 to the lower end of a housing 162.

15 The thermocouple wires 134 which extend from the sheath are connected by means of a suitable plug 164 to the wires 166 which extend from the rotatable outer portion 154 of the slip-ring means 146. The electric signal produced by the thermocouple 130 is
20 thereby transmitted via the wires 134 and 166 to the rotatable portion of the slip-ring means 146, and by the well known slip-ring method, are conducted to the fixed core 156 thereof. The signal received in the fixed core 156 is coupled by suitable wires 168
25 extending from the core 156 to a point of use (not shown).

The housing 162 is of cylindrical open ended configuration defining a bore 170 with a counterbore 171. The housing 162 is suspendingly carried by the
30 rotary bearing means 80 such as by means of the bayonette mounting arrangement 172 shown in Figures 1 and 2, and the split clamps 173 and 174 shown best in

those same figures.

In that the reaction chambers 22 and/or 26 are provided with the depending tubular shafts 24 and 28 and the driveshaft assembly 51 is tubular, the
5 rotatable substrate supporting mechanism 20 is provided with a purging system by which the reactant gas, and deposition material carried thereby, through the reaction chamber, will be prevented from flowing into the area below the susceptor 30 and downwardly
10 into the mechanism 20.

As shown in Figure 3, the bearing mounting plate 110 is provided with a passage 176 one end of which opens into the bore 111 thereof, with the other end being provided with means 178, such as the fitting
15 shown, for directing a suitable purge gas under elevated pressure from an external source (not shown) into the bore 111 of the bearing mounting plate. A gas restrictor housing 180 is mounted in the bore 111 of the bearing mounting plate 110 and is configured
20 to have an inverted cup-shaped body 182. The body 182 is provided with an annular groove 183 which aligns with the inwardly opening end of the passage 176 for receiving the purge gas therefrom. A plurality of incrementally spaced injection ports 184
25 extend from the annular groove 183 radially into the cavity 186 defined by the cup-shaped body 182. In that the body 182 opens downwardly, the purge gas received in the cavity 186 will flow downwardly into the annular recess between the reduced diameter upper
30 end 59 of the spindle 56 and the upper end of the sleeve 82 of the rotary bearing means 80. The gas received in that annular recess will flow through the

passages 72 of the spindle 56 into the bore 62 of the spindle. By virtue of the O-ring seal 142 which sealingly separates the lower end of the bore of the driveshaft assembly 51 from the upper end thereof, 5 the purge gas received from the passages 72 will flow upwardly in the bore 62 of the spindle 56 into the bore 52 of the rotation shaft 51. In that the top end of the rotation shaft 51 is open so that the thermocouple sheath 132 can extend therefrom to the 10 susceptor 30, upwardly flowing purge gas will exit the rotation shaft 51 under the central portion of the susceptor 30.

The gas restrictor housing 180 further includes a boss 188 which extends axially upwardly from the 15 cup-shaped body 182 and defines a bore 190 through which the rotation shaft 51 axially extends. The outside diameter of the rotation shaft 51 is smaller than the inside diameter of the bore 190 to provide an annular gap therebetween. Therefore, some of the 20 purge gas received in the cavity 186 will flow upwardly through that annular gap into the bore of the tubular shaft 24 or 28 of the reaction chambers 22 or 26, and that gas will flow upwardly into the area below the susceptor 30.

25 A suitable bracket means 192 is mounted so as to depend from the support plate 33 and a variable speed DC motor 194 is carried by the bracket. A drive pulley 195 is mounted on the output shaft 196 of the motor, and a belt 198 is employed to transmit 30 rotary power from the DC motor 194 to the driven pulley 86 carried on the driveshaft assembly 50 of the substrate supporting mechanism 20.

As indicated in phantom lines in Figure 4, most, if not all, substrates are provided with a notch 199 for orientation purposes. For this reason, it is desirable that the susceptor 30 be stopped at the same point in its rotation each time that it is stopped for placement and removal of a substrate. Therefore, the position indicator wheel 88, which was hereinbefore mentioned as being part of the drive means 90, is provided with a circular base 200 to which a nut 201 is demountably attached, such as by means of the illustrated threaded engagement, to hold an index means 202 therebetween. The index means 202 preferably includes a pair of ring-shaped plates 203 and 204 which are in contiguous coaxial engagement with each other. As shown in Figure 9, the upper plate 203 has a notch formed in its peripheral edge and the lower plate 204 has a similar notch. The two plates 203 and 204 may be adjustably rotated relative to each other so that the notches thereof cooperatively form a slot 206 which is adjustably variable as to its length. This adjustment feature of the index means 202 is desirable to provide the rotatable susceptor mechanism 20 with the capability of being repeatedly stopped at the same place, i.e. home position, regardless of the rotational home speed at which the mechanism is to be driven. However an index means having a fixed size slot (not shown) may be used whenever a single rotational home speed is to be used, as will hereinafter be described.

The index means 202 is disposed so that the variably sized slot 206 thereof is rotatably driven

through a groove 207 formed in the bifurcated end of a sensor switch 208. The sensor switch 208 is carried in a suitable mounting bracket 210 which is bolted or otherwise attached to the housing 162 so that the bifurcated end of the switch 208 extends radially into the interior of the housing 162 and straddles the rotational path of the index means 202 of the position indicator wheel 88.

Reference is now made to the schematic wiring diagram of Figure 13 which shows the various components which cooperatively form a control system 212 for driving the rotatable substrate supporting mechanism 20. First of all, a suitable programmable input system 214, which is not part of the control system 212, except for its supplying of an input signal having a predetermined time duration, is used to adjustably determine, among other things, the length of time of a mechanism cycle. The input system 214 applies an input signal, i.e. a voltage, via a conductor 215 to a junction point 216 so that the voltage is simultaneously applied by a conductor 217 to the first terminal of voltage comparator 218 and by a conductor 219 to a potentiometer P1. The potentiometer P1 is adjustably set for determining the normal rotational speed of the mechanism 20, in otherwords, the input system 214 cannot drive the mechanism 20 at speeds above that set by the potentiometer P1. The output voltage from the potentiometer P1 provides a first control signal which is directed through a two position contactor 220 of a relay R1 and through a resistive-capacitive network 221 (RC) by a conductor 222 which applies

that voltage to a suitable amplifier 223. The amplified voltage is directed by a conductor 224 to the variable speed DC motor 194 for driving the driveshaft means at a relatively high speed.

5 A second potentiometer P2 is used to apply an adjustably variable voltage to the second input terminal of the above mentioned voltage comparator 218. The comparator 218 is non-conductive when the voltage value from the input system 214 is above the 10 voltage value applied by the potentiometer P2. In otherwords, when the voltage from the input system 214 is at a relatively high value, for producing normal rotational speed of the motor 194, the comparator 218 will be non-conductive. However, when 15 the voltage from the input system 214 begins to decrease in value, indicative of an end of a cycle of the mechanism 20, the comparator 218 will be enabled when the voltage from the input system 214 drops in value below that applied by the potentiometer P2. 20 When the comparator 218 is enabled, a voltage at its output terminal will be coupled by conductor 225 to the relay R1, for energizing thereof. When the relay R1 is energized in this manner, it will move the two position contactor 220 out of its normal position 25 into contact with the terminal 226, and simultaneously close the normally open contactor 227 thereof. When the two-position contactor 220 is moved into contact with the terminal 226, the output voltage from a third potentiometer P3 provides a 30 second control signal which is coupled through the RC network 221, the amplifier 223 to the D.C. motor 194. The potentiometer P3 is adjustably set to a

voltage value which is less than that of the output value of the potentiometer P1 for rotatably driving the mechanism 20 at a reduced, or "home" speed.

The above mentioned sensor switch 208 is an optical device including a photoemitter diode 230 and a normally open photoreceptor transistor 232 on opposite sides of the index means 202 of the position indicator wheel 88. When the slot 206 of the index means 202 is rotated into position between the photoemitter diode 230 and the photoreceptor transistor 232, impinging light will render the photo transistor 232 conductive. When enabled in this way, the supply voltage applied to the input terminal of the photo transistor 232 by conductor 234, will pass through the contactor 227, which was closed upon energization of the relay R1, and will energize another relay R2. When the relay R1 is energized it will close its contactor 236 which completes a grounding circuit at the input of the amplifier 223 to drop the voltage at the input to zero thus stopping the motor 194.

The RC network 221 of the control system 212 is a time constant circuit which is used to control start-up and slow-down speeds of the rotational drive of the mechanism. In otherwords, the start-up and slow-down speeds must not be too abrupt or the substrate carried on the susceptor could be dislodged. Thus, the RC network produces in a well known manner, relatively smooth build-up or ramp, in the applied voltages to the motor 194, and a relatively smooth decrease or ramp, in those voltages when they are being removed from the motor 194.

While the control system 212 is preferably provided with the potentiometers P1, P2 and P3 for adjustable versatility of the mechanism 20, it will be understood than in most applications, fixed value voltage dropping resistors (not shown) could be used.

As indicated in FIG. 6, the susceptor 30 may be provided with a smooth planar upper surface 240 upon which a substrate to be processed is supportable. However, due to rotation of the susceptor and the flow of gas through the reaction chamber 22 and/or 26, it is preferred that the susceptor be formed with a non-smooth upper planar surface for positional stability of the substrate. In a first modified susceptor 30A shown in FIG. 7, a circular central recessed area 242 is provided for receiving a substrate and retaining it in the desired position within a circular rim 244. In a second modified susceptor 30B shown in FIG. 8, the upper surface 246 has a plurality of concentric grooves 248 of varying diameters, and a plurality of radially extending channels 250 formed therein. The grooves 248 and channel 250 cooperatively interact to allow the free flow of gasses between the substrate and the susceptor during placement and removal of the substrate to prevent undesired slipping movement of the substrate.

As hereinbefore mentioned, the substrate supporting mechanism 20 includes a temperature sensing system with the hereinbefore described heat sensing means 130 forming a part thereof. The temperature sensing system further includes a fixed ring structure 252 which is supported in

substantially surrounding concentric relationship relative to the susceptor 30. The ring structure 252 is supported in upwardly spaced relationship with respect to the bottom surface 23 or 27 of the reaction chambers 22 or 26 by a stand 254 which is preferably formed of transparent material. The stand 254 as best seen in FIG. 6, has a multi-sided substantially ring-shaped rail 256 having depending feet 258 for resting on the bottom surface of the reaction chamber and upstanding pins 260 for supporting the ring structure 252 in a fixed non-rotating position. Although the stand 254 is shown as being of a fixed height relative to the bottom surface of the reaction chamber(s), that height may be change such at the time of manufacture, by employing feet and/or pins of different lengths.

As shown in FIGs. 4 and 5, the fixed ring structure 252 includes an inner ring body 262 and an outer ring body 264 which cooperatively define an annular passage 266 about the ring structure. In the illustrated embodiment, three temperature sensing means 268, 270, and 272 are shown as being disposed at various locations in the annular passage 266 of the ring structure 252. It will be understood that as few as one temperature sensing means can be employed or a multiplicity can be used as necessary to achieve the desired temperature sensing capability. It has been found that in horizontal flow reaction chambers, such as the one indicated at 22 in FIG. 1, the three temperature sensing means 268, 270, and 272 provide ideal temperature sensing capabilities when used in conjunction with the

previously described temperature sensing means 130. As indicated by the arrow 274 in FIG. 4, the gas carrying the desired deposition materials, will flow across the ring structure 252 in a direction from
5 what may be considered as the leading edge 276 to the trailing edge 278. The temperature sensing means 268 is located at the leading edge 276 to sense the temperature at that point. The temperature sensor means 130 will, as hereinbefore described, sense the
10 temperatures at the center of the rotatable susceptor 20, and the other two temperature sensor means 270 and 272 will sense the temperature proximate the trailing edge 278 of the ring structure 252. The temperature sensing means 268, 270, and 272 are
15 preferably of the same configuration as the previously described temperature sensor means 130. That is, the temperature sensor means are in the preferred form of thermocouples each of which is mounted in a sheath 280 of transparent material. The
20 sheaths 280 of each of the thermocouples 268, 270, and 272 are of elongated configuration and extend from the ring structure 252 via suitable apertures 282, 283, and 284 formed through the outer ring body 264. In this way, the conductive wires 286, 288, and
25 290 of the thermocouples 268, 270, and 272 respectively, extend out of the hostile environment of the susceptor 20 and ring structure 252. The electric signals produced by the thermocouples 120, 268, 270, and 272 are coupled to a suitable
30 temperature control device (not shown) which forms no part of the substrate supporting mechanism 20 of this invention.

