

Oct. 23, 1956

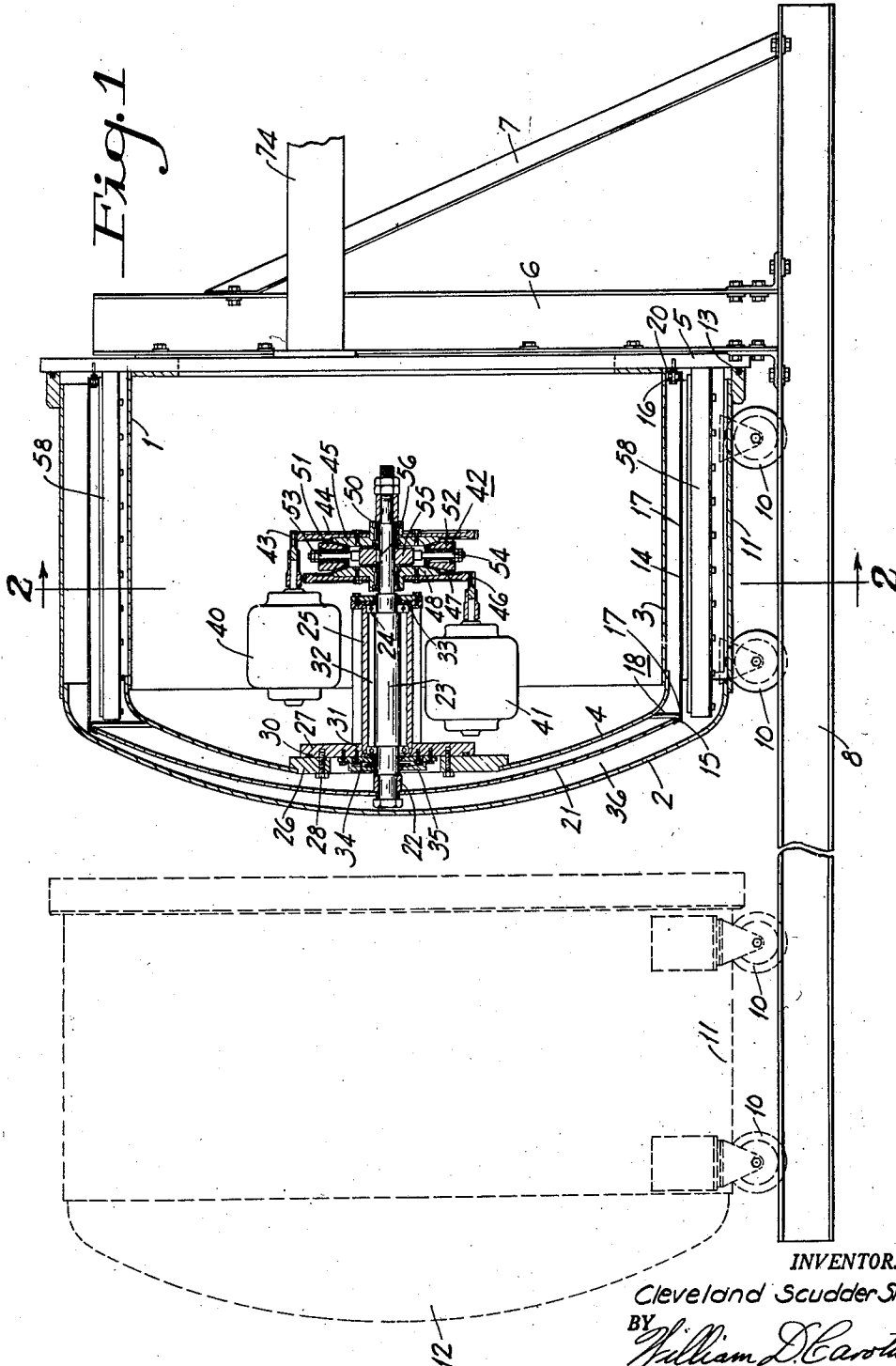
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2,767,682

