

Sept. 29, 1959

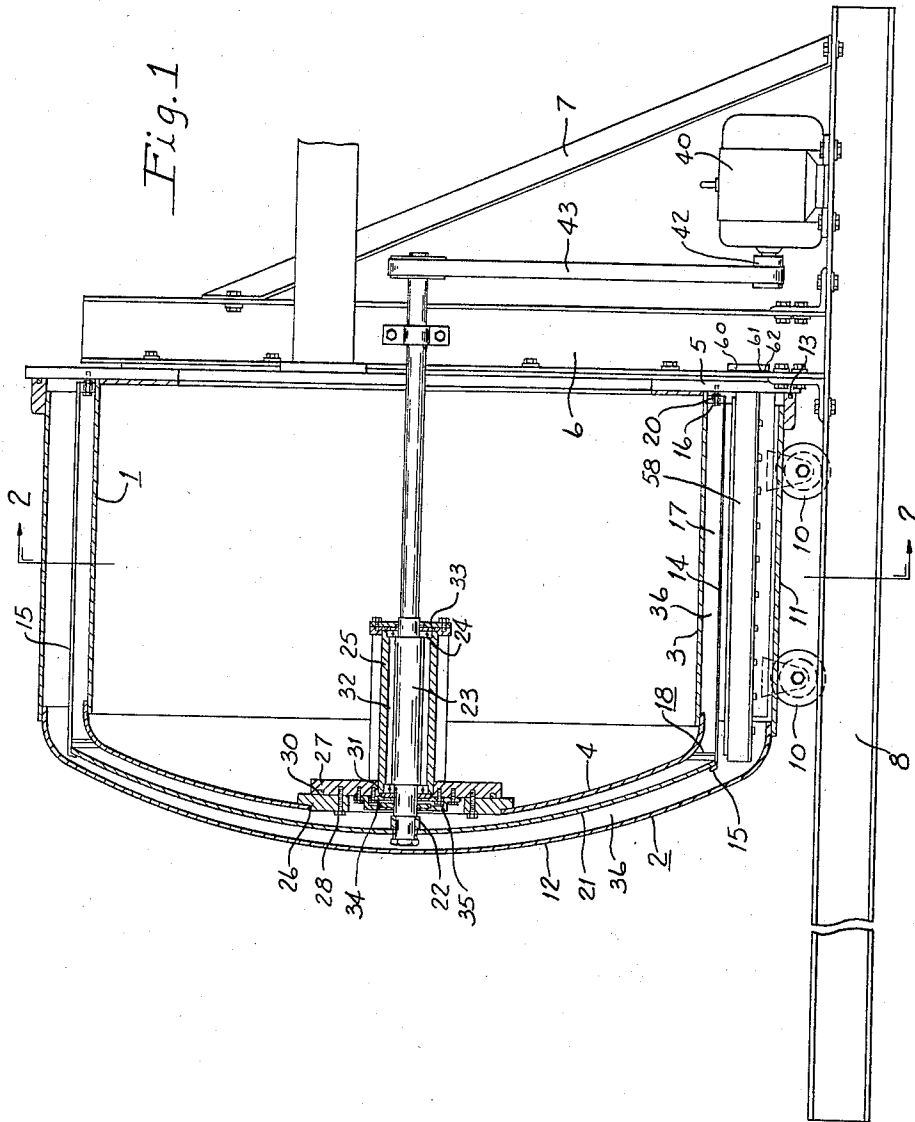
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2,906,236