Reference is now made to FIGs. 10, 11 and 12 wherein a modified form of the rotatable substrate supporting mechanism is shown and is indicated generally by the reference numeral 20A. The mechanism 20A is essentially the same as the previously described mechanism and has a modified form of gas restrictor housing 294 mounted in the bore 111 of the bearing seal mounting plate 110. The gas restrictor housing 294 has an inverted cup-shaped body 296 with the annular groove 298 and injection ports 299 for receiving the purge gas from the passage 176 of the seal mounting plate 110. The purge gas is directed into the downwardly opening cavity 300 of the gas restrictor housing 294, for movement downwardly and then upwardly into the bore 52 of the rotation shaft 51 in the manner hereinbefore fully described with reference to the mechanism 20. The modified gas restrictor housing 294 of the mechanism 20A has an elongated tube 302 extending axially upwardly therefrom. The rotation shaft 51 extends axially through the tube 302 which is sized to provide an annular gap 304 between the outside diameter of the rotation shaft 51 and the inside diameter of the tube 302 of the gas restrictor housing 294. Therefore some of the purge gas received in the cavity 300 of the gas restrictor housing 294 will flow upwardly through the annular gap 304 and emerge from the tube 302 below the susceptor 30.

The uppermost end of the tube 302 of the gas restrictor housing 294 is suitably configured to carry a stand means 306 preferably of transparent

material upon which the ring structure 252 is supported. The stand means 306 includes a disc shaped body 308 having at least three arms 310 extending therefrom. Each of the arms 310 is
5 provided with an upstanding pin 311 upon which the fixed ring structure 252 is carried.

By mounting the ring structure 252 on the stand means 306, rather than the stand 254 of the mechanism 20, the stand means 306, and thereby the
10 ring structure 252 and the temperature sensing means 268, 270, and 272 (FIG. 4) carried thereby, are vertically adjustable along with the susceptor 30 as hereinbefore described with reference to the mechanism 20.

15 The modified form of substrate supporting mechanism 20A further includes a modified coupling plate 312 which, as in the case of the previously described coupling plate 114, is free to float into aligning relationship with the bearing mounting plate
20 110 and the depending tubular shaft 24 and/or 28 of the reaction chamber 22 or 26. The coupling plate 312 is provided with an axially upwardly extending externally threaded boss 314 defining an axial bore 316. The clamping nut 124, is threadingly carried on
25 the boss 314 for exerting a circumferentially compressive force on the O-ring seal 122 by virtue of the compression ring 126 carried in the clamping nut 124. Purge gas, from an external source is supplied to a passage 318 formed in the coupling plate 312
30 such as through a suitable fitting means 320 so that the purge gas is directed into the counterbored lower end 322 of the coupling plate 312 and will flow

upwardly in the annular space 324 between the depending tubular shaft 24 or 28 of the reaction chamber 22 or 26, and the elongated tube 302 of the gas restrictor housing 294.

5 Therefore, in the modified substrate supporting mechanism 20A the purging gas will flow upwardly through the rotation shaft 51, through the annular gap 304 between the rotation shaft 51 and the upstanding tube 302 of the gas restrictor housing 10 294, and through the annular space 324 discussed above.

The free floating coupling plate 114 of the first embodiment of the present invention was described as being bolted in a fixed position 15 subsequent to its having been positioned in the desired aligned position. In many reaction chamber installations, such bolting in place may not be able to be accomplished due to the inability to reach the necessary points for accomplishing such bolting. 20 Therefore, the modified mechanism 20A is shown as including an automatic clamping device 326.

The clamping device 326 includes a lever 328 which is pivotably carried on a suitable pin 330. The pivot pin 330 is mounted in clevis 332 which is 25 mounted atop the support plate 33A, and a depending lug 334 is mounted on the lever 328 with the pivot pin 330 passing through a suitable aperture provided in the lug. One end 336 of the lever 328 extends away from the mechanism 20A and a suitable adjustment 30 screw assembly 338 is carried in that end 336 of the lever. An electrically, pneumatically, or otherwise operated actuator mechanism 340 is mounted in the

support plate 33A, and is operable for extending and retracting movement of an actuator pin 342. When actuated, such as at the beginning of an operational cycle, or cycles, of the mechanism 20A, the actuator pin 342 will move to its illustrated extended position and produce a counterclockwise pivot movement of the lever 328, as viewed in FIG. 10.

The other end 344 of the lever 328 is bifurcated to provide a pair of spaced apart arms 346 which are stradlingly disposed on diametrically opposed sides of the upwardly extending boss 314 of the coupling plate 312. Each of the arms 346 is provided with a depending pin 348 which will bear down on the coupling plate 312 when the lever 328 is pivotably moved in the manner hereinbefore described. When the clamping force is applied to the coupling plate 312 a compressive force will be applied to the O-ring seals 350 to prevent gas leakage between the coupling plate 312 and the bearing mounting plate 110.

Reference is now made to FIG. 14 wherein a modified form of the rotatable substrate supporting mechanism is shown with the modified configuration being indicated in its entirety by the reference numeral 20B. The mechanism 20B, which may be identical to the hereinbefore described mechanisms 20 or 20A with the exception of the changes discussed below, includes a modified susceptor 30B which is provided with a central aperture 360 rather than the blind cavity 144 mentioned in the previous embodiments. The driveshaft assembly 50B includes the rotation shaft 51 with a modified spindle 56B. The spindle 56B includes the upper portion 57 and a

modified lower portion 58B which has a depending boss 362 on its lower end which is externally threaded as shown.

The drive shaft assembly 50B defines an axial
5 passage 364 which in this embodiment, is used for the transmission of radiated heat from the center of the substrate 32 and is, therefore left open. The radiated heat enters the axial bore, or passage, 364 through the central aperture 360 of the susceptor
10 30B, and is transmitted by radiation to a window means 366 which is carried on the depending boss 362 of the drive shaft assembly 50B. A suitable mounting means 368, such as the illustrated nut, is used to mount the window means 366 on the drive shaft
15 assembly for rotation therewith. The window means 366 includes a lens 370 which is formed of a material such as magnesium to the particular wavelength of radiated heat and are not dependent on the temperature for their transparency. The lens 370 is
20 mounted in a suitable ring 372 and is carried by the mounting means 368 with a suitable O-ring gasket 374 is employed to prevent the passage of purge gas around the window means 366. The radiated heat passing through the window means 366 is sensed by a
25 radiation pyrometer 376 of a type well known in the art, which produces an electric signal indicative of the sensed temperature.

While the principles of the invention have now been made clear in the illustrated embodiments,
30 there will be immediately obvious to those skilled in the art, many modifications of structure, arrangements, proportions, the elements, materials

and components used in the practice of the invention and otherwise, which are particularly adapted for specific environments and operation requirements without departing from those principles. The
5 appended claims are therefore intended to cover and embrace any such modifications within the limits only of the true spirit and scope of the invention.

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CLAIMS

WHAT WE CLAIM IS:

1. A mechanism for demountably supporting a single substrate in the reactant gas flow path of a chemical vapor deposition reaction chamber of the type having a bottom surface with a tubular shaft depending therefrom, said mechanism comprising:

a) drive shaft means defining a rotational axis, said drive shaft means being for spaced coaxial placement within the tubular shaft of the reaction chamber and having a top end which extends upwardly from the tubular shaft into the reaction chamber and having a lower end which depends therefrom;

b) drive means coupled to the lower end of said drive shaft means for rotational driving thereof; and

c) a susceptor defining a top surface for demountably receiving the substrate in a position wherein the center of the received substrate is in a substantially aligned and overlaying relationship with the center of said susceptor, said susceptor being coupled to said drive shaft means for rotation therewith and supported in a position wherein the rotational axis of said drive shaft means is normal with respect to the center of said susceptor.

2. A mechanism as claimed in Claim 1 and further comprising means for receiving a purge gas under elevated pressure from a remote source and directing it upwardly through the tubular shaft of

the reaction chamber when said drive shaft means is disposed therein for inhibiting the flow of reactant gas into the area below said susceptor and into the tubular shaft of the reaction chamber.

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3. A mechanism as claimed in Claim 1 and further comprising spider means on the top of said drive shaft means for coupling said susceptor thereto.

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4. A mechanism as claimed in Claim 1 and further comprising:

a) said drive shaft having an axial bore; and

15 b) temperature sensing means disposed in a spaced coaxial position within the axial bore of said drive shaft means and extending from the top thereof into the vicinity of the center of the bottom of said susceptor for sensing the temperature at the

20 center of said susceptor and producing a signal indicative of that sensed temperature.

5. A mechanism as claimed in Claim 4 and further comprising means for receiving a purge gas

25 under pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber and through the axial bore of said drive shaft means when said drive shaft means is disposed in the tubular shaft of the reaction chamber for

30 inhibiting the flow of reactant gas into the area below said susceptor and into the tubular shaft of the reaction chamber and into the axial bore of said

drive shaft means.

6. A mechanism as claimed in Claim 1 and further comprising:

5 a) said susceptor having a central aperture formed therethrough;

b) said drive shaft means defining an axial bore for receiving radiant heat from the center of the substrate through the aperture of said
10 susceptor when the substrate is mounted thereon and transmitting the radiant heat through the axial bore of said drive shaft means;

c) window means on the lower end of said drive shaft means for sealed closing thereof, aid
15 window means being transparent to the wavelengths of the radiant heat transmitted through the axial bore of said drive shaft means; and

d) a radiation pyrometer for sensing the temperature of the radiant heat transmitted through
20 said window means and producing a signal indicative of that sensed temperature.

7. A mechanism as claimed in Claim 6 wherein said window means includes a lens formed of
25 magnesium fluoride.

8. A mechanism as claimed in Claim 6 wherein said window means includes a lens formed of calcium fluoride.

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9. A mechanism as claimed in Claim 6 and further comprising means for receiving a purge gas

under pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber and through the axial bore of said drive shaft means when said drive shaft means is disposed
5 in the tubular shaft of the reaction chamber for inhibiting the flow of reactant gas into the area below said susceptor and into the tubular shaft of the reaction chamber and into the axial bore of said drive shaft means.

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10. A mechanism as claimed in Claim 1 and further comprising:

a) stand means for placement in the reaction chamber;

15 b) a ring structure means supported on said stand means in a fixed position which is in concentric surrounding relationship with said susceptor; and

c) at least one temperature sensor means
20 mounted in said ring structure means for sensing the temperature at a point on said ring structure means proximate the periphery of said susceptor and producing a signal indicative of that sensed temperature.

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11. A mechanism as claimed in Claim 1 and further comprising:

a) a support plate for placement in downwardly spaced relationship with the reaction
30 chamber and having an opening which is coaxial with said drive shaft means;

b) mounting means on said support plate

for attachment to the tubular shaft of the reaction chamber, said mounting means defining an axial opening which is coaxial with the opening of said support plate and through which said drive shaft
5 means extends axially; and

c) bearing means depending from said mounting means in circumscribing engagement with an intermediate portion of said drive shaft means for supporting and rotatable journaling of said drive
10 shaft means.

