United States Patent

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[45] **May 23, 1972**

[54] SPUTTERING SYSTEM

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[52] **U.S. Cl.** **204/298**

[51] **Int. Cl.** **C23c 15/00**

[58] **Field of Search** 204/298, 192

[56] **References Cited**

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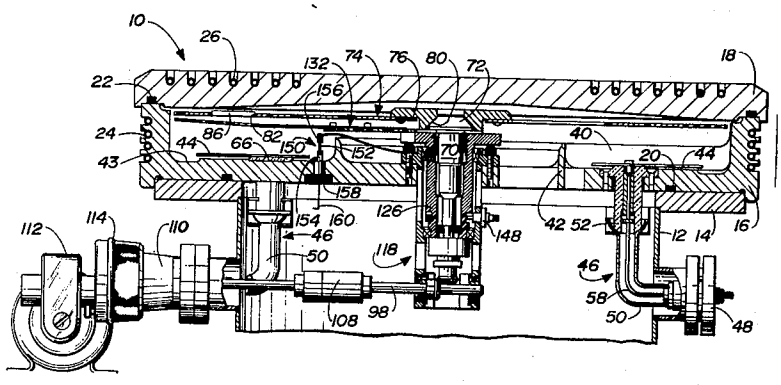
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[57] **ABSTRACT**

A sputtering system includes a pair of spaced electrodes, one formed from titanium and the other formed from platinum. Substrates are rotated over both electrodes by a turntable that is actuated by a reversible drive mechanism. A mask alternately blocks each electrode. The mask is coupled to the turntable drive mechanism by a slip clutch and is moved between the two blocking positions when the direction of rotation of the turntable is reversed. In the use of the system, the electrodes are actuated in sequence. The mask is positioned to block each electrode during the initial portion of its operation. This deposits the material of the electrodes on the mask until the electrodes are clean.

9 Claims, 6 Drawing Figures



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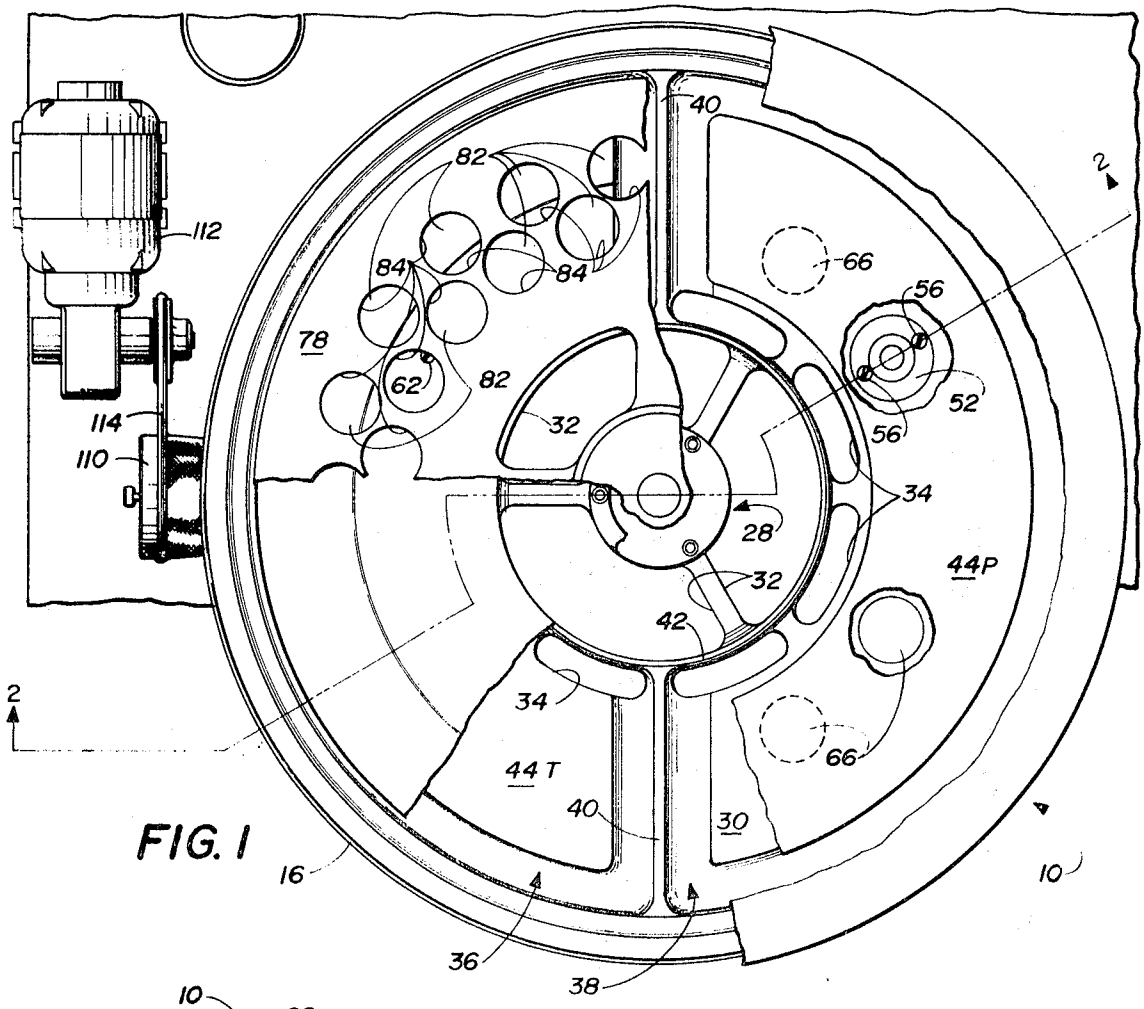


