

DESCRIPTION

DEPOSITION MATERIAL SUPPLY SYSTEM

5 **Technical Field**

[0001]

The present invention relates to a deposition material supply system, and in more detail relates to a deposition material supply system which, in a vacuum deposition apparatus, quantitatively supplies a deposition material from a deposition material supply chamber to a ring hearth of a deposition chamber.

[0002]

A discharge electrode is formed on a front glass substrate which becomes a panel of a plasma display panel (PDP) used in a plasma television, and a magnesium oxide (MgO) film is formed to protect the discharge electrode. The marked spread of plasma televisions in recent years rapidly increases the demand for panels, and accordingly a vacuum deposition apparatus for MgO film formation is required to increase its production capacity.

[0003]

As an MgO supply system in a conventional vacuum deposition apparatus for MgO film formation, such one as shown in Fig. 21 is known. Referring to Fig. 21, a carrying mechanism 128 for carrying in and out a

substrate G on which an electrode is formed in a horizontal position is provided in an upper portion of a deposition chamber 120 of the vacuum deposition apparatus, and two ring hearths 150 to evaporate MgO pellets as a material for a protective film each together with a pierce gun 151 to generate an electron beam are placed below the glass substrate G. A deposition material supply chamber 110 is provided above either side portion of the deposition chamber 120, and a mechanism for feeding the MgO pellets into the deposition chamber 120 is provided in the deposition material supply chamber 110 and connected with the deposition material supply chamber 110 via a gate valve 113. In the deposition chamber 120, rotary cylindrical feeders 141 each being a mechanism for supplying the MgO pellets to the ring hearth 150 are provided. The deposition chamber 120 is evacuated by vacuum pumps 109, and the deposition material supply chamber 110 is evacuated by a vacuum pump not shown. Incidentally, the MgO pellet is supplied as a granular or columnar one (for example, having 5 mm to 6 mm in diameter and 3 mm to 5 mm in height).

Background Art

[0004]

However, with the recent increase in the size of the glass substrate, there arises a need for arranging

three ring hearths 150 side by side in the deposition chamber 120 as shown in Fig. 22. Above these ring hearths, as shown in Fig. 22, the glass substrate G is transferred by the mechanism 128 in a direction perpendicular to the paper surface, but even if the same deposition material supply system as in the case of the ring hearths 150 at both ends is tried to be provided in order to supply MgO pellets as a deposition material to the middle ring hearth 150, as is clear from the figure, the deposition material supply chambers 110 and the rotary cylindrical feeders 141 cannot be placed without affecting the glass substrate G.

[0005]

On the other hand, in Japanese Patent Application Laid-open No. 2003-321768, an apparatus in which circumferentially arranged three ring hearths are rotated and heated in sequence by an electron gun, above these ring hearths, plural substrates held by a circular substrate holder are rotated, and thereby a deposition material from the ring hearths is deposited thereon is described. The deposition material is supplied to these ring hearths by a linear feeder. Thus, the deposition material can be evenly supplied to the three ring hearths. The apparatus is not an apparatus in which as in the present invention, a substrate is transferred in a predetermined direction

above ring hearths arranged in a lower portion thereof,
and the controllability of the linear feeder is not
described at all.

[0006]

5 Patent Document 1: Japanese Patent Application Laid-
open No. 2003-321768

Patent Document 2: Japanese Patent Application Laid-
open No. 2000-199050

10 **Disclosure of the Invention**

Problem to be solved by the Invention

[0007]

The present invention is made in view of the
foregoing problem, and seeks to provide a deposition
15 material supply system capable of, with respect to
three or more ring hearths arranged side by side in a
width direction of a substrate to be transferred,
supplying a deposition material also to a middle ring
hearth other than ring hearths at both ends and besides
20 capable of evenly supplying the deposition material to
all the ring hearths.

Means for solving the problem

[0008]

The foregoing problem is solved by a deposition
25 material supply system of a vacuum deposition apparatus
characterized in that in the vacuum deposition
apparatus which evaporates a deposition material

supplied from a deposition material supply chamber
accommodating a large quantity of the deposition
material lasting long-period continuous running on a
ring hearth in a deposition chamber to thereby form a
5 film on a substrate transferred above the ring hearth,
three or more of the ring hearths are arranged side by
side in a width direction of the transferred substrate,
and the deposition material is supplied to at least a
middle ring hearth other than ring hearths at both ends
10 by an electromagnetic vibrating feeder allowed to
adjust a supply quantity of the deposition material.