12. A mechanism as claimed in Claim 11 and further comprising:

a) said mounting means including a
15 coupling means for sealed attachment to the tubular shaft of the reaction chamber with the axial opening of said mounting means being in communication with the inside of the tubular shaft of the reaction chamber when attached thereto; and
20 b) said mounting means including means for receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber for inhibiting the flow of reactant gas in the area below said
25 susceptor and into the tubular shaft of the reaction chamber.

13. A mechanism as claimed in Claim 11 and further comprising:
30 a) said mounting means including a coupling means for sealed attachment to the tubular shaft of the reaction chamber with the axial opening

of said mounting means being in communication with the inside of the tubular shaft of the reaction chamber when attached thereto;

b) said drive shaft means having an axial bore and passage means extending from the axial bore thereof to the axial opening of said mounting means;

c) temperature sensing means disposed in a spaced coaxial position within the axial bore of said drive shaft means and extending from the top thereof into the vicinity of the center of the bottom surface of said susceptor for sensing the temperature at that location and producing a signal indicative of the sensed temperature; and

d) said mounting means including means for receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber and the axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of the reaction chamber and into the axial bore of said drive shaft means.

14. A mechanism as claimed in Claim 11 and further comprising:

a) said mounting means including coupling means for sealed attachment to the tubular shaft of the reaction chamber with the axial opening of said mounting means being in communication with the inside surface of the tubular shaft of the reaction chamber when attached thereto;

b) said susceptor having a central aperture formed therethrough;

c) said drive shaft means having an axial bore for receiving radiant heat from the center of the substrate through the aperture of said susceptor when the substrate is mounted thereon and transmitting the radiant heat through the axial bore of said drive shaft means, said drive shaft means further having passage means extending from the axial bore thereof to the axial opening of said mounting means;

d) window means on the lower end of said drive shaft means for sealed closing of the axial bore thereof, said window means being transparent to the wavelengths of the radiant heat transmitted through the axial bore of said drive shaft means;

e) a radiation pyrometer for sensing the temperature of the radiant heat transmitted through said window means and producing a signal indicative of that sensed temperature; and

f) said mounting means including means for receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber and the axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of the reaction chamber and into the axial bore of said drive shaft means.

15. A mechanism as claimed in Claim 11 wherein said mounting means is adjustable on said support plate for setting the perpendicularity and alignment of said drive shaft means relative to the reaction chamber and the depending tubular shaft thereof.

16. A mechanism as claimed in Claim11 and further comprising:

a) elevating means coupled to said support
5 plate for vertically moving said mounting means, said bearing means, said drive shaft means, said spider means and said susceptor as an entity relative to the reaction chamber; and

b) adjustment means on said drive shaft
10 means and on said bearing means for axial adjustment of said drive shaft means relative to said bearing means, said elevating means and said adjustment means cooperatively interacting to permit optimum positioning of said susceptor in the reactant gas
15 flow path of the reaction chamber.

17. A mechanism as claimed in Claim 11 and further comprising:

a) said mounting means including a
20 coupling means for sealed attachment to the tubular shaft of the reaction chamber with the axial opening of said mounting means being in communication with the inside of the tubular shaft of the reaction chamber when attached thereto;
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b) said mounting means including an elongated tube extending axially upwardly therefrom in spaced coaxial relationship with said drive shaft means for spaced coaxial positioning within the tubular shaft of the reaction chamber, said elongated
30 tube having a top end which is disposed between the bottom surface of the reaction chamber and said spider when said elongated tube is positioned in the

tubular shaft of the reaction chamber;

c) stand means attached to the top end of said elongated tube of said mounting means;

d) a ring structure means supported on
5 said stand means in a fixed position which is in concentric surrounding relationship with said susceptor; and

e) at least one temperature sensing means in said ring structure for sensing the temperature
10 at a point on said ring structure means proximate the periphery of said susceptor and producing a signal indicative of that sensed temperature.

18. A mechanism as claimed in Claim 17 and
15 further comprising, said mounting means including means for receiving a purge gas under elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber and upwardly through the elongated tube of
20 said mounting means for inhibiting the flow of reactant gas in the area below said susceptor and into said elongated tube of said mounting means and into the tubular shaft of the reaction chamber.

25 19. A mechanism as claimed in Claim 17 and further comprising:

a) said drive shaft means having an axial bore; and

b) temperature sensing means disposed in a
30 spaced coaxial position within the axial bore of said drive shaft means and extending from the top thereof into the vicinity of the center of the bottom

of said susceptor for sensing the temperature at the center of said susceptor and producing a signal indicative of that sensed temperature.

5 20. A mechanism as claimed in Claim 19 and further comprising, said mounting means including means for receiving a purge gas under elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction 10 chamber, through the elongated tube of said mounting means and through the axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of the reaction chamber, into the elongated tube of 15 said mounting means and into the axial bore of said drive shaft means.

21. A mechanism as claimed in Claim 19 and further comprising:

20 a) said susceptor having a central aperture formed therethrough;

b) said drive shaft means defining an axial bore for receiving radiant heat from the center of the substrate through the aperture of said 25 susceptor when the substrate is mounted thereon and transmitting the radiant heat through the axial bore of said drive shaft means;

c) window means on the lower end of said drive shaft means for sealed closing thereof, said 30 window means being trans-parent to the wavelengths of the transmitted radiant heat; and

d) a radiation pyrometer for sensing the

temperature of the radiant heat transmitted through said window means and producing a signal indicative of that sensed temperature.

5 22. A mechanism as claimed in Claim 21 and further comprising, said mounting means including means for receiving a purge gas under elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction 10 chamber, through the elongated tube of said mounting means and through the axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of the reaction chamber, into the elongated tube of 15 said mounting means and into the axial bore of said drive shaft means.

23. A mechanism as claimed in Claim 17 wherein said mount ing means is adjustable on said support 20 plate for setting the perpendicularity and alignment of said drive shaft means relative to the reaction chamber and the depending tubular shaft thereof.

24. A mechanism as claimed in Claim 17 and 25 further comprising:

a) elevating means coupled to said support plate for vertically moving said mounting means, said bearing means, said drive shaft means, said spider means, said susceptor, said stand means and 30 said ring structure means relative to the reaction chamber; and

b) adjustment means on said drive shaft

means and on said bearing means for axial adjustment of said drive shaft means relative to said bearing means, said elevating means and said adjustment means cooperatively interacting to permit optimum
5 positioning of said susceptor and said ring structure means in the reactant gas flow path of the reaction chamber.

25. A mechanism as claimed in Claim 1 wherein
10 said drive means comprises:

a) an electric motor; and

b) means for driving said motor at adjustably variable speeds.

15 26. A mechanism as claimed in Claim 1 wherein said drive means comprises:

a) input means for supplying an input signal having a predetermined time duration;

b) a motor coupled for rotating said
20 drive shaft means, said drive shaft means having a predetermined home position;

c) means responsive to the presence of said input signal for operating said motor to rotate said drive shaft means at a relatively high speed and
25 responsive to the termination of said input signal for slowing the operation of said motor to rotate said drive shaft means at a relatively slower speed; and

d) means responsive to the slowing of
30 the speed of rotation of said drive shaft means for detecting the home position thereof and stopping said drive shaft means at the home position.

27. A mechanism for demountably supporting a single substrate in the reactant gas flow path of a chemical vapor deposition reaction chamber of the type having a bottom surface with a tubular shaft depending therefrom, said mechanism comprising:

a) drive shaft means defining a rotational axis, said drive shaft means being for spaced coaxial placement within the tubular shaft of the reaction chamber and having a top end which extends upwardly from the tubular shaft into the reaction chamber and having a lower end which depends therefrom;

b) a support plate for placement in downwardly spaced relationship with the reaction chamber and having an opening which is coaxial with said drive shaft means;

c) mounting means on said support plate for attachment to the tubular shaft of the reaction chamber, said mounting means defining an axial opening which is coaxial with the opening of said support plate and through which said drive shaft means extends axially;

d) bearing means dependingly attached to said mounting means in circumscribing engagement with an intermediate portion of said drive shaft means for supporting and rotatably journaling said drive shaft means;

e) drive means coupled to the lower end of said drive shaft means for rotational driving thereof; and

f) a susceptor defining a top surface for

demountably receiving the substrate in a position wherein the center of the substrate is in a substantially aligned overlaying relationship with the center of said susceptor, said susceptor being coupled to said drive shaft means for rotation therewith and supported in a position wherein the rotational axis of said drive shaft means is normal with respect to the center of said susceptor.

28. A mechanism as claimed in Claim 27 and further comprising spider means on the top of said drive shaft means for coupling said susceptor thereto.

29. A mechanism as claimed in Claim 27 and further comprising:

a) said mounting means including a coupling means for sealed attachment to the tubular shaft of the reaction chamber with the axial opening of said mounting means being in communication with the inside of the tubular shaft of the reaction chamber when attached thereto; and

b) said mounting means including means for receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of the reaction chamber.

30. A mechanism as claimed in Claim 27 and further comprising:

a) said mounting means including a coupling means for sealed attachment to the tubular shaft of the reaction chamber with the axial opening of said mounting means being in communication with
5 the inside of the tubular shaft of the reaction chamber when attached thereto;

b) said susceptor having a blind cavity in the center of its bottom surface;

c) said drive shaft means having an axial
10 bore and passage means extending from the axial bore thereof to the axial opening of said mounting means;

d) temperature sensing means disposed in a spaced coaxial position within the axial bore of said drive shaft means and extending from the top
15 thereof into the blind cavity of said susceptor for sensing the temperature at that location and producing a signal indicative of the sensed temperature; and

e) said mounting means including means for
20 receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber and the axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor
25 and into the tubular shaft of the reaction chamber and into the axial bore of said drive shaft means.

31. A mechanism as claimed in Claim 30 wherein said temperature sensing means comprises:

30 a) an elongated tubular sheath having a closed end and an open end; and

b) a thermocouple located in the closed

end of said sheath, said thermocouple having conductive wires extending therefrom through said tubular sheath and exiting the open end of said sheath.

5

32. A mechanism as claimed in Claim 31 and further comprising a slip ring structure having a rotatable portion connected to the lower end of said drive shaft means, said conductive wires of said
10 thermocouple being connected to the rotatable portion of said slip ring structure, said slip ring structure having a non-rotatable portion in slip ring engagement with the rotatable portion thereof and having conductive wires extending therefrom for
15 conducting the signal from said thermocouple to a point of use.

33. A mechanism as claimed in Claim 27 and further comprising:
20 a) said mounting means including a coupling means for sealed attachment to the tubular shaft of the reaction chamber with the axial opening of said mounting means being in communication with the inside of the tubular shaft of the reaction
25 chamber when attached thereto;

b) said susceptor having an aperture formed through the center thereof;

c) said drive shaft means having an axial bore and passage means extending from the axial bore
30 thereof to the axial opening of said mounting means, said drive shaft means being disposed so that the open upper end of its axial bore is proximate the

central aperture of said susceptor for receiving radiant heat from the center of the substrate when the substrate is mounted on said susceptor;

d) window means on said drive shaft means for sealed closing of the lower open end of the axial bore thereof, said window means being transparent to the wavelengths of radiant heat received in the open upper end of the axial bore of said drive shaft means;

e) a radiation pyrometer for sensing the temperature of the radiant heat transmitted through said window means and producing a signal indicative of that sensed temperature; and

f) said mounting means including means for receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of the reaction chamber and the axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of the reaction chamber and into the axial bore of said drive shaft means.