FIG. 1

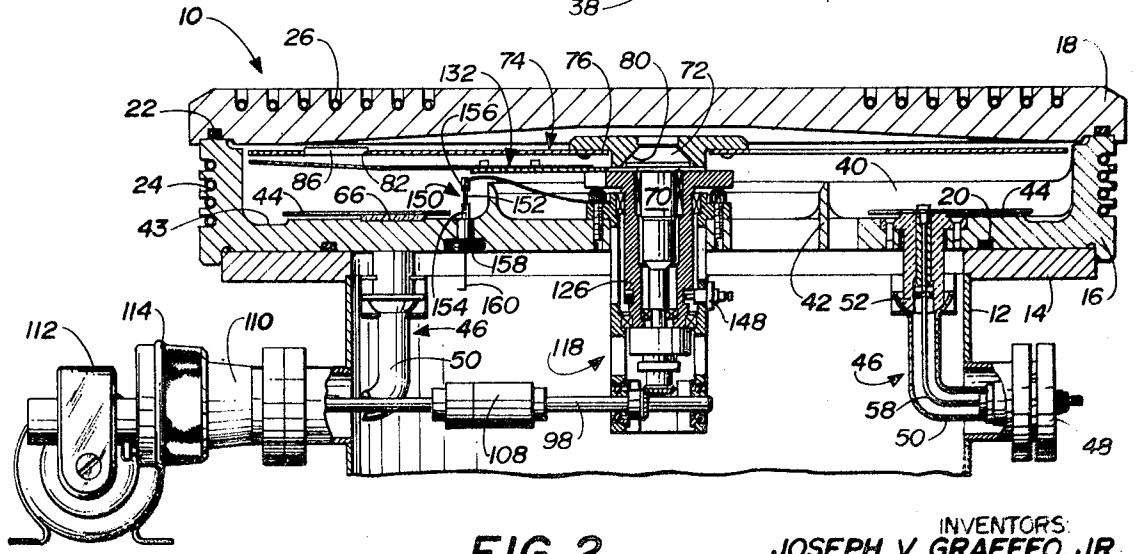


FIG. 2

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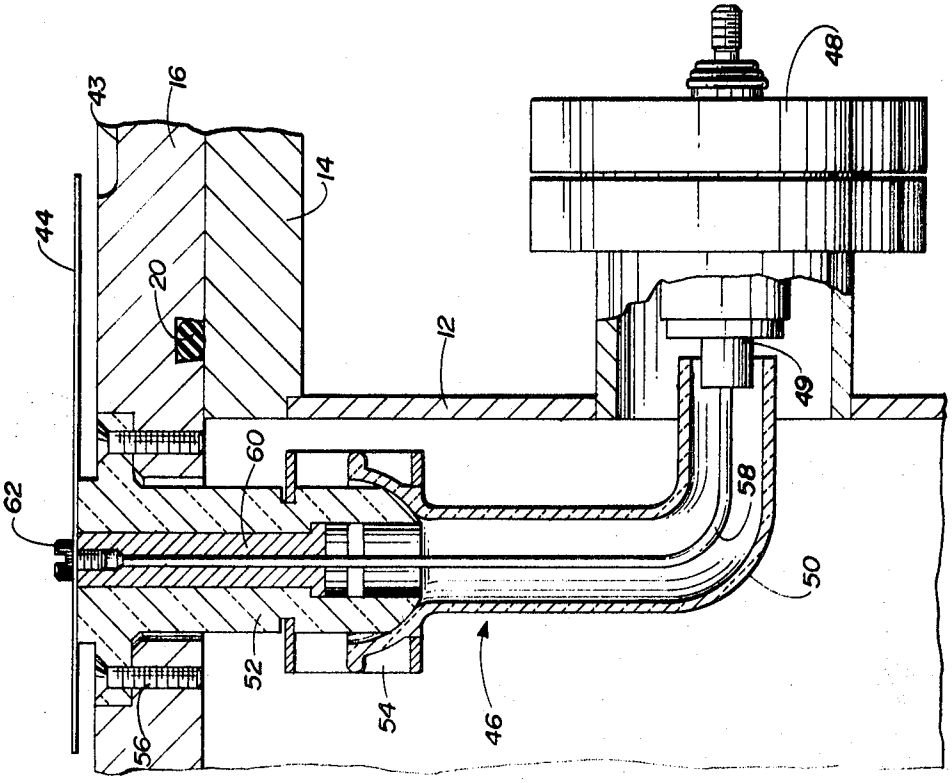