[0009]

Further, the foregoing problem is solved by a
deposition material supply system of a vacuum
15 deposition apparatus characterized in that in the
vacuum deposition apparatus which evaporates a
deposition material supplied from a deposition material
supply chamber accommodating a large quantity of the
deposition material lasting long-period continuous
20 running on a ring hearth in a deposition chamber to
thereby form a film on a substrate transferred above
the ring hearth, three or more of the ring hearths are
arranged side by side in a width direction of the
transferred substrate, the deposition material is
25 supplied to at least a middle ring hearth other than
ring hearths at both ends by an electromagnetic
vibrating feeder allowed to adjust a supply quantity of

the deposition material, and in the deposition material supply chamber at either end, a deposition material hopper which discharges the deposition material downward, a weighing hopper which weighs the deposition material discharged from the deposition material hopper and receives a fixed quantity of the deposition material, and a funnel-shaped hopper which receives a fixed quantity of the deposition material discharged from the weighing hopper and discharges it downward, and a quantitative transfer unit which receives the deposition material discharged from the funnel-shaped hopper and supplies it to the ring hearth therebelow at a predetermined supply speed are placed.

Effect of the Invention

[0010]

Also when three or more ring hearths are arranged side by side in a width direction of a substrate to be transferred and the substrate to be subjected to film formation is transferred above these ring hearths, a deposition material can be evenly supplied to each of the ring hearths, and a uniform film can be formed on the substrate.

Brief Description of Drawings

[0011]

[Fig. 1] Fig. 1 is a front sectional view of a

deposition apparatus according to a first embodiment of the present invention;

[Fig. 2] Fig. 2 is a longitudinal sectional view of a deposition material supply chamber in the apparatus;

5 [Fig. 3] Fig. 3 is a plan view of a deposition material supply chamber in the first embodiment of the present invention;

[Fig. 4] Fig. 4 is a fragmentary view taken in the direction of the arrows along the line [4]-[4] in Fig.
10 2;

[Fig. 5] Fig. 5 is a fragmentary view taken in the direction of the arrows along the line [5]-[5] in Fig.
2;

[Fig. 6] Figs. 6 are sectional views conceptually
15 showing the movement and weighing of MgO pellets by a first light sensor, opening and closing of a first discharge port of a deposition material hopper, and opening and closing of a second discharge port of a weighing hopper;

20 [Fig. 7] Figs. 7 are views showing a rotary cylindrical feeder and a ring hearth in a deposition chamber, Fig. 7-A is a partially omitted plan view, and Fig. 7-B is a partially cutaway side view;

[Fig. 8] Fig. 8 is a sectional view showing the
25 operation of the rotary cylindrical feeder;

[Fig. 9] Fig. 9 is a partially omitted perspective view conceptually showing a deposition material supply

system constituted of three hoppers in the deposition material supply chamber and the rotary cylindrical feeder in the deposition chamber;

5 [Fig. 10] Fig. 10 is a plan view of an electromagnetic vibrating feeder applied to the embodiment of the present invention;

[Fig. 11] Fig. 11 is a side view of the same;

[Fig. 12] Fig. 12 is a sectional view in the direction of the line [12]-[12] in Fig. 10;

10 [Fig. 13] Fig. 13 is a sectional view in the direction of the line [13]-[13] in Fig. 12;

[Fig. 14] Fig. 14 is a front view of the same;

15 [Fig. 15] Fig. 15 is a graph showing a relationship between a coil current value and an MgO carrying quantity in the electromagnetic vibrating feeder;

[Fig. 16] Fig. 16 is a side view showing a case where three-step electromagnetic vibrating feeders are lined up with a level difference being provided therebetween;

20 [Fig. 17] Fig. 17 is a partial side view illustrating vacuum sealing of a coil of the electromagnetic vibrating feeder;

[Fig. 18] Fig. 18 is a graph showing a relationship between a particle size of carried MgO and splash occurrence frequency;

25 [Fig. 19] Fig. 19 is a side view showing a case where wire netting is stretched over a trough;

[Fig. 20] Fig. 20 is a schematic plan view showing a

modified example of the deposition apparatus;

[Fig. 21] Fig. 21 is a sectional front view of a deposition apparatus of a conventional example; and

[Fig. 22] Fig. 22 is a sectional front view showing a case where in Fig, 21, three ring hearths are arranged side by side.