34. A mechanism as claimed in Claim 33 wherein said window means includes a lens formed of magnesium fluoride.

35. A mechanism as claimed in Claim 33 wherein said window means includes a lens formed of calcium fluoride.

36. A mechanism as claimed in Claim 27 wherein said

mounting means is adjustable on said support plate for setting
the perpendicularity and alignment of said drive shaft means relative to the reaction chamber and the
5 depending tubular shaft thereof.

37. A mechanism as claimed in Claim 27 and further comprising:

a) elevating means coupled to said support
10 plate for vertically moving said mounting means, said bearing means, said drive shaft means, said spider means and said susceptor as an entity relative to the reaction chamber; and

b) adjustment means on said drive shaft
15 means and on said bearing means for axial adjustment of said drive shaft means relative to said bearing means, said elevating means and said adjustment means cooperatively interacting to permit optimum positioning of said susceptor in the reactant gas
20 flow path of the reaction chamber.

38. A mechanism as claimed in Claim 28 wherein said drive shaft means comprises:

a) an elongated spindle means forming the
25 intermediate portion of said drive shaft means which is supported and rotatably journaled in said bearing means and forming the lower end of said drive shaft means; and

b) a rotation shaft demountably attached
30 to the top end of said spindle means for rotation therewith, said rotation shaft forming the top end of said drive shaft means.

39. A mechanism as claimed in Claim 38 wherein said rotation shaft and said spider means are formed of a transparent material for the transmission of
5 heating radiation.

40. A mechanism as claimed in Claim 27 wherein said susceptor is of circular substantially planar configuration with a central recess formed in the top
10 surface for receiving the substrate and providing positional stability thereof.

41. A mechanism as claimed in Claim 27 wherein said susceptor is of circular substantially planar
15 configuration with a plurality of concentric grooves of varying diameters and a plurality of radial channels formed in the top surface thereof to provide positional stability of the substrate receivable thereon.
20

42. A mechanism as claimed in Claim 28 and further comprising:

a) said mounting means including a coupling means for sealed attachment to the tubular
25 shaft of the reaction chamber with the axial opening of said mounting means being in communication with the inside of the tubular shaft of the reaction chamber when attached thereto;

b) said mounting means including an
30 elongated tube extending axially upwardly therefrom in spaced coaxial relationship with said drive shaft means for spaced coaxial positioning within the

tubular shaft of the reaction chamber, said elongated tube having a top end which is disposed between the bottom surface of the reaction chamber and said spider means when said elongated tube is positioned
5 in the tubular shaft of the reaction chamber;

c) stand means attached to the top end of said elongated tube of said mounting means;

d) a ring structure means supported on said stand means in a fixed position which is in
10 concentric surrounding relationship with said susceptor; and

e) at least one temperature sensing means in said ring structure for sensing the temperature at a point on said ring structure means proximate the
15 periphery of said susceptor and producing a signal indicative of that sensed temperature.

43. A mechanism as claimed in Claim 42 wherein said temperature sensing means comprises:
20 a) an elongated tubular sheath having a closed end and an open end; and

b) a thermocouple located in the closed end of said sheath and having conductive wires extending therefrom through said sheath and exiting
25 through the open end of said sheath for conducting the signal from said thermocouple to a point of use.

44. A mechanism as claimed in Claim 42 and
30 further
comprising, said mounting means including means for receiving a purge gas under elevated pressure from a

remote source and directing it upwardly through the tubular shaft of the reaction chamber and upwardly through the elongated tube of said mounting means for inhibiting the flow of reactant gas in the area below
5 said susceptor and into said elongated tube of said mounting means and into the tubular shaft of the reaction chamber.

45. A mechanism as claimed in Claim 42 and
10 further comprising:

a) said susceptor having a blind cavity formed centrally in its bottom surface;

b) said drive shaft means having an axial bore; and

15 c) temperature sensing means disposed in a spaced coaxial position within the axial bore of said drive shaft means and extending from the top thereof into the blind cavity of said susceptor for sensing the temperature at the center of said
20 susceptor and producing a signal indicative of that sensed temperature.

46. A mechanism as claimed in Claim 45 and further comprising:

25 a) said drive shaft means including passage means extending from the axial bore thereof to the axial opening of said mounting means; and

b) said mounting means including means for receiving a purge gas under elevated pressure from a
30 remote source and directing it upwardly through the tubular shaft of the reaction chamber, through the elongated tube of said mounting means and through the

axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of the reaction chamber into the elongated tube of said mounting
5 means and into the axial bore of said drive shaft means.

47. A mechanism as claimed in Claim 45 wherein said temperature sensing means comprises:
10 a) an elongated tubular sheath having a closed end and an open end; and
b) a thermocouple located in the closed end of said sheath, said thermocouple having conductive wires extending therefrom through said
15 tubular sheath and exiting the open end of said sheath.

48. A mechanism as claimed in Claim 47 and further comprising a slip ring structure having a
20 rotatable portion connected to the lower end of said drive shaft means, said conductive wires of said thermocouple being connected to the rotatable portion of said slip ring structure, said slip ring structure having a non-rotatable portion in slip ring
25 engagement with the rotatable portion thereof and having conductive wire extending therefrom for conducting the signal from said thermocouple to a point of use.

30 49. A mechanism as claimed in Claim 42 and further comprising:
a) said susceptor having an aperture

formed centrally therethrough;

b) said drive shaft means defining an axial bore for receiving radiant heat from the center of the substrate through the aperture of said
5 susceptor when the substrate is mounted thereon and transmitting the radiant heat through the axial bore of said drive shaft means;

c) window means on the lower end of said drive shaft means for sealed closing of the axial
10 bore thereof, said window means being transparent to the wavelengths of the radiant heat transmitted through the axial bore of said drive shaft means; and

d) a radiation pyrometer for sensing the temperature of the radiant heat transmitted through
15 said window means and producing a signal indicative thereof.

50. A mechanism as claimed in Claim 49 wherein said window means includes a lens formed of
20 magnesium fluoride.

51. A mechanism as claimed in Claim 49 wherein said window means includes a lens formed of calcium fluoride.
25

52. A mechanism as claimed in Claim 49 and further comprising:

a) said drive shaft means including passage means extending from the axial bore thereof
30 to the axial opening of said mounting means; and

b) said mounting means including means for receiving a purge gas at elevated pressure from a

remote sources and directing it upwardly through the tubular shaft of the reaction chamber, through the elongated tube of said mounting means and through the axial bore of said drive shaft means for inhibiting
5 the flow of reactant gas in the area below said susceptor and into the tubular shaft of the reaction chamber through the elongated tube of said mounting means and into the axial bore of said drive shaft means.

10

53. A mechanism as claimed in Claim 42 wherein said mounting means is adjustable on said support plate for setting the perpendicularity and alignment of said drive shaft means relative to the reaction
15 chamber and the depending tubular shaft thereof.

54. A mechanism as claimed in Claim 42 and further comprising:

a) elevating means coupled to said support
20 plate for vertically moving said mounting means, said bearing means, said drive shaft means, said spider means, said susceptor, said stand means and said ring structure means relative to the reaction chamber; and

25 b) adjustment means on said drive shaft means and on said bearing means for axial adjustment of said drive shaft means relative to said bearing means, said elevating means and said adjustment means cooperatively interacting to permit optimum
30 positioning of said susceptor and said ring structure means in the reactant gas flow path of the reaction chamber.

55. A mechanism as claimed in Claim 42 wherein said drive means comprises:

a) an electric motor; and

b) means for driving said motor at
5 adjustably variable speeds.

56. A mechanism as claimed in Claim 42 wherein said drive shaft means comprises:

a) an elongated spindle means forming the
10 intermediate portion of said drive shaft means which is supported and rotatably journaled in said bearing means and forming the lower end of said drive shaft means; and

b) a rotation shaft demountably attached
15 to the top end of said spindle means for rotation therewith, said rotation shaft forming the top end of said drive shaft means.

57. A mechanism as claimed in Claim 56 wherein
20 said rotation shaft, said spider means, said elongated tube of said mounting means and said stand means are formed of a transparent material for the transmission of heating radiation.

25 58. A mechanism as claimed in Claim 27 wherein said drive means comprises:

a) input means for supplying an input signal having a predetermined time duration;

b) a variable speed motor coupled for
30 rotating said drive shaft means;

c) indicator means mounted on said drive shaft means for rotation therewith to provide said

drive shaft means with a predetermined home position;

d) means responsive to the presence of said input signal for generating a first control signal which operates said motor for rotating said drive shaft means at a relatively high speed and terminating said first control signal upon termination of said input signal;

e) means responsive to the termination of said first control signal which operates said motor for rotating said drive shaft means at a relatively slower speed; and

f) sensor means responsive to the presence of said second control signal for detecting the home position of said drive shaft means and terminating said second control signal to stop the operation of said motor and the rotation of said drive shaft means when said drive shaft means is in the home position thereof.

59. A chemical vapor deposition mechanism comprising:

a) a reaction chamber defining a reactant gas flow path therethrough and having a bottom surface with a tubular shaft depending therefrom;

b) drive shaft means defining a rotational axis, said drive shaft means having a top end disposed in said reaction chamber and depending in spaced coaxial relationship through the tubular shaft thereof to provide an intermediate portion and a lower portion which extends below the tubular shaft of said reaction chamber;

c) a support plate in downwardly spaced

relationship with said reaction chamber and defining an opening which is coaxial with said drive shaft means;

d) mounting means on said support plate and attached to the tubular shaft of said reaction chamber, said mounting means defining an axial opening which is coaxial with the opening of said support plate and through which said drive means axially extends;

e) bearing means dependingly attached to said mounting means in circumscribing engagement with the intermediate portion of said drive shaft means for supporting and rotatable journaling of said drive shaft means;

f) drive means coupled to the lower end of said drive shaft means for rotational driving thereof;

g) spider means on the top end of said drive shaft means for rotation therewith; and

h) a susceptor defining a top surface for demountably receiving a substrate for deposition purposes in a position wherein the center of the substrate is in a substantially aligned overlaying relationship with the center of said susceptor, said susceptor being mounted on said spider means for rotation therewith and being supported thereby in a position wherein the rotational axis off said drive means is normal with respect to the center of said susceptor.

60. A chemical vapor deposition mechanism as claimed in Claim 59 and further comprising:

a) said mounting means being in sealed attachment with the tubular shaft of said reaction chamber with the axial opening of said mounting means being in communication with the inside of the tubular
5 shaft of said reaction chamber; and

b) said mounting means including means for receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft into said reaction chamber for
10 inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of said reaction chamber.

61. A chemical vapor deposition mechanism as
15 claimed in Claim 59 and further comprising:

a) said mounting means being in sealed attachment with the tubular shaft of said reaction chamber with the axial opening of said mounting means being in communication with the inside of the tubular
20 shaft of said reaction chamber;

b) said susceptor having a blind cavity in the center of its bottom surface;

c) said drive shaft means having an axial bore and passage means extending between its axial
25 bore and the axial opening of said mounting means;

d) temperature sensing means in a spaced coaxial position in the axial bore of said drive shaft means for sensing the temperature in the center of said susceptor and extending therefrom into the
30 blind cavity of said susceptor and producing a signal indicative of that sensed temperature; and

e) said mounting means including means for

receiving an inert gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of said reaction chamber and the axial bore of said driveshaft means for inhibiting the flow
5 of reactant gas in the area below said susceptor and into the tubular shaft of said reaction chamber and into the axial bore of said drive shaft means.

62. A mechanism as claimed in Claim 61 wherein
10 said temperature sensing means comprises:

a) an elongated tubular sheath having a closed end and an open end; and

b) a thermocouple located in the closed end of said sheath, said thermocouple having
15 conductive wires extending therefrom through said tubular sheath and exiting the open end of said sheath.