FIG. 4

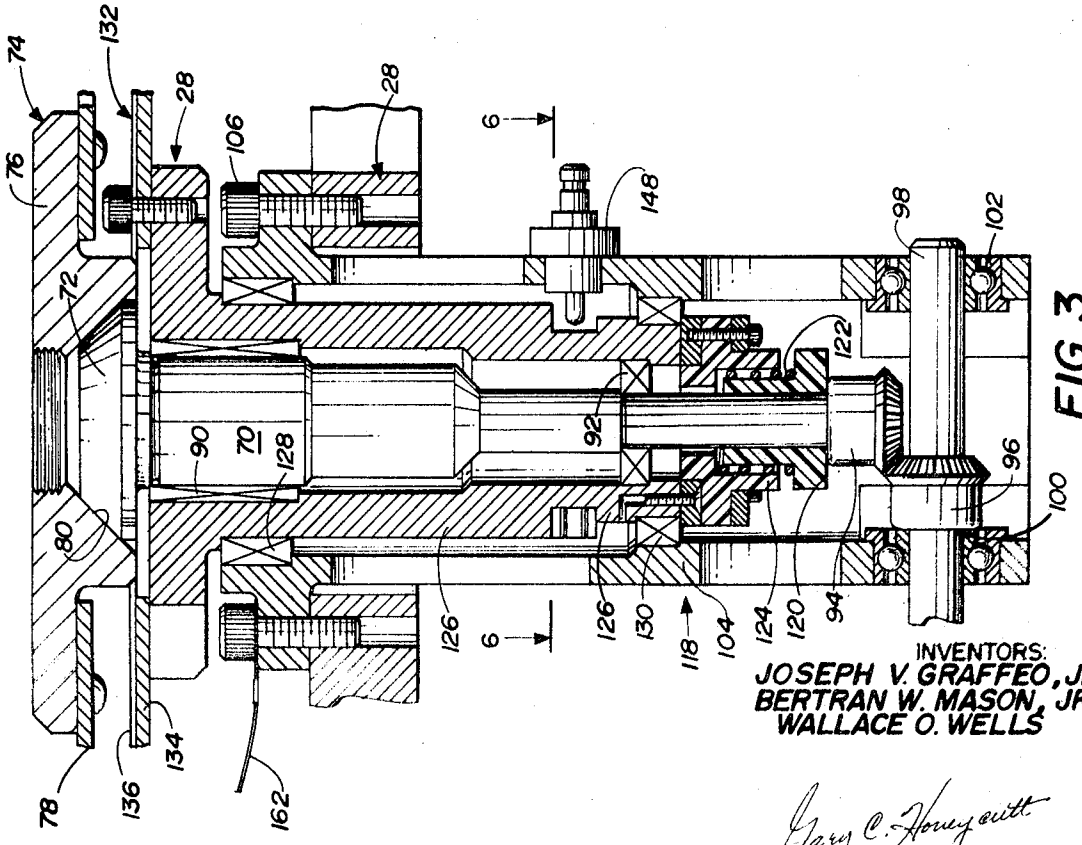


FIG. 3

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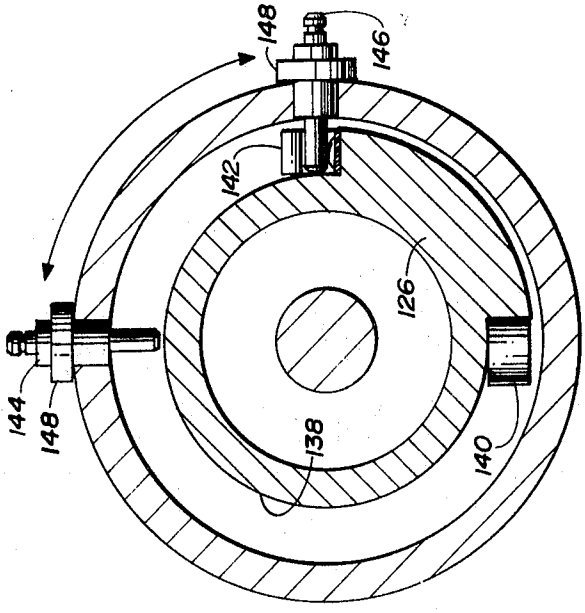