REVOLVING CYLINDRICAL FRAME FOR SELENIUM DEPOSITORS

Filed May 11, 1954

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

Fig. 2

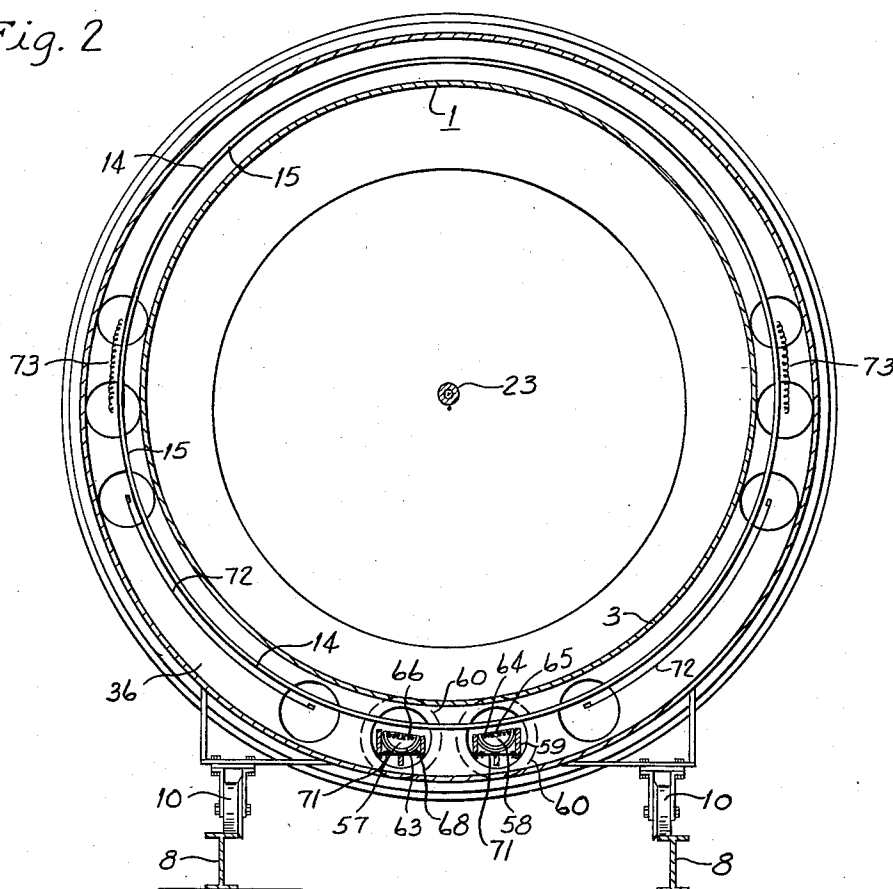
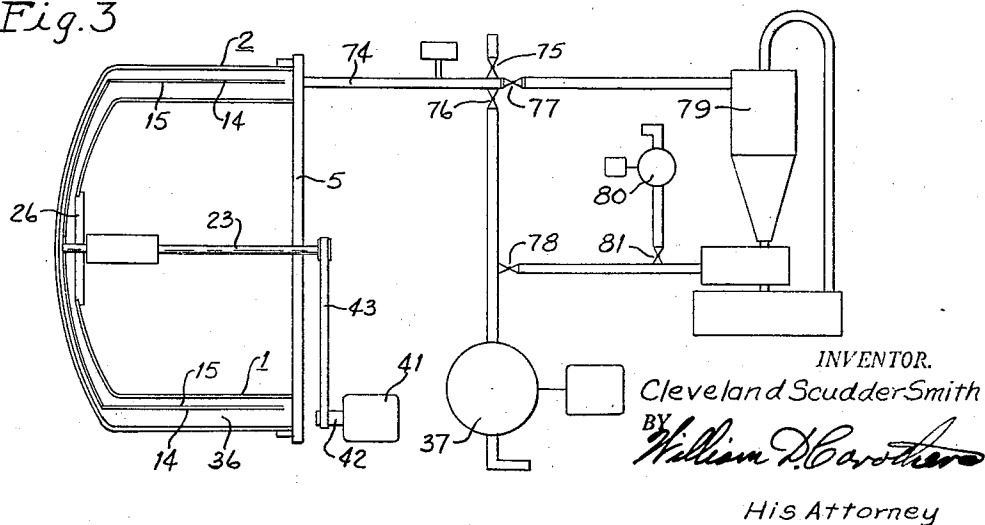