63. A mechanism as claimed in Claim 62 and
20 further comprising a slip ring structure having a rotatable portion connected to the lower end of said drive shaft means, said conductive wires of said thermocouple being connected to the rotatable portion of said slip ring structure, said slip ring structure
25 having a non-rotatable portion in slip ring engagement with the rotatable portion thereof and having conductive wire extending therefrom for conducting the signal from said thermocouple to a point of use.

30

64. A chemical vapor deposition mechanism as claimed in Claim 59 and further comprising:

a) said mounting means being in sealed attachment with the tubular shaft of said reaction chamber with the axial opening of said mounting means being in communication with the inside of the tubular
5 shaft of said reaction chamber;

b) said susceptor having a central aperture formed therethrough;

c) said drive shaft means having an axial bore and passage means extending from the axial bore
10 thereof to the axial opening of said mounting means, said drive shaft means being disposed so that the open upper end of its axial bore is proximate the central aperture of said susceptor for receiving radiant heat from the center of the substrate when
15 the substrate is mounted on said susceptor;

d) window means on said drive shaft means for sealed closing of the lower end of the axial bore thereof, said window means being transparent to the wavelengths of radiant heat received in the open
20 upper end of the axial bore of said drive shaft means;

e) a radiation pyrometer for sensing the temperature of the radiant heat transmitted through said window means and producing a signal indicative
25 of that sensed temperature; and

f) said mounting means including means for receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of said reaction chamber and the axial
30 bore of said drive shaft means for inhibiting the flow of reactant gas into the area below said susceptor and into the tubular shaft of said reaction

chamber and into the axial bore of said drive shaft means.

65. A chemical vapor deposition mechanism as claimed in Claim 64 wherein said window means includes a lens formed of magnesium fluoride.

66. A chemical vapor deposition mechanism as claimed in Claim 64 wherein said window means includes a lens formed of calcium fluoride.

67. A mechanism as claimed in Claim 59 wherein said mounting means is adjustable on said support plate for setting the perpendicularity and alignment of said drive shaft means relative to the reaction chamber and the depending tubular shaft thereof.

68. A mechanism as claimed in Claim 59 and further comprising:

a) elevating means coupled to said support plate for vertically moving said mounting means, said bearing means, said drive shaft means, said spider means and said susceptor as an entity relative to the reaction chamber; and

b) adjustment means on said drive shaft means and on said bearing means for axial adjustment of said drive shaft means relative to said bearing means, said elevating means and said adjustment means cooperatively interacting to permit optimum positioning of said susceptor in the reactant gas flow path of the reaction chamber.

69. A mechanism as claimed in Claim 59 wherein said drive shaft means comprises:

a) an elongated spindle means forming the intermediate portion of said drive shaft means which
5 is supported and rotatably journaled in said bearing means and forming the lower end of said drive shaft means; and

b) a rotation shaft demountably attached to the top end of said spindle means for rotation
10 therewith, said rotation shaft forming the top end of said drive shaft means.

70. A mechanism as claimed in Claim 69 wherein said rotation shaft and said spider means are formed
15 of a transparent material for the transmission of heating radiation.

71. A mechanism as claimed in Claim 59 wherein said susceptor is of circular substantially planar
20 configuration with a central recess formed in the top surface for receiving the substrate and providing positional stability thereof.

72. A mechanism as claimed in Claim 59 wherein
25 said susceptor is of circular substantially planar configuration with a plurality of concentric grooves of varying diameters and a plurality of radial channels formed in the top surface thereof to provide positional stability of the substrate receivable
30 thereon.

73. A mechanism as claimed in Claim 59 and

further comprising:

a) said mounting means being in sealed attachment to the tubular shaft of said reaction chamber with the axial opening of said mounting means
5 being in communication with the inside of the tubular shaft of said reaction chamber;

b) said mounting means including an elongated tube extending axially upwardly therefrom in spaced coaxial relationship with said drive shaft
10 means and in a spaced coaxial position within the tubular shaft of said reaction chamber, said elongated tube having a top end which is disposed between the bottom surface of said reaction chamber and said spider means;
15 c) stand means attached to the top end of said elongated tube of said mounting means;

d) a ring structure means supported on said stand means in a fixed position which is in concentric surrounding relationship with said
20 susceptor; and

e) at least one temperature sensing means in said ring structure means for sensing the temperature at a point on said ring structure means proximate the periphery of said susceptor and
25 producing a signal indicative of that sensed temperature.

74. A mechanism as claimed in Claim 73 wherein said temperature sensing means comprises:
30 a) an elongated tubular sheath having a closed end and an open end; and

b) a thermocouple located in the closed

end of said sheath and having conductive wires extending therefrom through said sheath and exiting through the open end of said sheath for conducting the signal from said thermocouple to a point of use.

75. A mechanism as claimed in Claim 73 and further comprising, said mounting means including means for receiving a purge gas under elevated pressure from a remote source and directing it upwardly through the tubular shaft of said reaction chamber and upwardly through the elongated tube of said mounting means for inhibiting the flow of reactant gas in the area below said susceptor and into said elongated tube of said mounting means and into the tubular shaft of said reaction chamber.

76. A mechanism as claimed in Claim 73 and further comprising:

a) said susceptor having a blind cavity formed centrally in its bottom surface;

b) said drive shaft means having an axial bore; and

c) temperature sensing means disposed in a spaced coaxial position within the axial bore of said drive shaft means and extending from the top thereof into the blind cavity of said susceptor for sensing the temperature at the center of said susceptor and producing a signal indicative of that sensed temperature.

77. A mechanism as claimed in Claim 76 and further comprising,

a) said drive shaft means including passage means extending from the axial bore thereof to the axial opening of said mounting means; and

b) said mounting means including means for receiving an inert gas under elevated pressure from a remote source and directing it upwardly through the tubular shaft of said reaction chamber, through the elongated tube of said mounting means and through the axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of said reaction chamber, into the elongated tube of said mounting means and into the axial bore of said drive shaft means.

78. A mechanism as claimed in Claim 76 wherein said temperature sensing means comprises:

a) an elongated tubular sheath having a closed end and an open end; and

b) a thermocouple located in the closed end of said sheath, said thermocouple having conductive wires extending therefrom through said tubular sheath and exiting the open end of said sheath.

79. A mechanism as claimed in Claim 78 and further comprising a slip ring structure having a rotatable portion connected to the lower end of said drive shaft means, said conductive wires of said thermocouple being connected to the rotatable portion of said slip ring structure, said slip ring structure having a non-rotatable portion in slip ring

engagement with the rotatable portion thereof and having conductive wire extending therefrom for conducting the signal from said thermocouple to a point of use.

5

80. A mechanism as claimed in Claim 73 and further comprising:

a) said susceptor having an aperture formed centrally therethrough;

10 b) said drive shaft means defining an axial bore for receiving radiant heat from the center of the substrate through the aperture of said susceptor when the substrate is mounted thereon and transmitting the radiant heat through the axial bore

15 of said drive shaft means;

c) window means on said drive shaft means for sealed closing of the lower end of the axial bore thereof, said window means being transparent to the wavelengths of the radiant heat transmitted

20 through the axial bore of said drive shaft means; and

d) a radiation pyrometer for sensing the temperature of the radiant heat transmitted through said window means and producing a signal indicative thereof.

25

81. A mechanism as claimed in Claim 80 wherein said window means includes a lens formed of magnesium fluoride.

30 82. A mechanism as claimed in Claim 80 wherein said window means includes a lens formed of calcium fluoride.

83. A mechanism as claimed in Claim 80 and further comprising:

a) said drive shaft means including passage means extending from the axial bore thereof
5 to the axial opening of said mounting means; and

b) said mounting means including means for receiving a purge gas at elevated pressure from a remote source and directing it upwardly through the tubular shaft of said reaction chamber through the
10 elongated tube of said mounting means and through the axial bore of said drive shaft means for inhibiting the flow of reactant gas in the area below said susceptor and into the tubular shaft of said reaction chamber and into the elongated tube of said mounting
15 means and into the axial bore of said drive shaft means.

84. A mechanism as claimed in Claim 73 wherein said mounting means is adjustable on said support
20 plate for setting the perpendicularity and alignment of said driveshaft means relative to said reaction chamber and the depending tubular shaft thereof.

85. A mechanism as claimed in Claim 73 and
25 further comprising:

a) elevating means coupled to said support plate for vertically moving said mounting means, said bearing means, said drive shaft means, said spider means, said susceptor, said stand means and
30 said ring structure means relative to said reaction chamber; and

b) adjustment means on said drive shaft

means and on said bearing means for axial adjustment of said drive shaft means relative to said bearing means, said elevating means and said adjustment means cooperatively interacting to permit optimum
5 positioning of said susceptor and said ring structure means in the reactant gas flow path of said reaction chamber.

86. A mechanism as claimed in Claim 73 wherein
10 said drive means comprises:

a) an electric motor; and

b) means for driving said motor at adjustably variable speeds.

15 87. A mechanism as claimed in Claim 73 wherein said drive shaft means comprises:

a) an elongated spindle means forming the intermediate portion of said drive shaft means which is supported and rotatably journaled in said bearing
20 means and forming the lower end of said drive shaft means; and

b) a rotation shaft demountably attached to the top end of said spindle means for rotation therewith, said rotation shaft forming the top end of
25 said drive shaft means.

88. A mechanism as claimed in Claim 87 wherein said rotation shaft, said spider means, said elongated tube of said mounting means and said stand
30 means are formed of a transparent material for the transmission of heating radiation.

89. A mechanism as claimed in Claim 59 wherein said drive means comprises:

a) input means for supplying an input signal having a predetermined time duration;

5 b) a variable speed motor coupled for rotating said drive shaft means;

c) indicator means mounted on said drive shaft means for rotation therewith to provide said drive shaft means with a predetermined home position;

10 d) means responsive to the presence of said input signal for generating a first control signal which operates said motor for rotating said drive shaft means at a relatively high speed and terminating said first control signal upon

15 termination of said input signal;

e) means responsive to the termination of said first control signal which operates said motor for rotating said drive shaft means at a relatively slower speed; and

20 f) sensor means responsive to the presence of said second control signal for detecting the home position of said drive shaft means and terminating said second control signal to stop the operation of said motor and the rotation of said

25 drive shaft means when said drive shaft means is in the home position thereof.