VAPORIZING APPARATUS FOR PRODUCING SELENIUM RECTIFIERS

Original Filed March 22, 1951

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

Fig. 2

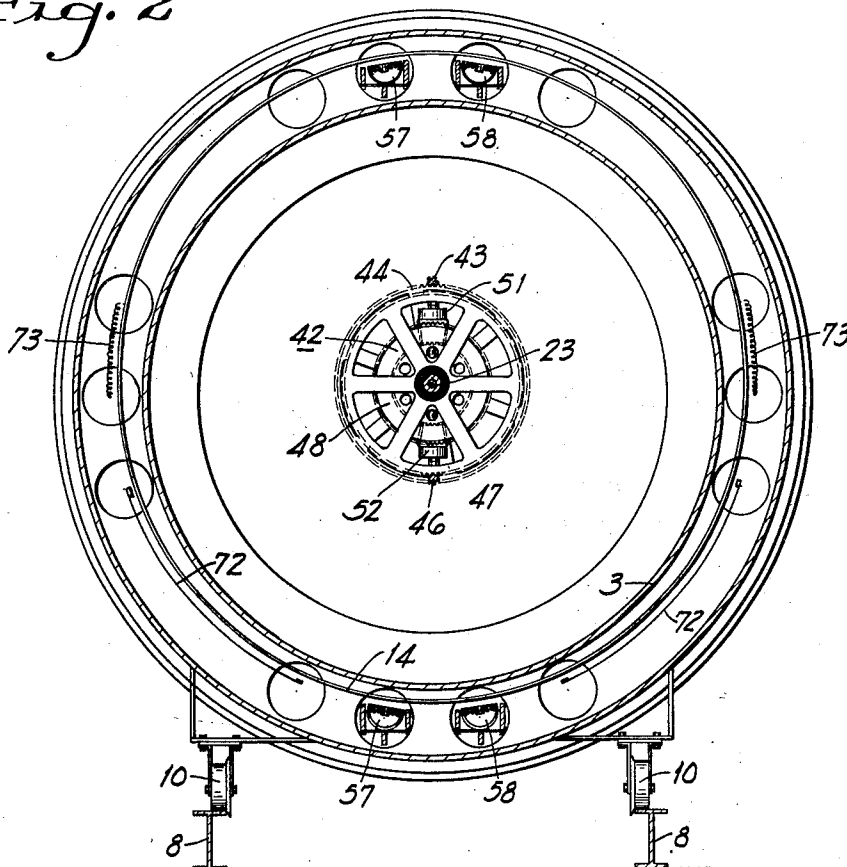
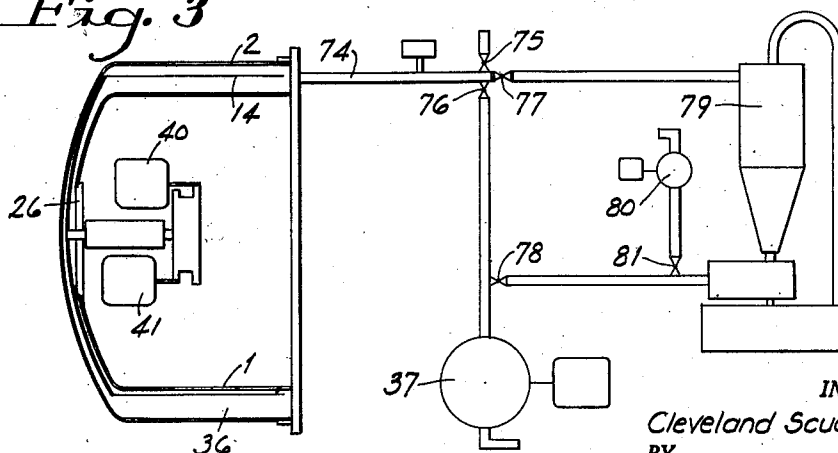


Fig. 3



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4 Sheets-Sheet 3

Fig. 4

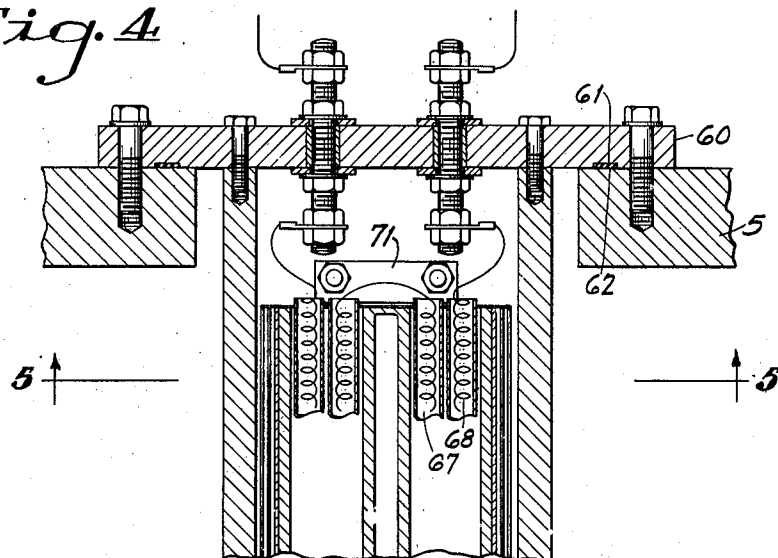
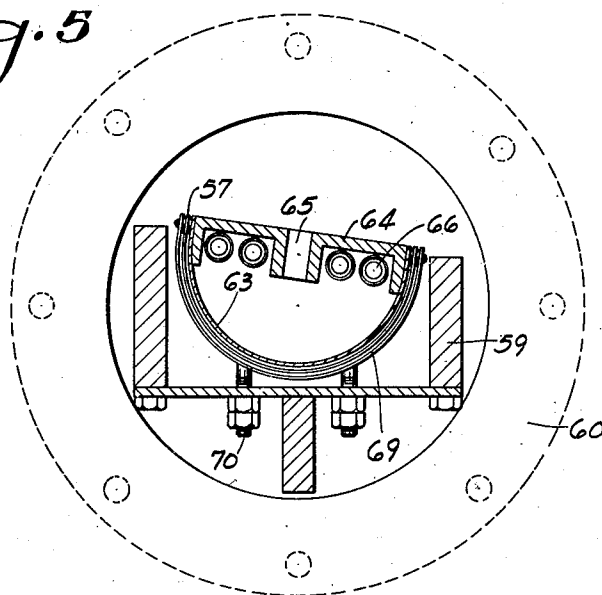