Fig. 3



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4 Sheets-Sheet 3

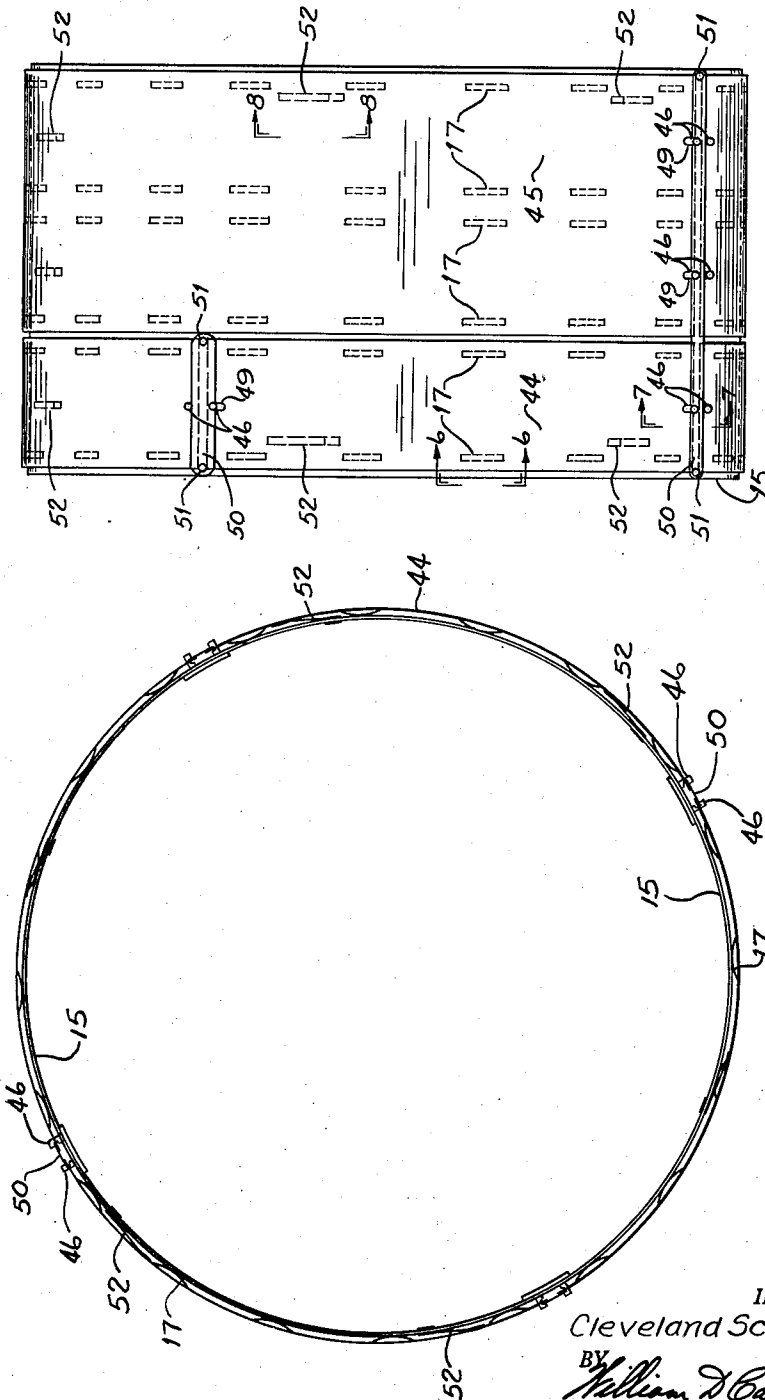


Fig. 5

Fig. 4

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4 Sheets-Sheet 4

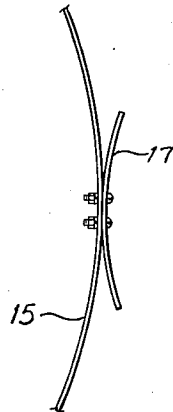


Fig. 6

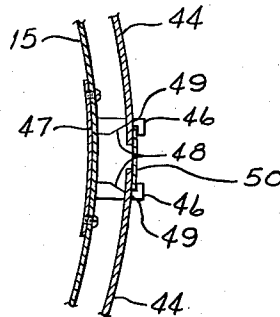


Fig. 7

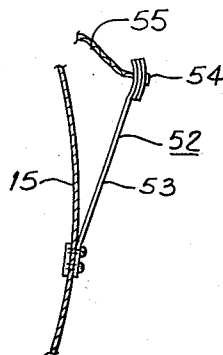


Fig. 8

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REVOLVING CYLINDRICAL FRAME FOR SELENIUM DEPOSITORS

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Application May 11, 1954, Serial No. 428,863

8 Claims. (Cl. 118—49.1)

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

This revolving cylindrical frame for a selenium depositor may be employed in different structures in which a selenium or other metals may be deposited on a conductor base. The purpose of this invention is to provide a support for the conductor base during the time that the deposit is made thereon. This deposit may be made in vacuum or it may be made under different atmospheric conditions.