30

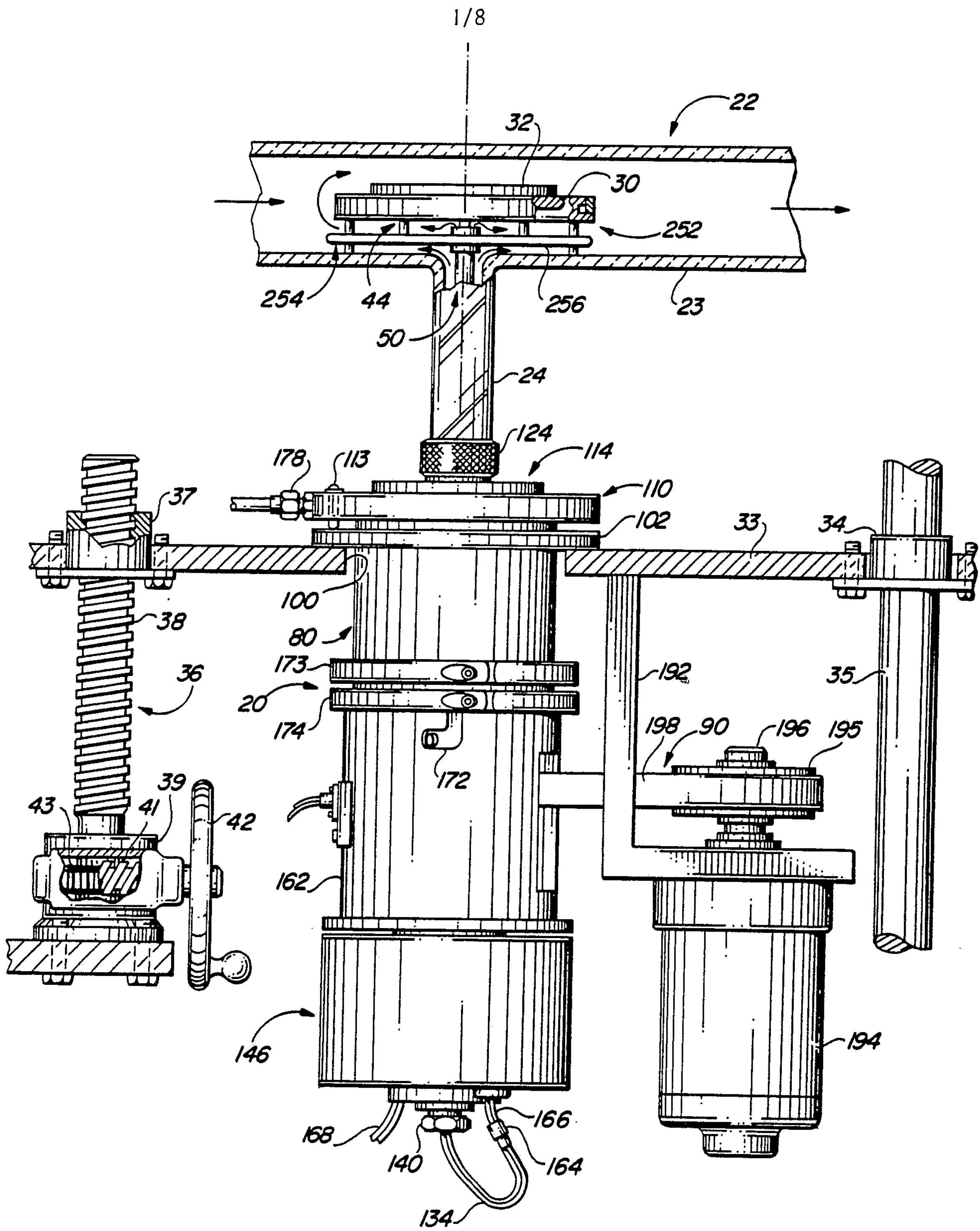


FIG-1

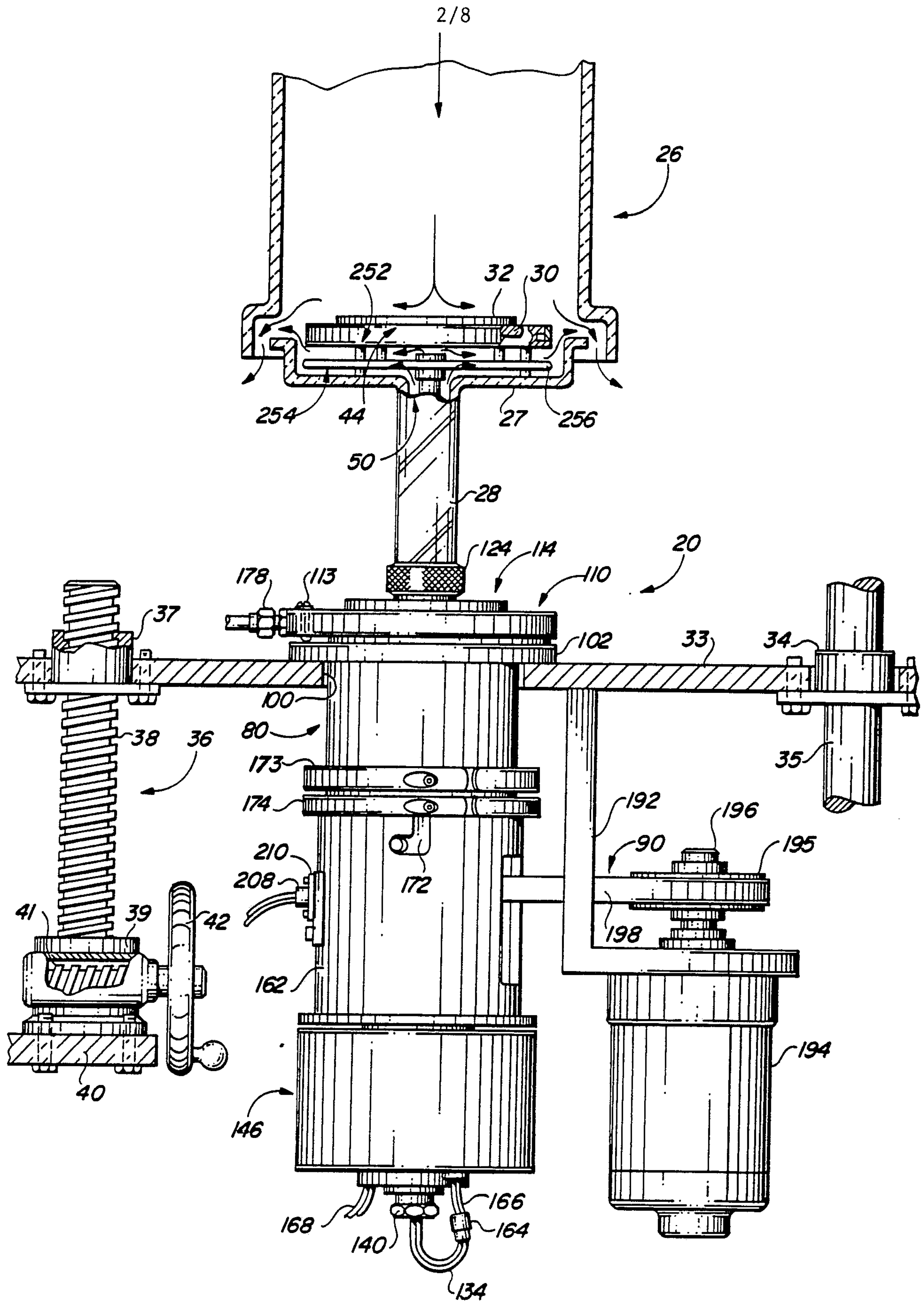


FIG. 2

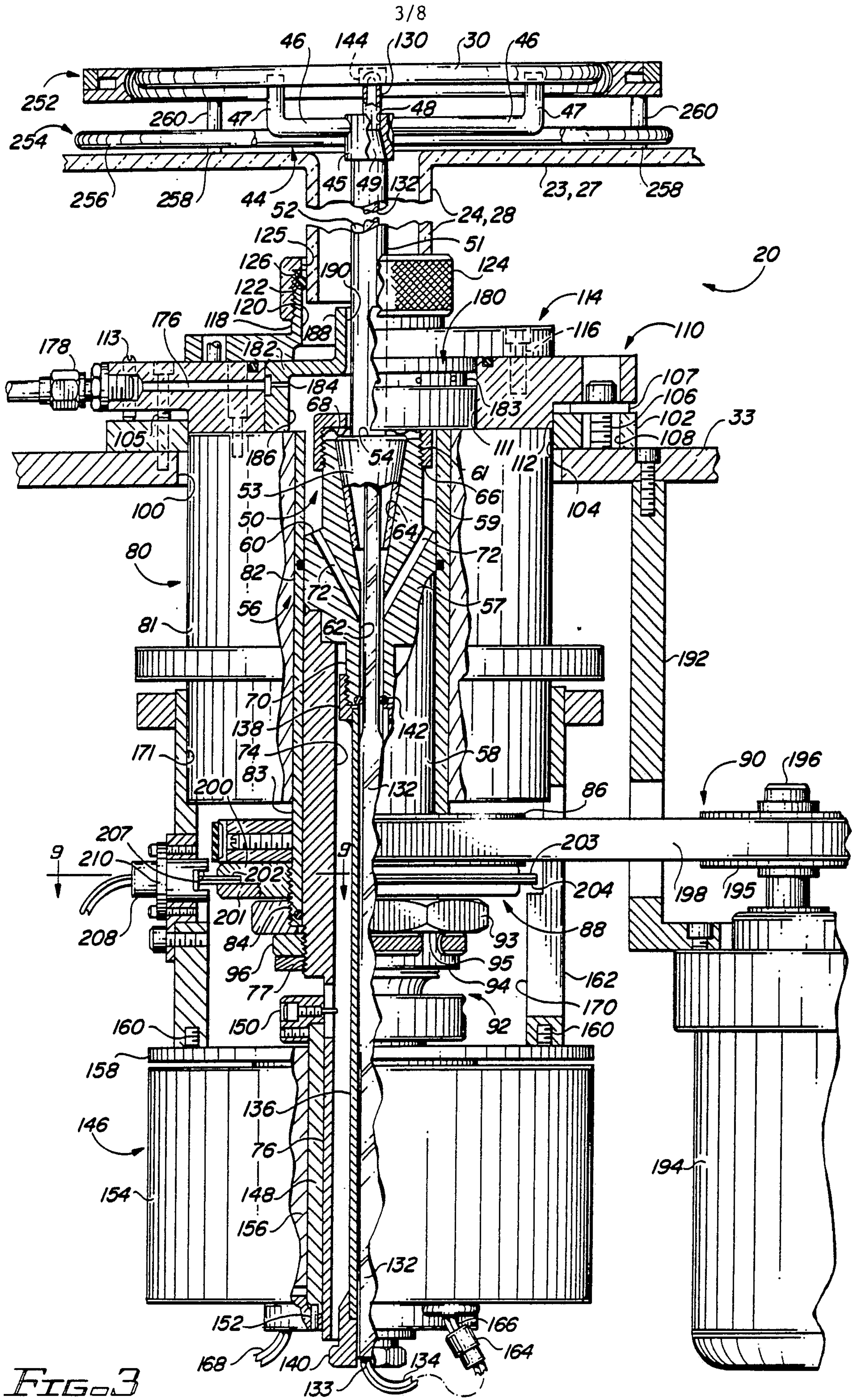
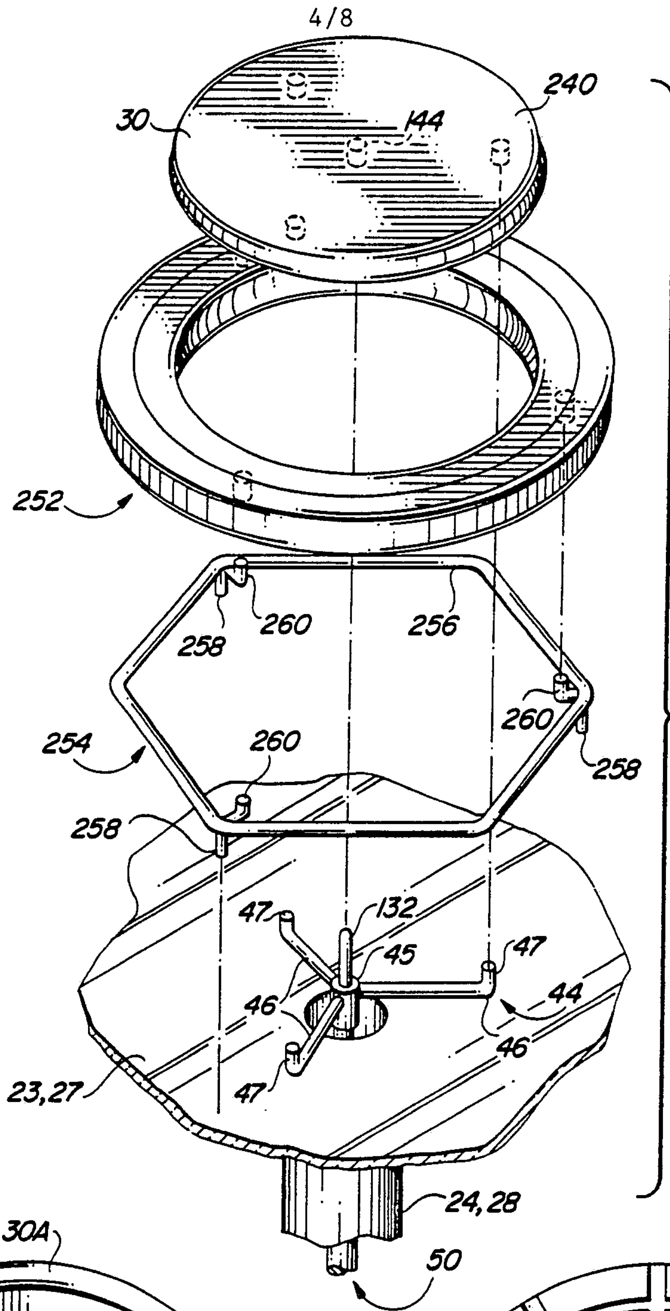