Fig. 5



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4 Sheets-Sheet 4

Fig. 6

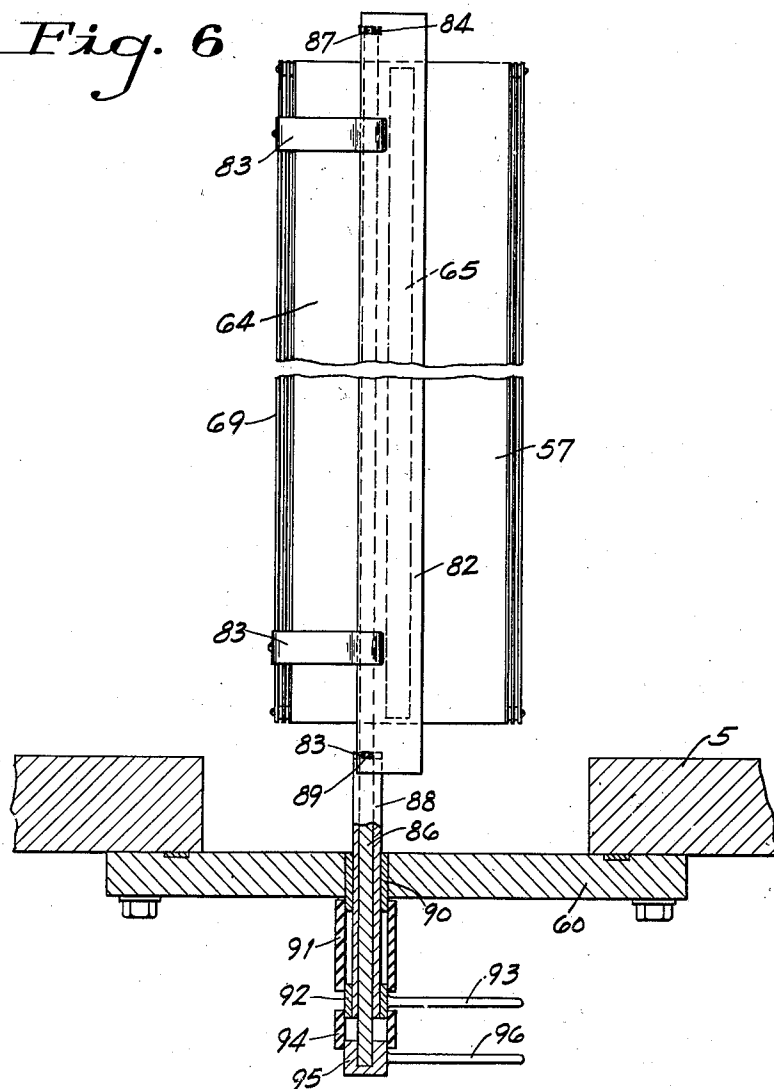
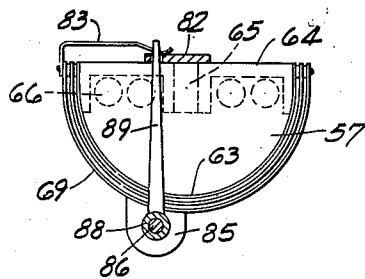


Fig. 7



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2,767,682

VAPORIZING APPARATUS FOR PRODUCING
SELENIUM RECTIFIERS

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Continuation of application Serial No. 217,032, March 22, 1951. This application June 26, 1953, Serial No. 364,461

21 Claims. (Cl. 118—49)

This invention relates generally to apparatus for producing blocking cell devices and more particularly to apparatus for evaporating the semiconducting material on a conductor base in making up blocking cell devices.

This application is a continuation of my application Serial No. 217,032, filed March 22, 1951, and which is now abandoned. The disclosure in the present application is the same as that in the former application, and the claims attached hereto in addition to those formerly allowed are my original invention.

The principal object of this invention is the provision of apparatus for evaporating a semiconducting material such as selenium on a conductor base such as aluminum. This invention contemplates the provision of an annular chamber which can be evacuated and in which a large sheet of the conductor base metal can be mounted for rotation to receive a series of layers of the semiconducting material deposited by evaporation over the full width of the sheet under controlled conditions. Heaters are provided to control the temperature of the sheet and the deposits thereon and other heaters are provided to control the temperature of the evaporators. This device permits accurate control of the speed and direction of rotation of the sheet and the speed may be retained constant. This variable control of speed is obtained by a dual motor drive through a differential gearing where the motors themselves are variable in speed and direction of rotation and are effective singly or in combination when driving through the differential gearing. The rotating conductor base sheet is adjustable relative to the evaporator to vary the space through which the vapors travel in depositing on the sheet. This adjustment may be obtained two ways, by raising or lowering the evaporator or by changing the relative position of the shaft bearing which supports the rotary frame that carries the sheet. The evaporator may also be leveled or tilted to provide a uniform depth of selenium along the length of the evaporator to produce uniform vaporation along the evaporator.