The principal object of this invention is the provision of a revolving cylindrical frame for supporting a base material on which another material is deposited. The depositor might be in the form of a brush, it might be in the form of a spray, or it may be induced by evaporation. The purpose of this revolving cylindrical frame is to hold the material or sheet on which the deposit is made in a substantially uniform cylindrical path while being rotated so as to provide an even deposit of the material on its surface.

Another object is the provision of means for locking the sheet on which the deposit is to be made so that it is readily and conveniently removably mounted on the revolving frame.

Another object is the provision of a locking strip to prevent accidental removal or shifting of the sheet member on which the deposit is to be made during the process of depositing material thereon.

Other objects and advantages appear hereinafter 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 illustrating the principles of the invention wherein:

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

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

Fig. 3 is a diagrammatic view of the apparatus in conjunction with an exhaust pumping system which has been selected for showing the use of this apparatus.

Fig. 4 is an enlarged detail view of the revolving cylindrical frame comprising this invention.

Fig. 5 is an enlarged detail view showing the surface of the frame as illustrated in Fig. 4.

Fig. 6 is an enlarged sectional view of a spring taken on the line 6—6 of Fig. 5.

Fig. 7 is an enlarged sectional view of the sheet hook means taken on the line 7—7 of Fig. 5.

Fig. 8 is an enlarged sectional view of a thermal element taken on the line 8—8 of Fig. 5.

The apparatus chosen for illustrating this invention is a structure for producing selenium blocking devices and as shown in the drawing comprises a vacuum member constructed of two bell members 1 and 2, the first of

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which is stationary and the second is mobile. The stationary bell member consists of a cylindrical portion 3 secured at one end to a disk or head portion 4 and at the other end welded 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 and inner bell members may be of any suitable size depending on the size of sheets to be used therein.

A selenium blocking layer device has a conductor base member 14 which is preferably an aluminum sheet which may be as long as the perimeter of the inner shell and approximately as wide. For convenience this sheet may be divided into two or more sections. The sheets 14 are wrapped around the annulus or cylinder 15. One end of the cylinder 15 has an angular hoop support 16. The cylinder 15 carries a series of leaf springs 17 on its outer periphery to resiliently support the sheets 14 to allow for expansion and contraction. The hoop 16 is made of channel iron 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 other end of the cylinder 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 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 each 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 variable speed motor 40 through the variable speed transmission 42 and the flexible drive 43.

Referring to Figs. 4 to 8, the cylindrical frame member 15 is a continuous sheet formed in halves and welded

together. The springs 17 are equally spaced about the periphery of the cylinder. As shown in Fig. 6, the springs 17 are flexible leaf members having their intermediate portion secured to the cylinder by two spaced machine screws held by nuts and lock washers. As shown in Fig. 5 the springs 17 are positioned in two closely spaced rows. This arrangement would be for three conductor base strips 14 equal in width to the strip numbered 44 in Fig. 5. However the wide strip 45 takes up the same width as two strips 44.

The strip sheets 44 and 45 may be made substantially as long as the circumference. However strip 44 extends only between adjacent circumferentially spaced sets of mounting pins 46. As shown in Figs. 4, 5 and 7 two mounting projections or pins 46 extend from a plate 47. Each plate is bolted to the inner surface of the cylinder 15 and the pins project through the surface of the cylinder but they are not as high as the free ends of the springs 17. Each pin 46 has a notch 48 forming a hook means with an overhanging abutment and these notches of a pair of pins face each other as shown in Fig. 7. The strip sheets 44 have a hole or an abutment 49 adjacent each end and substantially in the center of each strip. One end of the strip is inserted over a pin 46 and caught under the shoulder formed by the notch 48 and is then driven over the springs 17. A hook similar to a bale hook is inserted in the opposite hole and sufficient pressure is applied to the strip to compress all the springs 17 thereunder and the opposite hole 49 in the strip is then slid over the next adjacent pin 46 of the next perimetral set of pins and held under the shoulder of the notch 48 of that pin. When released by the hook the springs 17 engaging under the strip hold it at a substantially uniform radius determined by the surface of the cylinder 15 and the springs 17 mounted thereon.