Description of reference numerals

[0012]

- | | | |
|----|----|------------------------------------|
| 10 | 10 | Deposition Material Supply Chamber |
| | 11 | Deposition Material Hopper |
| | 12 | First Discharge Port |
| | 13 | First Pivot Shaft |
| | 14 | First Opening/Closing Arm |
| 15 | 15 | Insertion Plug |
| | 16 | First Air Cylinder |
| | 17 | Pipe-Shaped Heater |
| | 20 | Deposition Chamber |
| | 21 | Weighing Hopper |
| 20 | 22 | Second Discharge Port |
| | 23 | Second Pivot Shaft |
| | 25 | Cover Plate |
| | 26 | Second Air Cylinder |
| | 27 | First Light Sensor |
| 25 | 30 | Inflow Guide |
| | 31 | Funnel-Shaped Hopper |
| | 32 | Discharge Pipe |

- 33 Trough
- 34 Base
- 35 Leaf Spring
- 37 Coil
- 5 41 Rotary Cylindrical Feeder
- 42 Cylindrical Container
- 43 Ribbon-Shaped Screw
- 44 Rotating Shaft
- 47 Motor
- 10 48 Decelerator
- 49 Supply Chute
- 50 Ring Hearth
- F Electromagnetic Vibrating Feeder
- S Wire Netting

15

Best mode for carrying out the Invention

[0013]

As shown in Fig. 1, a deposition material supply system of the present invention is applied to a vacuum deposition apparatus having the same constitution as that shown in Fig. 22 of a conventional example, and a deposition material supply chamber in the deposition material supply system for a ring hearth at either end is shown by Fig. 2 to Fig. 5. Namely, Fig. 2 is a longitudinal sectional view schematically showing a deposition material supply chamber 10, and Fig. 3 is a plan view of the deposition material supply chamber 10.

Further, Fig. 4 is a sectional view in the direction of the line [4]-[4] in Fig. 2, and Fig. 5 is a sectional view in the direction of the line [5]-[5] in Fig. 2.

[0014]

5 Referring to Fig. 2, a deposition material hopper 11, a weighing hopper 21 directly below a first discharge port 12 of the deposition material hopper 11, a funnel-shaped hopper 31 directly below a second discharge port 22 of the weighing hopper 21 are
10 provided in the deposition material supply chamber 10, and a discharge pipe 32 at the bottom of the funnel-shaped hopper 31 is inserted into a deposition chamber 20. The deposition material supply chamber 10 is evacuated by a vacuum pump 9. Further, referring to
15 Fig. 2, Fig. 3, and Fig. 5, 12 pipe-shaped heaters 17 are provided, suspended from a ceiling portion 1 of the deposition material supply chamber 10 so as to be stuck into MgO pellets as a deposition material in the deposition material hopper 11. Additionally, a heater
20 is wrapped around an outer wall of the weighing hopper 21. Besides, referring to Fig. 2 to Fig. 4, an input cover 4 which is opened when the MgO pellets are put into the deposition material hopper 11 is provided in the ceiling portion 1.

25 [0015]

 The cylindrical first discharge port 12 of the deposition material hopper 11 is closed by inserting an

insertion plug 15 constituted of a columnar portion 15b
fixed to a front end side of a flat plate portion 14p
of a first opening/closing arm 14 turned by a first
pivot shaft 13 and a conical portion 15a thereon having
5 the same diameter from below, and opened by pulling out
the insertion plug 15 downward. Further, the second
discharge port 22 of the weighing hopper 21 is closed
by bringing a cover plate 25 turned by a second pivot
shaft 23 into contact therewith in an inclined state
10 from below, and opened by separating the cover plate 25
downward therefrom. Referring to Fig. 4, the first
pivot shaft 13 which causes the first discharge port 12
of the deposition material hopper 11 to be opened and
closed is driven by an air cylinder 16, and referring
15 to Fig. 5, the second pivot shaft 23 which causes the
second discharge port 22 of the weighing hopper 21 to
be opened and closed is driven by an air cylinder 26.
[0016]