FIG. 3



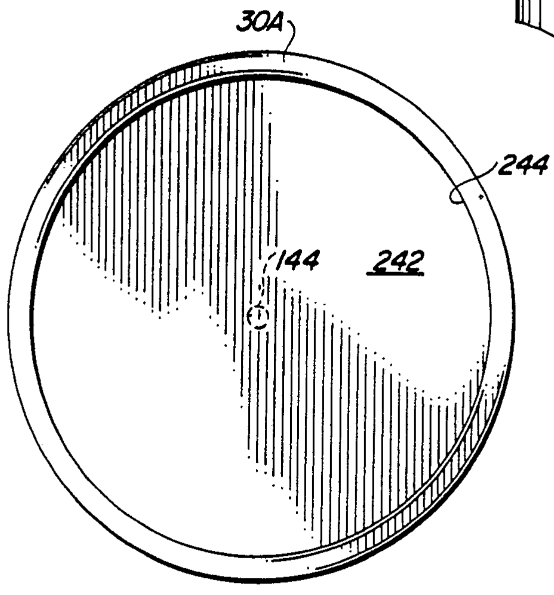


FIG. 7

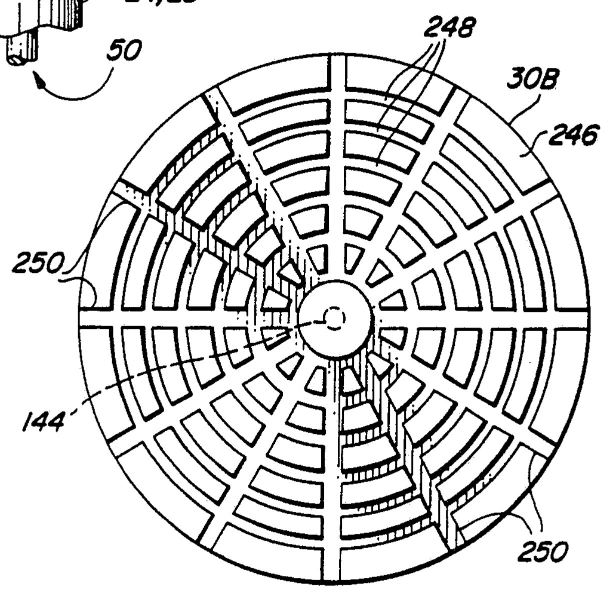


FIG. 8

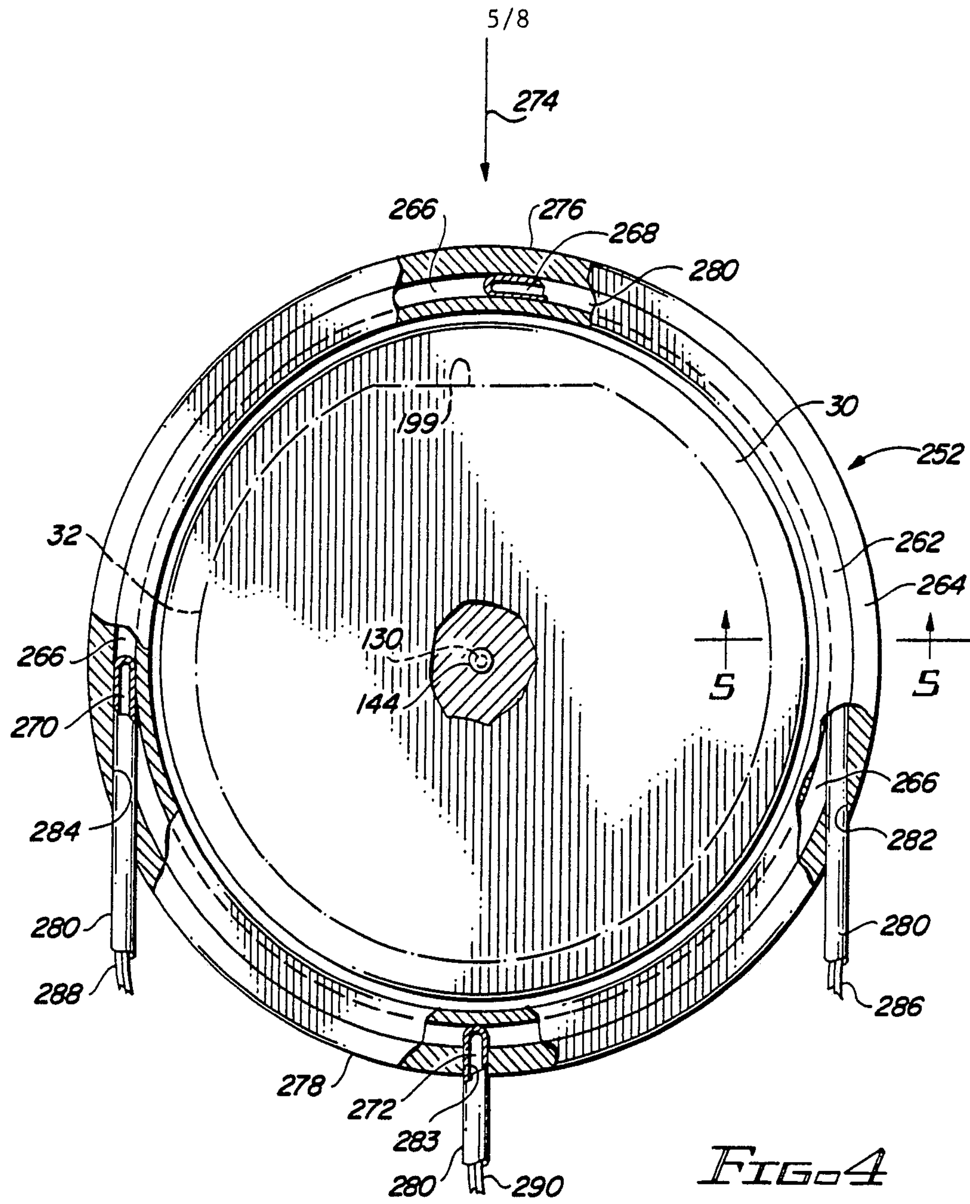


FIG. 4

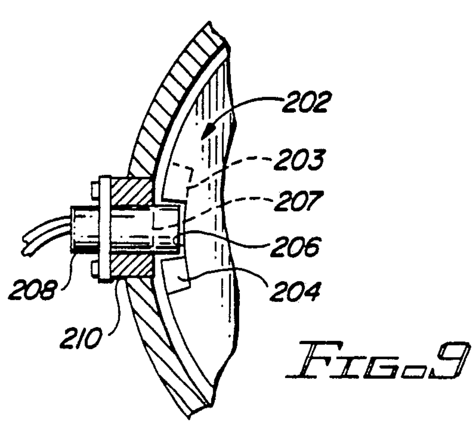


FIG. 9

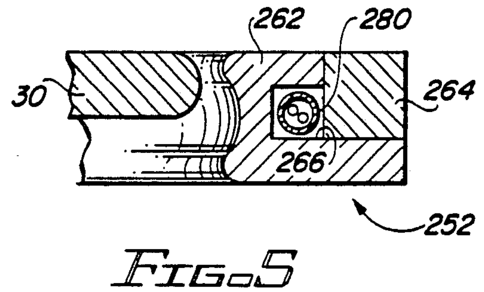


FIG. 5

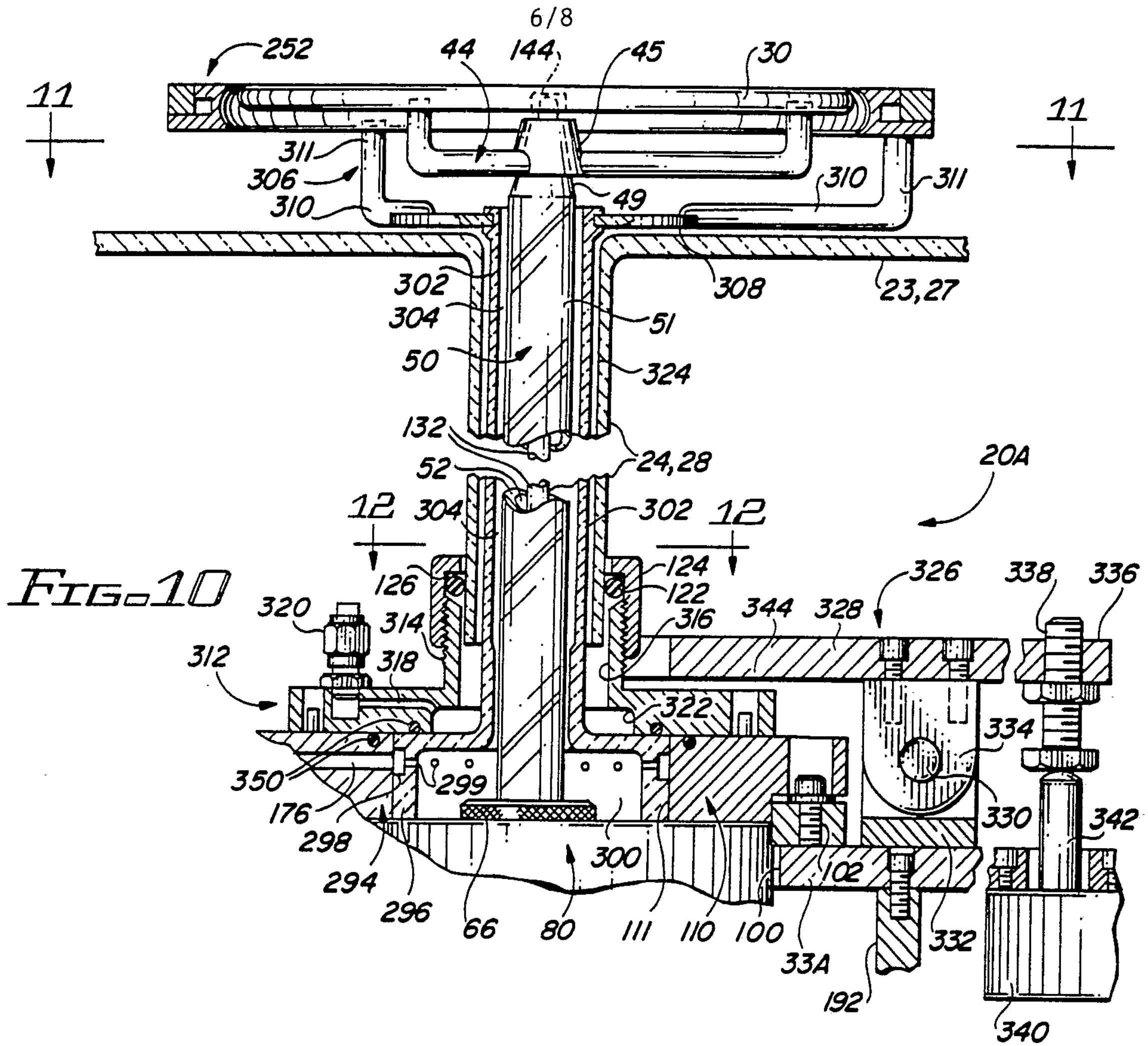


Fig. 10

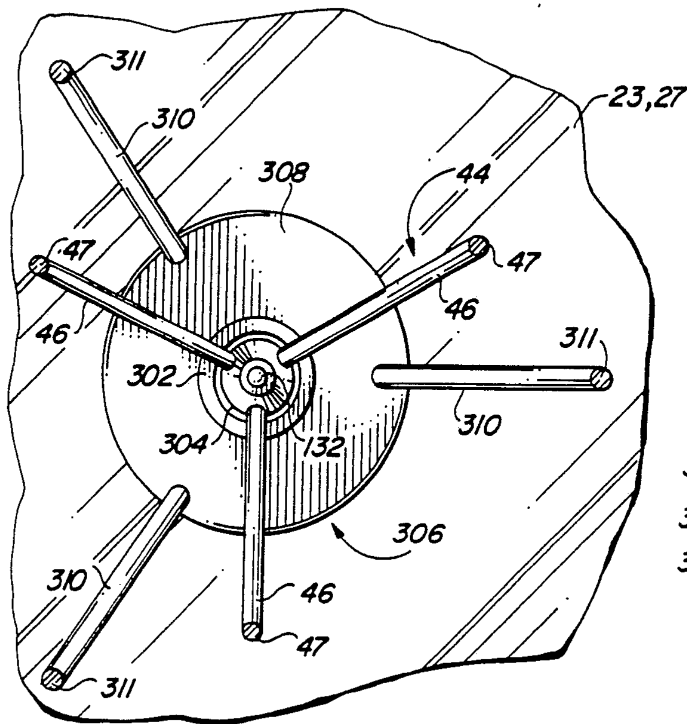


Fig. 11

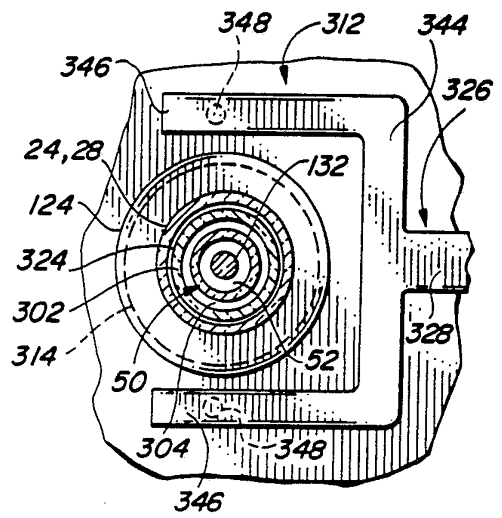


Fig. 12

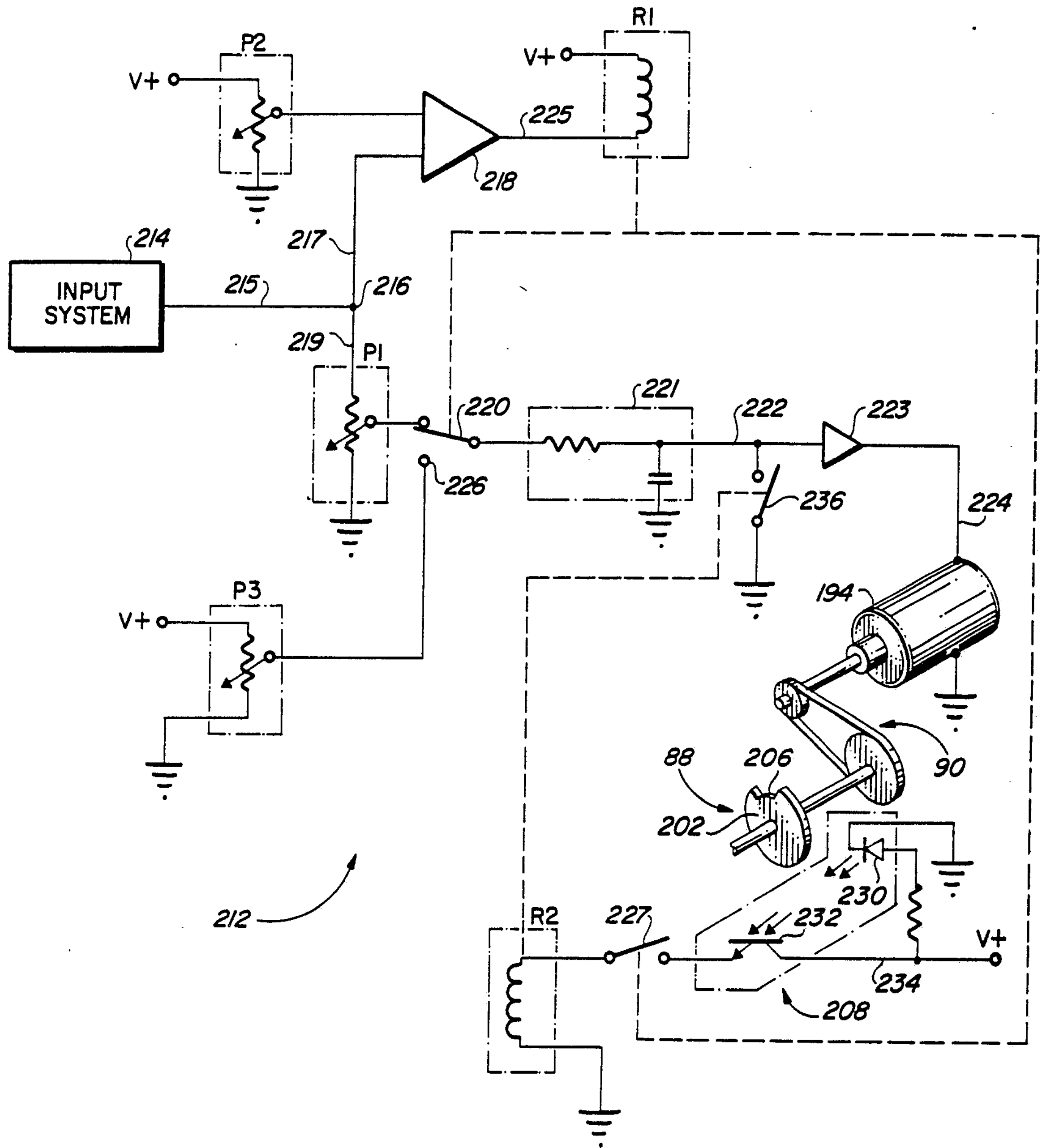


Fig. 13

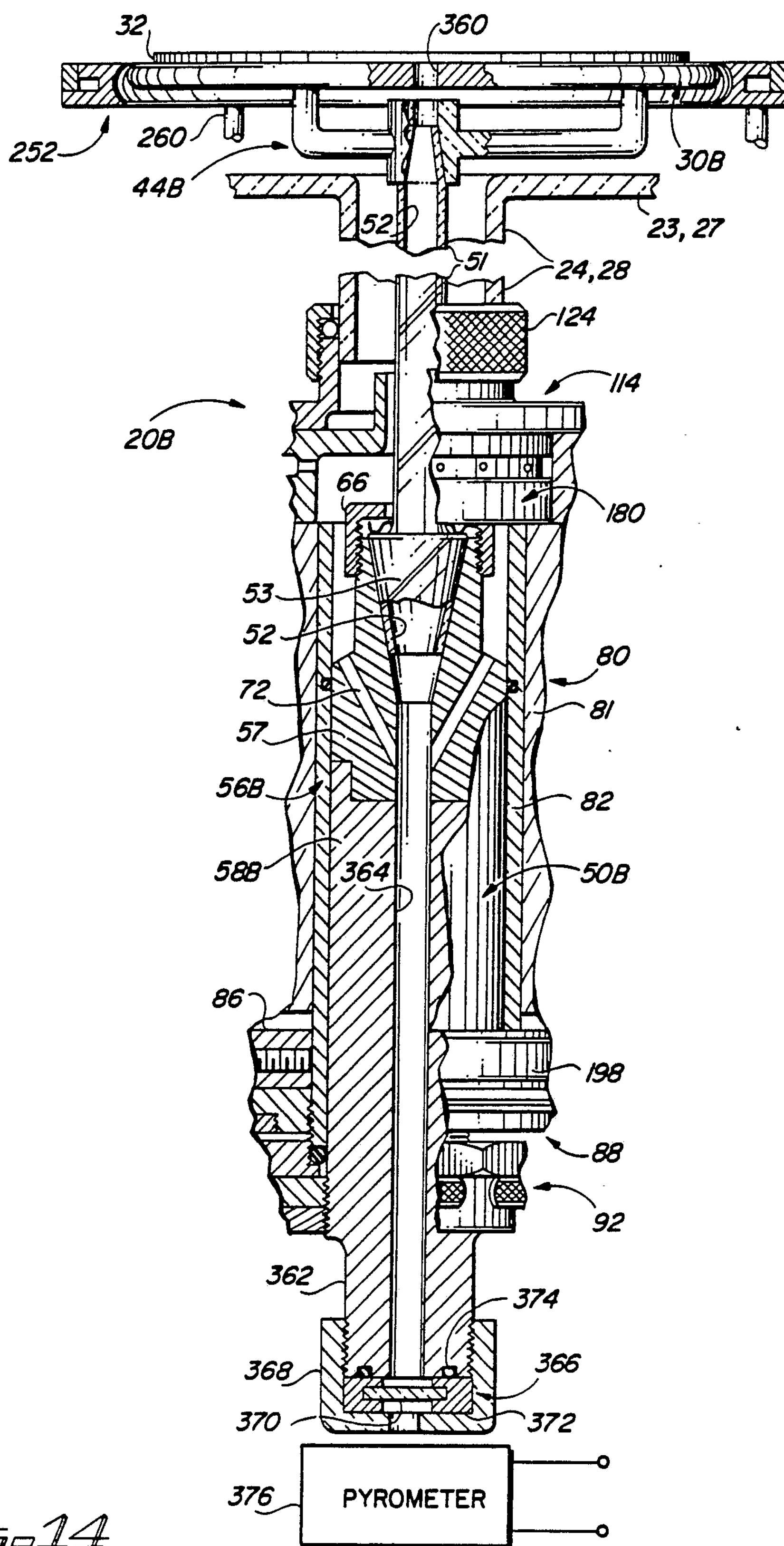


FIG. 14

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US88/01041

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(4) B65G 11/00; B05C 11/00
U.S. CL. 118/666, 730; 193/1

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	118/666, 730; 193/1

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	U.S., A, 4,714,594 (Mircea) 25 June 1985. See the entire document.	1-89

* Special categories of cited documents: [10]

"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.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14 July 1988	29 JUL 1988
International Searching Authority	**Signature of Authorized Officer**
ISA/US	Bernard D. Pianalto (signed) Bernard D. Pianalto

Form PCT/ISA/210 (second sheet) (Rev.11-87)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers , because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

3. ☐ Claim numbers__________, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

I. Claims 1-58 drawn to a mechanism classified in class 193, subclass 1.

II. Claims 59-89 drawn to a vapor deposition mechanism classified in class 118, subclass 666.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☒ No protest accompanied the payment of additional search fees.