148
146
142
126
144
148
138
140

FIG. 5

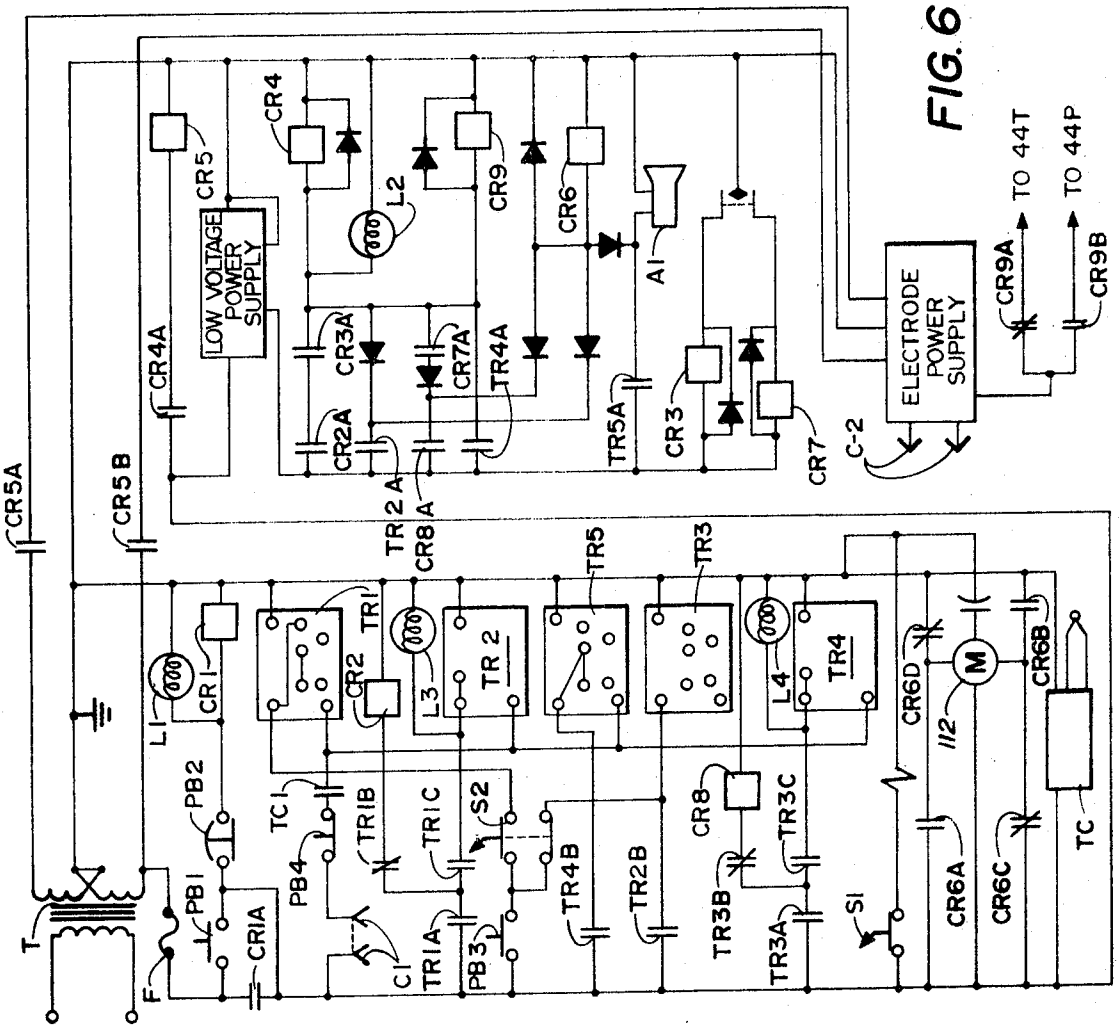

CR5A
CR5B
CR4
CR5
LOW VOLTAGE POWER SUPPLY
CR4A
CR3A
CR2A
CR2 A
CR8 A
CR7A
TR4A
L2
CR9
CR6
A1
TR5A
CR3
CR7
C-2
ELECTRODE POWER SUPPLY
CR9A
CR9B
TO 44T
TO 44P
TR1
CR2
L3
TR 2
TR5
TR3
L4
TR4
CR1
L1
PB2
PB1
CR1A
T
F
TC1
TR1B
TR1C
S2
PB4
C1
TR1A
PB3
TR4B
TR2B
CR8
TR3B
TR3C
TR3A
S1
CR6D
M
112
CR6A
CR6C
CR6B
TC

FIG. 6

SPUTTERING SYSTEM

BACKGROUND OF THE INVENTION

In the manufacture of various electronic components it is necessary to deposit thin metal films on substrates formed from silicon and other materials. One method of forming thin films is known as vacuum sputtering. Typically, vacuum sputtering systems include a vacuum chamber that houses a sputtering electrode and a substrate supporting target. The electrode is energized to direct the material of the electrode toward the target and onto substrates supported on the target.

To date, most vacuum sputtering systems have been comprised of laboratory type equipment. Such systems are incapable of large volume production and are, therefore, unsuitable for most commercial applications. Conversely, the few high volume vacuum sputtering systems that have been designed heretofore have been so expensive as to prevent their widespread commercial use.

This invention relates to a high volume vacuum sputtering system that is relatively inexpensive to manufacture and operate. The system includes a large turntable that transports substrates over electrodes formed from different materials. This permits the deposition of two thin films in one operation. The chamber of the system is relatively small in volume so that the cycle time of the system is minimized and has a small number of mechanical and electrical inputs to prevent leaks. Fully automatic control is provided to reduce human errors and yet permit adjustments in the operation of the system.

SUMMARY OF THE INVENTION

In accordance with the preferred embodiment, this invention comprises a vacuum sputtering system that includes a pair of electrodes and a mask that is alternately moved into alignment with each electrode. Preferably, workpieces are transported along a path that extends over both electrodes by a drive system that also moves the mask.

DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention may be had by referring to the following detailed description when taken in conjunction with the drawings wherein:

FIG. 1 is a top view of a sputtering system employing the invention in which certain parts have been broken away more clearly to illustrate certain features of the invention;

FIG. 2 is a sectional view taken generally along the line 2—2 in FIG. 1;

FIG. 3 is an enlargement of a portion of FIG. 2;

FIG. 4 is an enlargement of another portion of FIG. 2;

FIG. 5 is a partial sectional view taken generally along the line 5—5 in FIG. 3, and

FIG. 6 is a schematic illustration of a control circuit employed in the operation of the system shown in FIGS. 1 and 2.

DETAILED DESCRIPTION

Referring now to the drawings, there is shown a sputtering system 10 employing the invention. Referring particularly to FIG. 2, the system 10 is mounted on a cylinder 12 having a flange 14 extending from it. The cylinder 12 and the flange 14 preferably comprise portions of a commercially available vacuum pump. It should be understood that the cylinder and the flange are representative only and that the system 10 can be adapted for use with any of the many commonly employed vacuum pumping systems.

The system 10 includes a main housing 16 that rests upon the flange 14 and a cover 18 that rests upon the housing 16. The housing and the cover are both formed from a material having high thermal and electrical conductivity, such as aluminum. A pair of O-rings 20 and 22 are positioned between the housing 16 and the flange 14 and between the cover 18 and the housing 16, respectively, to effect seals therebetween. A pair of cooling coils 24 and 26 are mounted in the housing 16 and the cover 18, respectively, for use in controlling the temperature of the system 10.