The above deposition material hopper 11 can
20 accommodate the MgO pellets of a quantity enabling
continuous running of the vacuum deposition apparatus,
for example, for two weeks or more. The weighing hopper
21 receives the MgO pellets discharged by opening the
first discharge port 12 of the deposition material
25 hopper 11 thereabove with the second discharge port 22
at its bottom being closed, and the quantity to be
received is always a fixed quantity. Namely, referring

to Fig. 2, the weighing hopper 21 is provided with a first light sensor 27 constituted of a light-emitting element 27a attached to one sidewall of sidewalls facing each other at a predetermined height and a
5 light-receiving element 27b attached to the other sidewall, so that when the quantity of the MgO pellets received from the deposition material hopper 11 increases and thereby light from the light-emitting element 27a to the light-receiving element 27b of the
10 first light sensor 27 is cut off by the MgO pellets, the cutoff is detected and the first discharge port 12 of the deposition material hopper 11 is closed. The quantity of the MgO pellets weighed by the weighing hopper 21 is a quantity corresponding to the quantity
15 to be supplied to a rotary cylindrical feeder 41 described later in the deposition chamber 20.

[0017]

The funnel-shaped hopper 31 existing directly below the second discharge port 22 of the weighing
20 hopper 21 is a hopper to guide the MgO pellets discharged from the weighing hopper 21 as they are to the rotary cylindrical feeder 41 placed in the deposition chamber 20 without scattering and losing them, and the discharge pipe 32 in a vertical direction
25 attached to a bottom portion is inserted into the deposition chamber 20 without the bottom portion being opened and closed.

[0018]

Figs. 6 are partially omitted perspective views schematically showing the discharge and weighing of the MgO pellets by the above first light sensor 27, opening and closing of the first discharge port 12 of the deposition material hopper 11, and opening and closing of the second discharge port 22 of the weighing hopper 21. Namely, Fig. 6-A shows a state where the first discharge port 12 of the deposition material hopper 11 is closed, the MgO pellets are accommodated in the deposition material hopper 11, and the second discharge port 22 of the weighing hopper 21 to which the first light sensor 27 for weighing is attached is closed, Fig. 6-B shows a state where the first pivot shaft 13 turns the first opening/closing arm 14 and the insertion plug 15 downward to open the first discharge port 12 of the deposition material hopper 11 to thereby discharge the MgO pellets to the weighing hopper 21 therebelow, and Fig. 6-C shows a state where the surface level of the MgO pellets accommodated in the weighing hopper 21 rises and thereby a ray of light from the light-emitting element 27a to the light-receiving element 27b of the first light sensor 27 is cut off, whereby the first discharge port 12 of the deposition material hopper 11 is closed by inserting the insertion plug 15 thereinto by turning the first pivot shaft 13 in a reverse direction, so that a fixed

quantity of the MgO pellets are accommodated,
thereafter the second pivot shaft 23 turns the cover
plate 25 downward and thereby the fixed quantity of the
MgO pellets weighed in the deposition material hopper
11 are discharged to an upstream end portion of an
inflow guide 30 in the deposition chamber 20 therebelow
via the funnel-shaped hopper 31.

[0019]

Fig. 7s are views showing the rotary cylindrical
feeder 41 shown with a ring hearth 50 placed in the
deposition chamber 20, Fig. 7-A is a partially omitted
plan view, and Fig. 7-B is a partially cutaway side
view. As shown in Fig. 7-B, in the rotary cylindrical
feeder 41, a ribbon-shaped screw 43 is attached to an
inner peripheral surface of a cylindrical container 42
which is rotated with its axis center inclined, and a
rotating shaft 44 of the cylindrical container 42 is
supported by a bracket 46 via a bearing 45. The inner
capacity of the cylindrical container 42 is set larger
than the quantity of the MgO pellets in the weighing
hopper 21. The rotating shaft 44 is driven by the motor
47 and rotated while being decelerated by a decelerator
48. The above rotating shaft 44 is inclined at an angle
of 55 degrees with respect to a horizontal surface. As
shown in Fig. 8, the MgO pellets in the cylindrical
container 42 to which the ribbon-shaped screw 43 is
attached are transferred upward along the lowest

portion of an inner wall surface of the cylindrical container 42 being rotated and sent out from the lowest portion of an upper end edge of the cylindrical container 42.

5 [0020]

Incidentally, although not shown, a second light sensor which is monitoring the number of rotations of the rotating shaft 44 is provided near the rotating shaft 44. The supply quantity of the MgO pellets from the rotary cylindrical feeder 41 to the ring hearth 50 is calculated by the number of rotations of the rotating shaft 44, and when the supply quantity reaches a predetermined value, the second discharge port 22 of the weighing hopper 21 is opened, and the MgO pellets are discharged to the rotary cylindrical feeder 41 via the funnel-shaped hopper 31.