By employing large area sheets, which are subsequently punched and sheared after the blocking cell has been produced thereon, an increased production is obtained at lower costs, by reducing or otherwise controlling the spacing of the vaporizing aperture to the conductor base a materially less degree of vacuum is required. This is an important feature of this invention.

By controlling the speed of rotation and the rate of evaporation one can control the thickness of the layers and composition. Due to the uniform rate of rotation, composition is uniform in the direction of rotation. By suitable lateral adjustment of temperature of the conductor base, good lateral uniformity is also achieved.

Any desired thickness of the semiconducting deposited layers may be made. The layers may be made thick by reducing the speed and any number of layers may be applied. When using selenium these layers are preferably deposited in black amorphous or vitreous form and each layer may be heated to convert it to crystalline form be-

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fore the next layer is deposited. Two or more series of selenium layers are preferably applied in vitreous form.

Other objects and advantages appear in the following description and claims.

The accompanying drawings show, for the purpose of exemplification without limiting the invention or claims thereto, certain practical embodiments of the invention wherein:

Fig. 1 is the view in vertical section of the apparatus comprising this invention.

Fig. 2 is a view in vertical section taken on the line 2—2 of Fig. 1.

Fig. 3 is a diagrammatic view of the apparatus and the exhaust pumping system.

Fig. 4 is an enlarged plan view of an evaporator with parts broken away.

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4.

Fig. 6 is a detailed plan view of a valve controlled selenium evaporator.

Fig. 7 is an end view of the structure shown in Fig. 6.

The apparatus for producing blocking devices as shown in the drawing comprises a vacuum chamber which is constructed of two bell members 1 and 2, the first of which is stationary and the second is mobile. The stationary bell member consists of a cylindrical portion 3 and a disk or head portion 4 welded together and to the heavy metal ring 5 bolted to the upright beam support 6 which is braced by the angle irons 7. The support and the brace 7 are mounted on and secured to the parallel track members 8 which extend outwardly from the bell to support the outer bell member 2 by the rollers 10. The outer bell member 2 comprises the cylindrical member 11 and the head member 12 and is merely a hollow bell-shaped member that can be telescoped over the inner bell member 1 and have its rim seal against the annular ring plate 5 as indicated at 13. The outer bell member 2 may be of the order of six feet in diameter and approximately three and one-half feet deep.

The conductor base member 14 which is preferably an aluminum sheet may be of the order of 37½" wide and 208" long. For convenience this sheet may be divided into two sections, each measuring 104" long or into smaller sheets if desired. The sheet 14 is wrapped around two similar hoops 15 and 16 which are spaced apart. Each hoop 15 and 16 carries the sheets 14 spaced from the inner bell 1 as shown at 17 to allow for expansion and contraction of the sheets. The hoops 15 and 16 are made of channel irons with the channel facing toward the axis of the device. The channel hoop 16 is mounted on a series of rollers 20 rotatably mounted on outwardly extending stub shafts secured to the ring 5. This rotary support holds the ring 16 in position relative to its axis. The hoop 15 is secured to the outer perimeter of the disk wheel 21 which is welded to the hub 22 at its center. This conductor plate support is referred to as the frame 18. The hub 22 is slipped over and keyed to the hollow shaft 23 which is rotatably mounted on the spaced bearings 24 in the housing 25. Thus the frame 18 is secured relative to the hollow shaft 23.

The stationary head member 4 has an enlarged opening therein to which is secured by welding the disk 26. The axis of the disk 26 is approximately one inch and a half above the axis of the inner bell member 1. A flange component 27 of the shaft housing 25 is attached to the disk 26 by the bolts 28. The bolts 28 may be secured in bolt holes lying in either of two circles, one of which is offset one-quarter of an inch and the other three-quarters of an inch from the axis of the component disk 27. Thus the shaft 23 can be located above the axis of the inner bell member 1 by any of the following distances; three-quarters of an inch, one and one-quarter of an inch, one

and three-quarters of an inch and two and one-quarter inches. Finer adjustments can be achieved between the three-quarters inch and two and one-quarter inch variation by rotating the member 27 to any of six positions between the maximum up and down locations for either of the bolt circles. This transverse adjustment of the disk 27 that carries the shaft 23 and the frame 18 permits one to obtain different clearances above and below the frame 18 for applicators of different sizes. The component disk member 27 is sealed to the disk 26 by means of the sealing gasket member 30, which is set in a circular groove in the disk member 27. The inner face of the disk 27 is machined to receive the ball bearing race 31 which supports one of the bearing members 24 and which supports the shaft 23 within the housing 25. The space between the shaft and the housing, as indicated at 32, is sealed at either end thereof. One seal, as indicated at 33, is on the inner end of the housing, whereas the other seals indicated at 34 and 35 are in tandem to each other with respect to the space between the telescopic bell housing members. Thus three seals are provided between the atmosphere and the annular chamber which is indicated at 36 between the two bell housings. The space 32 within the housing 25 surrounding the shaft 23 is also filled with a vacuum pump oil to insure a vacuum and to prevent air from entering the vacuum system. The seals 34 and 35 are placed in tandem and the space between these seals is pumped to a rough vacuum by connecting it directly to a roughing pump such as indicated at 37.