As is best shown in FIG. 1, the housing 16 includes a central hub portion 28 and a large outer portion 30. A plurality of holes 32 and 34 are formed through the housing 16 between the hub portion 28 and the outer portion 30 to permit a vacuum to be more easily established within the housing 16. The outer portion 30 of the housing 16 is divided into two half-moon shaped sections 36 and 38 by a pair of radially extending partitions 40, a circular inner wall 42 and the outer wall of the housing. As is best shown in FIG. 2, a trough 43 extends along the outer edge of each of the sections 36 and 38.

The sections 36 and 38 of the housing 16 each enclose a half-moon shaped sputtering electrode 44. In the preferred embodiment, the section 36 houses an electrode 44T formed from titanium while the section 38 houses an electrode 44P formed from platinum. It should be understood, however, that the electrodes 44 may be formed from other materials and that the system 10 may be used in conjunction with deposition systems other than sputtering systems, if desired.

Referring now to FIGS. 2 and 4, electrical energy is supplied to each electrode 44 by an electrical feed through assembly 46. Each assembly 46 includes a conventional high voltage connector 48 that is coupled to the cylinder 12 and that is sealed to prevent leaks between the interior of the system 10 and the outside atmosphere. The connector 48 includes an insulator 49 that extends into a glass elbow 50. The elbow 50 in turn leads to a ceramic insulator 52. The insulator 52 is secured to the elbow 50 by a spring clip 54 and is secured to the housing 16 by a pair of fasteners 56.

A copper lead 58 extends through the elbow 50 to a titanium conductor 60 positioned within the insulator 52. The electrode 44 is secured to the conductor 60 by a fastener 62 formed from the same material as the electrode. Each electrode 44 is supported within the housing 16 by its respective ceramic insulator 52 and by a plurality of spacers 66 mounted at spaced points in the housing. The spacers 66 are formed from aluminum oxide and serve to conduct heat from the electrodes 44 to the housing 16.

As is best shown in FIGS. 2 and 3, a vertically extending shaft 70 is rotably supported in the central hub portion 28 of the housing 16. The upper end of the shaft 70 comprises a frustro-concical drive member 72. A substrate transporting turntable 74 is supported on and driven by the drive member 72. The turntable 74 includes a hub 76 and a substrate supporting plate 78 which extends radially outwardly from the hub 76. The plate 78 is formed from a material having a low coefficient of thermal expansion, such as molybdenum.

The hub 76 of the turntable 74 has a frustro-concical cavity 80 formed in it. The walls of the cavity 80 are adapted for driving engagement with the drive member 72 of the shaft 70. The substrate supporting plate 78 of the turntable 74 has a plurality of substrate receiving holes 82 formed in it. As is best shown in FIG. 1, each substrate receiving hole 82 has a substrate retaining lip 84 formed along its lower edge. In a typical use of the turntable 74, a substrate is mounted in each hole 82 in engagement with the lip 84 thereof and a ballast or heat sink member 86 of the type shown in FIG. 2 is mounted in the hole 82 on the top of the substrate.

The shaft 70 is supported in the hub portion 28 by a pair of bearings 90 and 92. From the drive member 72, the shaft 70 extends through the bearings 90 and 92 to a bevel gear 94. The gear 94 is mounted in mesh with a bevel gear 96 that is secured to a shaft 98. The shaft 98 is rotably supported in a pair of bearings 100 and 102 that are in turn secured to a vertically extending tubular member 104. The member 104 is secured in the hub portion 28 of the housing 16 by a plurality of fasteners 106.

The shaft 98 is connected to a conventional coupler 108 that is in turn connected to a commercially available rotary feed through 110. The feed through 110 is of the greaseless variety and operates to seal the interior of the system 10 against contamination from the outside atmosphere. The rotary feed through 110 is driven by a conventional gear motor 112 through a belt 114. The gear motor 112 is reversible so that the shaft 70 and the turntable 74 may be rotated in either direction, as desired.

In addition to driving the turntable **74**, the shaft **70** drives a slip clutch **118**. The clutch **118** includes a collar **120** that is formed from one of the various low friction plastic materials and that is secured to the shaft **70** at a point just above the point of attachment of the gear **94**. A two pitch helical spring **122** is positioned around the collar **120** and within an annularly shaped member **124** that is also formed from a low friction plastic material. The spring **122** forms a two directional slip clutch between the members **120** and **124**. That is, because of its double helical construction, the spring **122** slips relative to the collar **120** when a torque in excess of a predetermined level is developed between the members **120** and **124** in one direction and slips relative to the annularly shaped member **124** when an excess torque is developed in the reverse direction.

The annularly shaped member **124** is connected to a drive sleeve **126** that is rotatably supported in the member **104** by a pair of bearings **128** and **130**. The drive sleeve **126** is in turn connected to a mask **132** comprised of a hub **134** and a semicircularly shaped shutter **136** that extends radially outwardly from the hub **134**. As is best shown in FIG. **5**, the drive sleeve **126** has a slot **138** formed in it which extends to a pair of spring clips **140** and **142**. The clips **140** and **142** are mounted for engagement with a pair of pins **144** and **146**, respectively. The pins **144** and **146** are supported in a member **104** by a pair of insulators **148**.

Whenever the motor **112** is operated to rotate the turntable **74** in a counterclockwise direction, the mask **132** is driven through the slip clutch **118** in a counterclockwise direction until the clip **142** on the sleeve **126** engages the pin **146**. Thereafter, the slip clutch **118** permits the turntable **74** to continue to rotate in the counterclockwise direction while the mask remains in its most counterclockwise position. Similarly, whenever the motor **112** is actuated to rotate the turntable **74** in a clockwise direction, the mask **132** is driven in a clockwise direction through the slip clutch **118** until the clip **140** engages the pin **144**. Thereafter, the mask remains in its most clockwise position while the turntable **74** continues to rotate.