15

[0021]

Moreover, a supply chute 49 to receive the MgO pellets sent out from the cylindrical container 42 of the rotary cylindrical feeder 41 and supply them to the ring hearth 50 is provided near the downstream side of the rotary cylindrical feeder 41. Namely, one end side of the supply chute 49 is situated close to and so as to surround the upper end edge of the rotating cylindrical container 42, and the other end side extends to a position directly above the ring hearth 50. Further, referring to Fig. 9 which is a partially

20

25

omitted perspective view showing the deposition material supply chamber 10, the rotary cylindrical feeder 41, and the ring hearth 50 and a view showing a deposition material supply system of an embodiment of the present invention, in the deposition chamber 20 into which the discharge pipe 32 at the bottom of the funnel-shaped hopper 31 is inserted, the inflow guide 30, located directly below the discharge pipe 32, to guide the MgO pellets to the rotary cylindrical feeder 41 is provided, and a downstream end of the inflow guide 30 is placed so as to cover the rotating cylindrical container 42 at a slight distance therefrom. Further, the above supply chute 49 is placed downstream side of the rotary cylindrical feeder 41.

[0022]

Next, an electromagnetic vibrating feeder F used as a means for supplying the deposition material from the same deposition material supply chamber 10 as above to the middle ring hearth 50 will be described. As shown in Fig. 10 to Fig. 14, a base 34 is placed below a gutter-shaped trough 33, and the trough 33 is joined with this base by a pair of inclined leaf springs 35 and fixed to a trough mounting member 36 by bolts. Below this mounting member 36, an electromagnetic coil 37 is fixed to the above base 34. When an alternating current is passed through the electromagnetic coil 37, referring to Fig. 17, alternating magnetic attraction

force is generated between a fixed core 38 and a movable core 39, the trough 33 vibrates in the direction of the arrow α (Fig. 12) and MgO on the trough 33 is carried in the direction of the arrow P (Fig. 12) since the pair of leaf springs 35 is placed with an inclination.

[0023]

Fig. 15 shows a relationship between a coil current value and an MgO carrying quantity. This is created from mean values of 10 measurement values and highly reliable. It can be seen that when the coil current value which is represented by the horizontal axis increases, the MgO carrying quantity kg/hr increases almost linearly. This shows that the MgO carrying quantity can be easily adjusted by changing the current to be applied to the coil, for example, the magnitude of variable resistance. Thus, although MgO is supplied from the deposition material supply chamber 10 to the ring hearth 50 at either end portion, if the coil current value is adjusted so that the supply quantity becomes equal to the above supply quantity, MgO can be supplied evenly to three ring hearths 50.

[0024]

Fig. 18 is a graph showing a relationship between an MgO pellet particle size X (mm) and splash occurrence frequency (number of splashes per minute) where the acceleration voltage of an electron gun is 20

kv, the deposition speed is 3.6 nm/s, and the emission current of the electron gun is 200 mA, and the splash occurrence frequency is 1.2 when the MgO particle size X is 0.8 to 1.5, whereas the splash occurrence frequency is 0 when the MgO particle size X is 1 to 3, 2 to 3, and 4 to 5. Accordingly, if, as shown in Fig. 19, wire netting (for example, punching metal) S as a classifying means is stretched over the trough 33 and its pore size is set to 1 mm or 1.5 mm or less, MgO having a particle size equal to or less than the above size can be removed, whereby the occurrence of splashes can be mostly eliminated.

[0025]

In Fig. 19, numeral 52 represents a guide tube to collect MgO which has fallen from pores of the wire netting S. A receiving box 53 to accommodate MgO having a small particle size is provided therebelow.

[0026]

Incidentally, if instead of stretching the wire netting S of Fig. 19, the trough 33 is placed slightly upward with respect to a material transfer direction j, smaller MgO particles gradually occupy a lower portion of a layer to be transferred by a publicly known vibrating action, and they gather at a right end portion of the trough 33 in this figure, so that it is only necessary to provide the receiving box 53 at a right end.