The rotary frame 18 is driven by rotating the shaft 23 with the combined action of the motors 40 and 41 together with the differential gearing 42 connected intermediate of said motors. The motors 40 and 41 are mounted on suitable supports in the stationary inner bell member. The motor 40 may be a three-phase, four-speed induction motor with no load speeds of approximately 1800, 1200, 900 and 600 R. P. M. This motor is provided with a pinion 43 that meshes with the gear 44. The pinion is provided with five teeth and the gear 44 has two hundred teeth. The gear 44 has secured thereto a beveled gear 45 and therefore rotates at a speed one-fortieth of the motor speeds as hereinbefore stated.

The motor member 41 may likewise be a three-phase, four-speed motor similar to the motor 40 and is provided with a pinion 46 having six teeth and a gear which in turn is connected to the gear 47 having 180 teeth. A beveled gear 48 is secured to the spur gear 47 and therefore rotates at one-thirtieth of the motor speeds or at an R. P. M. of 60, 40, 30 and 20. Each of the gears 44 and 47 is rotatably mounted on the bearings 50 which are in turn mounted on the shaft 23. The beveled gears 51 and 52, which mesh with both of the beveled gears 45 and 48, are free to rotate on the radial shafts 53 and 54 which are in turn secured to the hub 55 that is keyed to the shaft 23 as indicated at 56. The shaft 23 and consequently the conductor base 14 are thus rotated at a speed of one-half the algebraic sum of the speeds of the beveled gears 45 and 48. A switch is provided to permit the selection of any of the four speeds for forward and reverse for either of the two motors. There is also provided a means for passing direct current through the motor windings for obtaining a virtually zero speed for either motor. The shaft speeds may be obtained from a range of one R. P. M. to 30 R. P. M. in precise and minute steps. It is important in this invention to maintain not only a uniform speed, but a predetermined speed which will enable one to establish the actual thickness of the layer as it is being applied. In other words, the slower the speed the thicker the layer as applied at any one time and the thickness of the layers may be adjusted from one phase of the deposit cycle to another.

As a typical example; one may employ a speed of approximately five R. P. M. in an evaporation period of time of twenty minutes, and thus obtain a series of one hundred layers. By selecting a slower speed one can in-

crease the thickness of each of the layers or by increasing the speed of the rotating sheet, one may increase the number of layers but decrease the thickness of each layer. Thus the exact control may be had of the selenium deposits.

Two sets of selenium evaporators 57 and 58 may be provided in each chamber; one set at the bottom to coat the outer surface of the plate 14 and the other set at the top to coat the inner surface of the plate 14 or to coat one surface of two sheets at one time. Evaporators are shown herein but the selenium layers could be sprayed or otherwise applied as taught in the prior art. The use of the term applicator in the claims includes evaporating as well as other different modes of applying the selenium as the plate or plates are being moved.

The selenium evaporators 57 and 58 are cradled in steel support channels 59 attached to disks 60 which are bolted over a six-inch diameter hole in the ring 5 and sealed by rubber gaskets 61 in the circular grooves 62 as shown in Figs. 4 and 5.

Each evaporator consists of a long stainless steel semicylinder 63 closed at the top by the cover member 64 which is provided with the uniform slot opening 65 extending the full width of the evaporator. Each of the evaporators is provided with a plurality of radiant heaters 66, each of which has an exterior quartz tubing 67 that contains a closed packed coil of heater wire 68. The heaters 66 extend the entire length of the evaporators. Shields 69 surround the semicylinder 63 to reduce the heat from the evaporator.

The evaporator can be adjusted to level the selenium thickness therein by four adjusting screws 70 attached to the angles 71. It may be noted that the evaporators are so tilted that the surface of the evaporator is tangent to the rotating plates 14 which are to receive the selenium. This permits a minimum free path for selenium to travel which may be one inch or less and permits successful deposition at pressures in the order of, or at least as high as, ten microns of mercury. This may be compared to the pressure of the order of one-tenth of a micron required by other vacuum methods wherein the selenium must travel for distances of many inches or as far as 12 inches or more from the evaporator to the conducting plate.

The sheets 14 are heated by two main radiant heaters 72 and by a myriad of auxiliary radiant heaters 73 which are spaced at equal intervals along a line parallel to the axis of rotation outside the frame carrying the plates. There may be as many as twenty-four or more of these heaters distributed between the ends of the radiant heaters 72.

All of these heaters may be independently controlled by a suitable apparatus such as thermocouples for each heater engaging or mounted adjacent to the sheets 14 aligned with its corresponding heater to provide a uniform temperature across the width of the sheet. The control wires of the thermocouples will pass through the hollow shaft 23 where they may be connected exteriorly by means of slip rings not shown to suitable control apparatus.

The selenium deposited by this apparatus is first mixed in batch form and it is preferable to employ a high concentration of halogen in one batch and a low concentration of halogen in another batch of selenium and place the same in each of the two evaporators 57 and 58. The sheets 14 are attached to the periphery of the frame. The batches may consist of amounts such as a thousand grams of concentrated halogen-selenium wherein the concentration is about one atom of halogen to two thousand atoms of selenium and which has been melted and held molten and is then poured through a heated funnel into the evaporator 57. The second selenium batch may consist of approximately 150 grams of selenium containing one halogen atom to 20,000 selenium atoms and is similarly poured into the evaporator 58. Air jets are inserted in the space between the

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evaporators and the support members and the air is turned on so as to cool the selenium rapidly enough to keep it in the black vitreous form.