The pins **144** and **146** and the clips **140** and **142** are so positioned in the member **104** and in the sleeve **126** respectively, that the mask **132** is aligned with the electrode **44T** positioned in the section **36** whenever the clip **142** is engaged with the pin **146**. Similarly, the mask **132** is aligned with the electrode **44P** positioned in the cavity **38** whenever the clip **140** is engaged with the pin **144**. Thus, the shutter **136** of the mask **132** alternately blocks each of the electrodes **44** as the direction of rotation of the turntable **74** is reversed.

In addition to enclosing the titanium electrode **44T**, the half-moon shaped section **36** encloses a resistance monitor **150**. The resistance monitor **150** includes a glass plate **152** that is secured between a pair of connectors **154** and **156**. The connector **154** is secured to the housing **16** by an insulating member **158** and is connected to suitable resistance monitoring circuitry by a lead **160**. The connector **156** is grounded through a lead **162** that is connected to one of the fasteners **106**.

It should be noted that in the system **10**, the housing **16** and the cover **18** comprise a combined vacuum enclosure and grounded target for the electrodes **44**. This feature results in increased substrate capacity and reduced system volume. These results combine to greatly increase the number of slices that can be processed in a given period of time relative to prior sputtering systems. It should be further noted that the cover **18** and the turntable **74** are secured to the respective mating parts by the force of gravity alone. This greatly facilitates the loading and unloading of substrates into and out of the system **10**.

In the use of the system **10**, the substrates supporting plate **78** of the turntable **74** is loaded by positioning substrates on the lips **84** of the holes **82** therein and then positioning a ballast **86** on top of each substrate. When the entire turntable has been loaded with substrates and ballasts, the cover **18** of the system **10** is removed and the turntable **74** is positioned in engagement with the drive members **72** of the shaft **70**. A suitable handle (not shown) is provided for mounting the turntable **74** in the system **10** so that the interior of the housing **16** is not contaminated during the loading operation.

When the loaded turntable **74** is in place in the housing **16**, the cover **18** is replaced and the vacuum pump of which the cylinder **12** and the flange **14** form a part is actuated to establish a vacuum in the housing **16**. When the housing has been evacuated sufficiently, argon is fed into the housing **16**. As is well known in the sputtering art, the presence of argon in a sputtering chamber aids in the establishment of a sputtering plasma therein.

When the proper atmosphere has been established in the housing **16**, the motor **112** is actuated to rotate the turntable **74** in a counterclockwise direction. This positions the mask **132** in blocking alignment with the electrode **44T** in the section **36** of the housing **16**. At this time, high voltage electric current is applied to the titanium electrode **44T** through its respective feed through **46**. This causes titanium from the electrode to initially sputter onto the shutter **136** of the mask **132**.

The mask **132** is positioned in blocking alignment with the electrode **44T** during the initial portion of its operation in order to prevent the material of the electrode from being sputtered onto the substrates until the electrode is clean. The state of cleanliess of the electrode **44T** is determined with the aid of resistance monitor **150**. The glass plate **152** of the resistance monitor **150** is positioned to receive material sputtered from the electrode **44T**. The resistance across the glass plate **152** is directly proportional to the cleanliness of the material being sputtered. Thus, when the resistance across the plate **152** drops to a predetermined level, it is known that the sputtering of the titanium onto the substrates in the turntable **74** can begin.

The sputtering of titanium onto the substrates is initiated by reversing the direction of rotation of the motor **112**. This causes the clutch **118** to drive the mask **132** clockwise until the clip **140** on the sleeve **126** engages the pin **144** on the member **104**. At this time, the mask **132** is positioned in blocking alignment with the platinum electrode **44P** and the titanium electrode **44T** is clear.

After the mask has been rotated out of alignment with the titanium electrode, the operation of that electrode is continued for a predetermined period of time to deposit a layer of titanium on the substrates. After a sufficient layer of titanium has been deposited on each substrate, the operation of the titanium electrode is terminated and high voltage electric current is directed to the platinum electrode **44P** through its associated feed through **46**.

Like the titanium electrode **44T**, the platinum electrode **44P** is initially operated with the mask **132** positioned between it and the substrates in the turntable so that the material of the platinum electrode is not deposited onto the substrates until the electrode is clean. When the platinum electrode has been operated for sufficient period of time to assure its cleanliness, the direction of rotation of the motor **112** is again reversed. This causes the clutch **118** to rotate the mask **132** in a counterclockwise direction until the clip **142** on the sleeve engages the pin **146** on the member **104**. At that time, the mask is positioned in alignment with the titanium electrode **44T** and out of alignment with the platinum electrode **44P**. The operation of the platinum electrode is thereafter continued until a sufficient quantity of platinum has been deposited on each substrate mounted in the turntable **74**.

When the sputtering of platinum has been completed, the interior of the housing **16** is allowed to cool. Then, the housing **16** is vented to the atmosphere, the cover **18** is lifted from the housing **16** and the turntable **74** is removed. Preferably, a second turntable **74** has meanwhile been loaded with substrates and ballasts. If such be the case, the second turntable **74** is immediately installed in housing **16**, and the operation of the system **10** is re-started.

It will be understood that as the system **10** is repeatedly operated, layers of titanium and platinum build up on the in-

terior portions of the housing **16** and the cover **18**. As the thickness of these layers increases they tend to break into pieces and fall toward the electrodes. Also, the substrates operated upon by the system **10** occasionally shatter during sputtering.