[0027]

Fig. 17 shows a seal mechanism of the electromagnetic coil 37, and a casing 40 is attached to the base 34 via a seal ring g so as to surround the coil 37. Although not shown, a through hole is provided in this base 34 (needless to say, inside the seal ring g), a lead wire to supply the current to be applied to the electromagnetic coil 37 is inserted therethrough, and although not shown, a cooling pipe to cool the electromagnetic coil 37 is inserted though the same through hole.

[0028]

The electromagnetic coil 37 is manufactured in a publicly known manner, and its outer insulating material is, for example, impregnated with varnish to ensure insulation. When the current is applied to the coil 37 in a vacuum, as might be expected, the coil 37 generates heat and rises in temperature. Consequently, a vacuum atmosphere is contaminated by the varnish and other evaporants, thereby adversely affecting film formation in the deposition chamber 20. Hence, it is desirable that as described above, the coil 37 be insulated from the vacuum atmosphere by the casing 40. However, depending on the structure of the coil 37 or depending on the heat generation temperature of the coil, it is also possible to omit the casing 40 for sealing and expose the coil in the deposition chamber

20.

[0029]

The embodiment of the deposition material supply system is constituted as above, and its operation will be described below.

[0030]

Referring to Fig. 1 to Fig. 5, in Fig. 2, it will be assumed that the deposition material hopper 11 of the deposition material supply chamber 10 is in a state where the insertion plug 15 with a conical portion 15a is inserted into the cylindrical first discharge port 12 at its bottom and thereby the first discharge port 12 is closed, the MgO pellets of a quantity enabling continuous running for two weeks or more of the vacuum deposition apparatus are accommodated in the deposition material hopper 11 and are in a heated state by the pipe-shaped heaters 17 inserted into the MgO pellets in the deposition material hopper 11, the deposition material supply chamber 10 is evacuated by the vacuum pump 9, and that moisture contained in the MgO pellets is sufficiently removed. Further, it will be assumed that the weighing hopper 21 accommodates a weighed predetermined quantity of the MgO pellets with its second discharge port 22 closed. Furthermore, citing Fig. 9, it will be assumed that also in the evacuated deposition chamber 20, a fixed quantity of the MgO pellets are accommodated in the cylindrical container

42 of the rotary cylindrical feeder 41, and that the rotary cylindrical feeder 41 and the ring hearth 50 are actuated.

[0031]

5 In the deposition chamber 20, referring to Fig. 7-B, the MgO pellets in the cylindrical container 42 of the rotary cylindrical feeder 41 rotated by the inclined rotating shaft 44 rise along the inner peripheral surface by the ribbon-shaped screw 43, are
10 quantitatively sent out from the lowest portion of the upper end edge and evenly supplied onto the ring hearth 50 which is rotating at a low rotation speed (for example, one rotation per hour) through the supply chute 49, and forms an MgO-deposited film on a
15 substrate in the deposition chamber 20. The number of rotations of the rotating shaft 44 of the rotary cylindrical feeder 41 is monitored by the second light sensor, and the supply quantity from the cylindrical container 42 to the ring hearth 50 is calculated,
20 whereby when the supply quantity reaches the predetermined value, the second air cylinder 26 is driven to turn the second pivot shaft 23 and also turn the cover plate 25 and thereby the second discharge port 22 of the weighing hopper 21 is opened, so that
25 the MgO pellets are discharged from the weighing hopper 21, received by the funnel-shaped hopper 31, and discharged from the vertical discharge pipe 32 at the

bottom of the funnel-shaped hopper 31 into the cylindrical container 42 of the rotary cylindrical feeder 41 via the inflow guide 30 of the deposition chamber 20. The capacity of the cylindrical container 42 is made larger than the quantity of the MgO pellets in the weighing hopper 21, so that the MgO pellets never overflow from the cylindrical container 42.