When the selenium evaporator is sufficiently cool the air is turned off and the air nozzle is removed and electric power is applied to the heaters for the purpose of heating the plates 14 from room temperature.

As shown in Fig. 3 the vacuum chamber 36 is connected by the pipes 74 to the valves 75, 76 and 77; the valve 75 being connected directly to the atmosphere whereas the valves 76 and 77 are directed to the exhausting equipment. The outer bell member 2 is telescoped over the inner bell member 1 and sealed in place so that the annular chamber 36 retains a conductor base plate on the frame for rotation. The selenium evaporators have been filled with the proper amount of selenium to be deposited and the evaporator heaters are connected for supplying electric current thereto and for regulating the temperature conditions under which the selenium is evaporated.

When one bell member is closed over the other bell member and sealed on the annular ring 5, the frame 18 is rotated and the valve 75 is closed, thus shutting off the chamber 36 to the atmosphere and valve 76 is open to permit the mechanical vacuum pump 37 to partially reduce the air pressure within the chamber 36. At this time heat is supplied to the plate heaters and after the closing of the valve 75 the pressure is reduced to several hundred microns of mercury and the valve 76 is closed. Valves 77 and 78 are both opened to connect the vapor pump 79 to pumping the vacuum system with the mechanical pump backing up the vapor pump. Under these conditions the selenium is then vaporized and deposited on the sheet 14.

A mechanical holding pump 80 is connected through a normally open valve 81 to maintain a vacuum on the vapor pump 79 when the equipment is idle or when the roughing pump 37 is pumping down the system.

The selenium evaporators 57 and 58 may be provided with a control valve 82 shown in Figs. 6 and 7 to regulate the degree of opening of the slot 65 or to close it off entirely and prevent evaporation of the selenium mix therein. The valve 82 is a flat plate that is wider and longer than the slot 65 which it covers. A series of finger springs 83 is attached to the side of the evaporator and overhangs the cover 64 but is short of the slot 65 and bears against the top surface of the valve to hold it down against the cover. As shown in Fig. 6 the valve is closed and has a hole 83 in one end and the hole 84 in its other end. Both project beyond the ends of the evaporator. A pair of downwardly projecting lugs 85 have aligned bearings to receive the shaft 86 which extends through the plate 60 to beyond the other end of the evaporator. The shaft 86 has the upwardly projecting arm 87 secured thereto which extends through the hole 84. A hollow sleeve shaft 88 is journaled on the shaft 86 and has the upwardly extending arm 89 attached thereto. This arm extends through the hole 83. The concentric shafts extend through the sleeve bearing 90 sealed in the plate 60. Thus the bearing extends beyond the plate to provide a seat for the hose 91, the other end of which is fastened to the annular seat on the hub 92 of the operating lever 93. The hub 92 has another annular seat to receive the hose 94 which is likewise sealed on the hub 95 of the operating lever 96. Thus each operating lever is sealed relative to the vacuum chamber.

By simultaneously moving both levers 93 and 96 counterclockwise as viewed in Figs. 6 and 7, the arms 87 and 89 slide the valve 82 back of the slot but keep the valve in alignment with the slot. The degree of opening of the valve in conjunction with the heat applied to the selenium determines the rate of evaporation of the selenium from the bowl 63. By controlling the extent of the valve opening, the temperature of evaporation and the

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speed of rotation of the sheet of conductor material, one may control the number of layers deposited, their thickness and the total amount of selenium deposited on either or both sides of the plate. If there are two plates mounted back to back then a deposit is only made on a single side. If a single plate is mounted in the machine and both sets of evaporators are operated, then selenium is evaporated on both sides of the plate.

If one wishes to vary the amount of selenium from one side of the plate to the other, then one operating lever 93 or 96 may be moved farther than the other and the slot opening will thus be wider at one end than at the other. This controls the rate of evaporation and that side of the sheet opposite the widest slot opening will have a heavier deposit than that part of the sheet opposite the narrowest slot. Yet the number of layers over the whole plate would be the same. Such a gradation in the selenium deposit would have special application and in most instances the slot is kept uniform throughout its length. Under these circumstances the operating levers 93 and 96 can be locked or tied together so that they may operate in unison.

I claim:

1. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, a frame movably mounted about an axis in said annular chamber, motor means to rotate said frame, attaching means to removably secure material receiving means on said frame, and an evaporator means having a passage opening into the chamber adjacent said frame to direct a vapor of material onto said material receiving means while the latter is moving to deposit a series of laminated layers of said depositing material on said material receiving means.

2. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, pump means connected to said chamber to reduce the pressure in said chamber, a frame movably mounted about an axis in said annular chamber, variable speed motor means mounted adjacent one of said shell members and connected to move said frame in said chamber, attaching means to removably secure material receiving means on said frame, and an evaporator means having a passage opening into the chamber adjacent said frame to direct vapors of material onto said material receiving means, while moving to deposit a series of laminated layers of said depositing material on said material receiving means.