In the event any foreign material, whether it be a dislodged piece of sputtered metal or a piece of broken substrate, becomes lodged between an electrode **44** and **16**, the electrode is shorted. This disables the system **10** and necessitates stopping the operation of the system **10** so that the foreign material can be removed. It has been found that the trough **43** formed in the housing **16** forms a reservoir which minimizes electrode shorting in the system **10**. That is, most foreign materials that are generated during the operation of the system are received by the trough **43** and do not engage either electrode.

A more complete understanding of the operation of the system **10** may be had by referring to FIG. **6** wherein a control circuit for the system is schematically illustrated. Conventional 208 volt, 60 Hertz line current is supplied to the primary of a transformer T. The secondary of the transformer T has a grounded center tap, and accordingly, operates to provide equal and opposite output signals.

One output of the transformer T is connected through a fuse F to a pair of on and off pushbuttons PB1 and PB2. Whenever the on pushbutton PB1 is actuated, a current path is established between the one output of the transformer T and ground through an "ON" lamp L1 and a control relay CR1. Once actuated, the relay CR1 locks operated through a normally open contact CR1A.

The control circuit further includes a pair of two position switches S1 and S2. The switch S1 is activated to direct argon into the housing **16** of the system **10** and to direct cooling water through the tubes **24** and **26**. The switch S2 is selectively actuated to cause the system **10** to sputter both titanium and platinum on the substrates or to cause the system to sputter platinum only.

Regardless of the position of the switch S2, a pushbutton PB3 must be depressed to initiate the operation of the system **10**. Assuming that the curcuit has previously been started by depression of the pushbutton PB1 and assuming that the switch S2 is in a position shown, this action initiates the operation of a timer TR1. As soon as it is started, the timer TR1 closes a pair of normally open contacts TR1A. This forms a path through a pair of normally closed contacts TR1B and a control relay CR2. Operation of the relay CR2 closes a normally open contact pair CR2A.

Whenever the clip **142** on the drive sleeve **126** is engaged with the pin **146** on the member **104**, a circuit is established through a control relay CR3. Assuming this to be the case at the start of the operation of the system **10**, operation of the relay CR3 closes a normally open contact pair CR3A. When both the contact pair CR2A and the contact pair CR3A are closed, two circuit paths are established between the outputs of a low voltage power supply circuit. One path extends through a signal lamp L2 while the other extends through a control relay CR4.

Operation of the relay CR4 closes a normally open contact pair CR4A to establish a circuit path through a control relay CR5. Operation of the control relay CR5 closes two normally open contact pairs CR5 and CR5B to connect the secondary of the transformer T to an electrode power supply circuit. The electrode power supply turn directs operating power to the titanium electrode **44T** of the system **10**.

When the timer TR1 times out, it momentarily closes a normally open contact pair TR1C. This initiates the operation of a timer TR2. As the timer TR2 begins to operate it establishes a current path through a signal lamp L3 and closes a normally open contact pair TR2A.

As the timer TR1 times out, its normally closed contact pair TR1B is opened at the same time the contact TR1C is closed. This breaks the current path through the control relay CR2 which permits the contact pair CR2A to open. However, a hold circuit for the control relay CR4 is maintained by a closure of the contact pair CR2A. Thus, the secondary of the transformer T remains connected to the electrode power supply circuit through the contacts CR5A and CR5B.

The closure of the contact pair TR2A also establishes an operating path for a control relay CR6. The operation of the relay CR6 closes two sets of normally open contact pairs CR6A and CR6B and opens two sets of normally closed contact pairs CR6C and CR6D. This immediately reverses the direction of operation of the motor **112**.

When the motor **112** reverses its direction of operation, the clutch **118** drives the mask **132** clockwise until the clip **140** on the drive sleeve **126** engages the pin **144** on the member **104**. This action breaks the operating path for the relay CR3 and establishes an operating path for a relay CR7. Operation of the relay CR7 closes a normally open contact pair CR7A.

When the timer TR2 times out, it momentarily closes a normally open contact pair TR2B to establish a starting path for a timer TR3. The timer TR3 is constructed identically to the timer TR1 and, accordingly, when the operation of the timer TR3 is initiated, the timer TR3 immediately closes a normally open contact pair TR3A. This action establishes a circuit path through a control relay CR8 which immediately operates to close a normally open contact pair CR8A. Since the contact pair CR7A was closed upon rotation of the mask **132** to its counterclockwise position, this establishes a hold path for the relay CR4. By this means, the secondary of the transformer T is maintained connected to the electrode power supply circuit even though the contact pair TR2A opens the timing out of the timer TR2. Similarly, a hold path for the relay CR6 is maintained through the contacts CR8A.

When both contact pair CR7A and the contact pair CR8A are closed, an operating circuit for a relay CR9 is established. Operation of the relay CR9 opens a normally closed contact pair CR9A and closes a normally opened contact pair CR9B. This action reverses the operation of the electrode power supply circuit so that the circuit discontinues supplying power to the titanium electrode **44T** and begins supplying platinum to the platinum electrode **44P**.

When the timer TR3 times out it momentarily closes a normally open contact pair TR3C to complete a circuit path to a timer TR4. Operation of the timer TR4 immediately establishes a circuit path through a signal lamp L4 and closes a normally open contact pair TR3A. This establishes hold paths for both the relay CR4 and the relay CR9 so that the electrode power supply circuit continues to supply operating power to the platinum electrode **44P** of the system **10**.