There may be several sets of posts 46 extending in a row across the cylinder surface. As shown in Fig. 5 there are three sets. The strip 45 is twice as wide as the strip 44 and twice as long. Thus it extends half way around the cylinder. The intermediate pins 46 may be removed or they may be low enough to permit the strip to pass thereover.

The ends of the strips 44 and 45 may be locked in position on the pins 46 by the transverse locking strip 50 which is as long as the cylinder 15 is wide and is as wide as the distance between the bottom of the notches 48 so that the locking strip 50 may lay over the adjacent ends of the strips 44 and 45 and be held down by the shoulder formed by the notches as shown in Fig. 7. The ends of the locking strips 50 have holes 51 to receive the hook for drawing them into and out of position. The locking strips may be held down by the shoulders on three or more sets of pins 46 but the strip being continuous for the full width of the cylinder covers the ends of the base strips 44 and 45 and provides a substantially continuous surface on the cylinder. The edges of these blocking layer strips are relatively close together.

The cylinder 15 has a series of thermal arms 52 attached thereto. These arms are shown in Fig. 8 and comprise the leaf spring 53 attached at one end to the cylinder 15. The free end of each spring arm 53 has a bithermal button 54 secured thereto. The opposite bimetallic of the button 54 are connected by conductors in the wire 55 to a central station for reading the temperature of the strips 44 and 45. A number of these thermocouples are positioned at various spots relative to the strips and they record the temperature conditions of the strips 44 and 45 during the process of coating the same.

A set of selenium evaporators 57 and 58 may be provided in the chamber to coat the outer surface of the plate 14. 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 Fig. 1.

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 length of the evaporator. Each of the evaporators is provided with a plurality of radiant heaters 66. The heaters 66 extend the entire length of the evaporators. Shields 68 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 twelve 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 evaporator 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

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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 13 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.

I claim:

1. A frame for supporting a flexible metal sheet comprising a rotary driven annulus, a series of springs attached to said annulus in circumferential and lateral spaced relation with their free ends projecting outwardly, at least one pair of spaced posts mounted on said annulus to extend outwardly, and a sheet attaching overhanging abutment on each of said posts positioned radially inwardly of the free ends of said springs to engage cooperating abutments at the opposite ends of said flexible metal sheet, the pressure of the springs holding the cooperative abutments in interlocked relation with the flexible metal sheet in cylindrical form.

2. The structure of claim 1 which also includes a locking strip engaging under the overhanging abutments on said pair of posts and against the outer surface of the flexible metal sheet to further retain the latter in locked position on said post.

3. A frame for supporting a flexible metal sheet to which material is to be applied comprising a rotary driven annulus, a series of spring means mounted in circumferential and lateral spaced relation on said annulus, at least a pair of circumferentially disposed sheet fasteners

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mounted on said annulus, each fastener having a hook turned toward each other and positioned inwardly of the radial length of said spring means when free, means defining an attaching hole at each end of said flexible metal sheet to be placed over its respective hook, the spacing of said fastening means and the distance between said holes in said flexible metal sheet when attached under said hooks causing said spring means to exert a pressure on the under surface of the flexible metal sheet and hold it cylindrically for treatment as rotated by the annulus.

4. The structure of claim 3 which also includes a locking strip engaging above the outer surface of the ends of the flexible metal sheet and under the oppositely disposed hooks of said fastener means to lock the latter in position.

5. A rotary coating machine for treating flexible sheets comprising an applicator, a rotary driven annular frame, outwardly extending springs mounted in spaced relation over the perimetral surface of said annular frame to engage the under surface of the flexed sheet to hold it spaced from the frame and rotatably carry the outer surface of the sheet in a path uniformly spaced from said applicator to apply layers of material thereon as the rotary driven annular frame carries the flexed sheet past said applicator.

6. The structure of claim 5 which also includes a sealed closure for enveloping said rotary driven annular frame and said applicator.

7. The structure of claim 5 which also includes heater means to heat the metal sheet when the material is applied thereto.

8. The structure of claim 7 which also includes a sealed closure for enveloping said rotary driven annular frame, said applicator and said heating means.

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