3. A semiconducting material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, a frame movably mounted about an axis in said annular chamber, motor means to rotate said frame, attaching means to removably secure material receiving means on said frame, an evaporator means having a passage opening into the chamber adjacent said frame to direct a vapor of semiconducting material onto said material receiving means while the latter is moving to deposit a series of laminated layers of said semiconducting material on said material receiving means, and a controlled heater means in said annular chamber effective to heat the material receiving means and the deposits thereon.

4. A material depositing apparatus comprising an inner

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and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, a frame movably mounted about an axis in said annular chamber, motor means mounted adjacent one of said shell members and connected to move said frame in either direction and at different speeds, attaching means to removably secure material receiving means on said frame, an evaporator means having a passage opening into the chamber adjacent said frame to direct a vapor of material onto said material receiving means while the latter is moving to deposit a series of laminated layers of said depositing material on said material receiving means, and a controlled heater means mounted adjacent said evaporator and effective to heat and vaporize the depositing material in said evaporator.

5. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, pump means connected to said chamber to reduce the pressure in said chamber, a frame movably mounted in said annular chamber, variable speed motor means mounted adjacent one of said shell members and connected to move said frame about an axis in said chamber, attaching means to removably secure material receiving means on said frame, and an evaporator means having a passage opening into the chamber adjacent said frame for directing the escape of vapors across the material receiving means while moving to deposit a series of laminated layers of depositing material across said material receiving means.

6. A material depositing apparatus comprising an inner and an outer bell member detachably mounted relative to each other in spaced telescopic relation, an annular sealing means between said members to seal them relative to each other adjacent their open ends to form an annular sealed chamber between their adjacent surfaces, a shaft extending through and journaled in the closed end of the inner bell and sealed therewith, variable controlling motor means mounted within the inner bell and connected to move said shaft, an arcuate frame mounted on said shaft for rotation in said sealed chamber, attaching means to removably secure a material receiving means on said arcuate frame, an evaporator means for a deposition material having a passage with a slot opening into said chamber for the full width of said material receiving means adjacent thereto, and adjusting means to orient said slot with its opening normal to a tangent of the curvature of the material receiving means on said arcuate frame.

7. A material depositing apparatus comprising an inner and an outer bell member detachably mounted relative to each other in spaced telescopic relation, an annular sealing means between said members to seal them relative to each other adjacent their open ends to form an annular sealed chamber between their adjacent surfaces, a shaft extending through and journaled in the closed end of the inner bell and sealed therewith, motor means mounted within the inner bell and connected to move said shaft, an arcuate frame mounted on said shaft for rotation in said sealed chamber, attaching means to removably secure a material receiving means on said arcuate frame, an evaporator means for a deposition material having a passage with a slot opening into said chamber for the full width of said material receiving means and closely adjacent thereto, and adjusting means to tilt said evaporator to maintain the deposition material with a uniform depth in the evaporator.

8. A material depositing apparatus comprising a vertically disposed support, an annular face on said support,

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an inner bell member having its open end mounted on said support and sealed with said annular face, an outer bell member mounted to be guided over the inner bell member in telescopic relation and detachably sealed against said annular face to produce a sealed annular chamber between the adjacent surfaces of said bell members, a sealed shaft extending through and rotatably supported in the closed end of the inner bell member, motor means to rotate said shaft, a frame mounted on said shaft for rotation in said annular chamber, means for mounting a conductor base plate means on said frame, and an evaporator means for a semiconducting material having a slot opening within the annular sealed chamber closely adjacent the conducting base plate means to discharge the vapors of the semiconducting material over the surface of said conducting base plate means while revolving.

9. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, a frame revolvably mounted about an axis in said annular chamber, motor means to rotate said frame, attaching means to removably secure material receiving means arcuately on said frame, and an applicator having a passage opening into the chamber adjacent said frame to direct material onto said material receiving means while the latter is moving to deposit a series of laminated layers of depositing material on said material receiving means.

10. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, a frame revolvably mounted about an axis in said annular chamber, motor means to rotate said frame, attaching means to removably secure material receiving means on said frame, an applicator having a passage opening into the chamber adjacent said frame to direct material uniformly across the surface of the material receiving means while the latter is moving to deposit a series of layers thereon, and means to control the amount of deposition material released by the applicator.

11. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, a frame revolvably mounted about an axis in said annular chamber, motor means to rotate said frame, attaching means to removably secure material receiving means on said frame, an applicator having a passage opening into the chamber adjacent said frame to direct material uniformly across the surface of the material receiving means while the latter is moving to deposit a series of layers thereon, and heater means and valve means mounted on said applicator to control the amount of deposition material released by the applicator.

12. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation and having substantially coextensive adjacent annular surfaces, an annular sealing means between said members to form a sealed annular chamber between their adjacent annular surfaces, a frame revolvably mounted about an axis in said annular chamber, motor means to rotate said frame, attaching means to removably secure material receiving means on said frame, an evaporator having a passage with a slot opening into the chamber adjacent said frame to direct a vapor of material onto said material receiving

means while the latter is moving and valve means controlling said slot to regulate the amount of deposition material released along the length of said slot to control the thickness of the laminated layers from one portion to another of the surface of the material receiving means.