As the timer TR3 times out, it breaks the circuit path including the relay CR8 and thereby opens the contact pair CR8A. Since the contact pair TR2A was opened upon the timing out of the relay TR2, no path is available to maintain the relay CR6 operated. When the relay CR6 is de-energized, the contact pairs CR6A and CR6B are re-closed and the contact pairs CR6C and CR6D are re-opened. This reverses the direction of operation of the motor **112** so that the mask **132** is rotated counterclockwise into alignment with the titanium electrode **44T** of the system **10**.

When the timer TR4 times out, it momentarily closes a contact pair TR4B. This action initiates the operation of a timer TR5. The timing out of the timer TR4 also opens the contact pair TR4A. This breaks the last hold path for the control relay CR4 and thereby causes the relay CR4 to de-energize. De-energization of the relay CR4 opens the contact pair CR4A which causes the relay CR5 to de-energize. This action disconnects the secondary of the transformer T from the electrode power supply circuit and thereby discontinues the operation of both of the electrodes **44** of the system **10**.

During the operation of the timer TR5 the interior of the housing **16** gradually cools. When the timer TR5 times out, it closes a normally open contact pair TR5A. This actuates an alarm A1 which produces a signal indicative of the end of the operating cycle of the system **10**. The alarm A1 is reset by actuation of a pushbutton PB4.

In addition to the various instrumentalities which control the normal functions of the system **10** the control circuit shown in FIG. **6** includes a temperature monitoring circuit TC which operates to discontinue the operation of the system **10** should the temperature of the cooling water in the tubes **24** and **26** exceed a predetermined level. The temperature monitoring circuit TC includes a temperature sensitive element and a relay (not shown) which operates under the control of the temperature sensitive element to open a normally closed contact pair TC1 should the temperature in the housing become too high. This action interrupts the operation of any of the timers TR1 through TR5 which may be operating and also discontinues the operation of the electrode power supply circuit which is connected to the contact pair TR1 through mated connector pairs C1–C2. In the event the operation of the system **10** is discontinued by the temperature monitoring circuit TC, it may be restarted by depressing the pushbutton PB4.

In some cases it is desirable to sputter substrates with platinum only rather than with both titanium and platinum. In such a case the switch S2 is actuated to break the connection from the pushbutton PB3 to the timer TR1 and to establish the connection with the pushbutton PB3 to the timer TR3. In such a case the operating cycle of the control circuit shown in FIG. **6** is the same as the complete operating cycle except that it begins with the initiation of the operation of the timer TR3 rather than with the initiation with the operation of the timer TR1.

From the foregoing it will be understood that the control circuit shown in FIG. **6** provides completely automatic control over the operation of the system **10**. This eliminates any possibility of human error in the operation of the system. Nevertheless, since each stage of the operation of the system **10** is controlled by a separate timer, the circuit shown in FIG. **6** allows complete control over every phase of the operation of the system.

Although only embodiment of the invention is illustrated in the drawing and described herein, it will be understood that the invention is not limited to the embodiment disclosed but is capable of rearrangement, modification and substitution of parts and elements without departing from the spirit of the invention.

What is claimed is:

1. A deposition system including:

a deposition chamber including at least two sputtering electrodes positioned at spaced points in the chamber;

means for transporting workpieces through the chamber;

means extending into the chamber for driving the transporting means;

wherein the workpiece transporting means includes a turntable and wherein the driving means alternately rotates the turntable in opposite directions;

a mask mounted in the chamber;

means coupling the mask to the driving means for moving the mask through the chamber;

means for limiting the movement of the mask in the chamber, and wherein the coupling means includes a slip clutch that couples the mask to the driving means for movement in opposite directions with the turntable and wherein the movement limiting means includes a pair of stops each for limiting the movement of the mask in a different direction and wherein the mask moving means and the movement limiting means cooperate to alternately position the mask in a blocking relationship with first one and then the other of the electrodes.

2. The deposition system according to claim **1** further including means for receiving material sputtered from the first electrode while the mask is positioned in alignment therewith and for producing an output indicative of the cleanliness of the first electrode.

3. The deposition system according to claim **1** wherein the workpiece moving means alternately moves workpieces through the chamber in two directions and wherein the mask moving means is coupled to the workpieces moving means and moves the mask to one of its positions whenever the workpieces moving means moves workpieces in one direction and moves the mask to the other of its positions whenever the workpiece moving means moves workpieces in the other direction.

4. The deposition system according to claim **1** further including means for operating the electrodes in sequence and for coordinating the operation of the mask moving means with the operation of the electrodes so that the mask blocks each electrode during the initial portion of the operation thereof.

5. The deposition system according to claim **1** wherein the mask moving means includes a pair of stops each corresponding to one of the positions of the mask and means for alternately moving the mask between the stops.

6. The deposition system according to claim **1** wherein the workpiece moving means includes a workpiece supporting turntable and a mechanism for rotating the turntable through the chamber and wherein the mask positioning means includes a mechanism for rotating the mask through the chamber and a clutch for coupling the mask rotating mechanism to the turntable rotating mechanism.

7. The deposition system according to claim **1** further including means for operating a first of the electrodes for a first period of time and for subsequently operating the second electrode for a second period of time and including a mask positioning means which positions the mask between the first electrode and the path during the initial portion of the first period, then positions the mask between the second electrode and the path during the terminal portion of the first period and during the initial portion of the second period, then positions the mask between the first electrode and the path during the terminal portion of the second period.

8. The deposition system according to claim **1** further including means for causing each electrode to sputter first onto the mask and then onto workpieces carried by the transporting means.

9. The deposition system according to claim **1** wherein the deposition chamber comprises housing means formed from a material having high thermal and electrical conductivity.

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