13. A material depositing apparatus comprising a vertically disposed support, an annular face on said support, an inner bell member having its open end mounted on said support and sealed with said annular face, an outer bell member mounted to be guided over the inner bell member in telescopic relation and detachably sealed against said annular face to produce a sealed annular chamber between the adjacent surfaces of said bell members, a sealed shaft extending through and rotatably supported in the closed end of the inner bell member eccentrically thereto, motor means connected to drive said shaft, a frame mounted on said shaft for rotation in said annular chamber, means for mounting a conductor base plate means on said frame, and an evaporator means for a semiconducting material having opening means within the annular sealed chamber closely adjacent to both sides of conductor base plate means to discharge the vapors of the semiconducting material over the surface on both sides of said conducting base plate means while revolving.

14. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation, an annular sealing means between said members to form a sealed annular chamber between their adjacent surfaces, a frame revolvably mounted about an axis in said annular chamber, motor means to move said frame in either direction and at different speeds, attaching means to removably secure material receiving means on said frame, an applicator having a passage opening into the chamber adjacent said frame to direct material onto said material receiving means while the latter is moving to deposit a series of laminated layers of said depositing material on said material receiving means, and speed adjusting means effective on said motor means to change the speeds thereof during the application of the deposition of material to vary the thickness of the layers throughout the deposition period.

15. A material depositing apparatus comprising an inner and an outer shell member detachably mounted relative to each other in telescopic relation, an annular sealing means between said members to form a sealed annular chamber between their adjacent surfaces, a frame revolvably mounted about an axis in said annular chamber, motor means to rotate said frame in either direction, attaching means to removably secure material receiving means on said frame, an applicator having a passage opening into the chamber adjacent said frame to direct material onto said material receiving means while the latter is rotating to deposit a series of laminated layers of said depositing material on said material receiving means, means to vary the speed of the motor means to change the thickness of the layers deposited, and controlled heating means positioned within said chamber to treat each layer after it has been deposited and before the next succeeding layer is applied.

16. A material depositing apparatus comprising a chamber, a support, an annular frame revolvably mounted on said support to rotate about a horizontal axis in said chamber when the latter is closed, pump means to lower the pressure in the chamber when closed, means to rotate said annular frame, attaching means on said annular frame to detachably hold material receiving means on said annular frame, an applicator having its discharge in said chamber to deposit material onto said material receiving means while the latter is carried in a circular path by the rotation of said annular frame, and controlled heater means mounted in said chamber in close proximity to the material receiving means on the annular frame to heat treat the layers deposited thereon.

17. The structure of claim 16 which also includes

speed adjusting means effective to change the speed of rotation of said frame during the application of material to said material receiving means to control the thickness of the layers deposited on said material receiving means.

18. A material depositing apparatus comprising, a support, a large annular rotary frame revolvably mounted on said support to rotate about a horizontal axis, fastening means to detachably secure material receiving sheet means to the annular frame, the material receiving means encircling the annular frame in cylindrical form, means to rotate said annular frame to revolve said cylindrical sheet means in a circular path, and applicator means having a discharge mounted inside and outside the cylindrical sheet means while the latter is carried in a circular path by the rotary annular frame to deposit a series of layers on both surfaces of the cylindrical sheet means, said frame being sufficiently large to shape the material receiving means in cylindrical form with a radius that will prevent dislodgment of the deposited material when the sheet means is reflexed flat.

19. A material depositing apparatus comprising a chamber, a support, a large annular frame revolvably mounted on said support to rotate about a horizontal axis in said chamber when the latter is closed, pump means to lower the pressure in the chamber when closed, drive means to rotate said annular frame, attaching means on said annular frame to detachably hold material receiving means flexed in curved cylindrical form on said annular frame to maintain its surface at a uniform distance from the axis of rotation of said frame, and a vapor applicator having its discharge portion in said chamber closely adjacent said material receiving means to deposit material thereon while the latter is carried in a circular path by the rotation of said annular frame, said frame being sufficiently large in diameter to prevent dislodgment of the deposited material when said material receiving means is removed and flattened.

20. The structure of claim 19 characterized in that said applicator is a boiler, the temperature of which is regulatable to control the generation of a vapor, and the boiler discharge is mounted to deposit the vapor on the material receiving means while the latter is carried in a circular path by the rotation of said annular frame.

21. A material depositing apparatus comprising inner and outer tubular members forming a closed annular chamber therebetween, pump means to lower the pressure in said annular chamber when closed, a large annular rotary frame revolvably mounted to rotate in said annular chamber about a horizontal axis, fastening means to detachably secure material receiving sheet means to the annular frame, the material receiving sheet means encircling the annular frame in cylindrical form, means to rotate said annular frame to revolve the cylindrical sheet means in a circular path, and applicator means having a discharge portion mounted adjacent the cylindrical sheet means in the annular chamber while the latter is carried in said circular path by the rotary annular frame to deposit vaporized metal in a series of layers on the surface of the cylindrical sheet means, said frame being sufficiently large in diameter to prevent dislodgment of the deposited material when said material receiving means is removed and flattened.

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