[0032]

When the cover plate 25 of the weighing hopper 21 is opened and a predetermined time passes, the second air cylinder 26 is actuated, the second pivot shaft 23 is turned in a reverse direction, and the cover plate 25 closes the second discharge port 22 of the weighing hopper 21. Subsequently, referring also to Fig. 6, the first air cylinder 16 is driven, the first pivot shaft 13, together with the first opening/closing arm 14, is turned, the insertion plug 15 which closes the first discharge port 12 of the deposition material hopper 11 is pulled out from the first discharge port 12, and the MgO pellets are discharged from the deposition material hopper 11 to the weighing hopper 21 by their own weight. With the passage of time, the surface level of the MgO pellets accommodated in the weighing hopper 21 rises, and when a cutoff of a ray of light from the light-emitting element 27a to the light-receiving element 27b of the first light sensor 27 by the accommodated MgO pellets is detected, the above first

air cylinder 16 is driven in a reverse direction, the insertion plug 15 is inserted into the first discharge port 12, and the first discharge port 12 of the deposition material hopper 11 is closed. At this time, it is closed by a conical surface of the conical portion 15a of the insertion plug 15 coming into contact with a lower end of the cylindrical first discharge port 12, but it is also possible to stop the insertion plug 15 by putting a distance smaller than the size of the MgO pellet between the lower end of the first discharge port 12 and the conical surface of the conical portion 15a. Thus, the predetermined quantity of the MgO pellets are accommodated in the weighing hopper 21. After this, the same operation is repeated, and film formation of the MgO film on a substrate G by the deposition material supply system is performed continuously over a long period.

[0033]

In addition to the above insertion plug 15, an insertion plug (corresponding to 15 in Fig. 2) such that using a columnar portion (corresponding to 15b in Fig. 2) whose diameter is made slightly smaller and a conical portion (corresponding to 15a in Fig. 2), and a gap between an outer peripheral surface of the columnar portion (corresponding to 15b in Fig. 2) and an inner surface of the first discharge port 12 is smaller than the size of the MgO pellet is also possible. In so

doing, the MgO pellets do not fall into the above gap, whereby the MgO pellets never get caught between the lower end of the first discharge port 12 and the flat plate portion 14p of the first opening/closing arm 14 to which the insertion plug (corresponding to 15 in Fig. 2) is fixed. Besides, a conical insertion plug having a bottom surface with the same diameter as a bottom surface of the insertion plug 15 or a conical insertion plug having a bottom surface with the same diameter as a bottom surface of the above insertion plug (corresponding to 15 in Fig. 2) with the slightly smaller diameter can be adopted.

[0034]

Moreover, according to the present invention, MgO is supplied from the electromagnetic vibrating feeder F to the middle ring hearth 50 out of three ring hearths 50 arranged side by side. As shown in Fig. 1, the substrate G to be subjected to deposition is being transferred in a direction orthogonal to the direction of the side-by-side arrangement, the electromagnetic vibrating feeder F is placed without its device height being set as large as that of the deposition material supply chamber 10 on either side and at a height lower than that thereof, whereby there is no problem in terms of the structure of the device, and further as described in Fig. 15, it is experimentally confirmed that when the coil current value is changed, for

example, from 0.4 A to 0.7 A as in Fig. 15, the MgO carrying quantity kg/hr almost linearly changes. In particular, the graph in Fig. 15 shows measurements from mean values of 10 measurements and is highly
5 reliable. If this graph is stored as a function in a storage of a control unit, it is possible to regulate the coil current value so that the supply quantity becomes equal to the supply quantity from the deposition material supply chamber 10 on either side
10 using this relationship and supply the same quantity as on either side also to the middle hearth 50.

[0035]

The embodiment of the present invention is described above, but the present invention is not
15 limited to the above but can be variously modified based on the technical idea of the present invention.

[0036]

For example, in the above embodiment, three ring hearths 50 are arranged side by side, but many more
20 ring hearths may be arranged side by side. Further, in the above embodiment, three ring hearths are used and MgO is supplied to the middle ring hearth 50 by the electromagnetic vibrating feeder F, but in the case of three or more ring hearths, it may be supplied to all
25 ring hearths other than ring hearths at both ends by the electromagnetic feeder F.

[0037]

Further, it may be also supplied to the ring
hearth 50 at either end by the electromagnetic
vibrating feeder F in place of the above rotary
cylindrical feeder 41. Furthermore, also at the
5 uppermost stream end of the electromagnetic vibrating
feeder, MgO may be supplied from the same device as the
deposition material supply chamber 10 on either side in
Fig. 1. Needless to say, in place of the above, MgO may
be supplied to the electromagnetic feeder from an
10 ordinary hopper.

[0038]

Fig. 20 shows a modified example of the present
invention, and in this case, the rotary cylindrical
feeders 41 on both sides are omitted, and instead,
15 electromagnetic vibrating feeders F1, F3, and F4 are
placed with their discharge ports facing onto the ring
hearths 50 respectively. Above upstream side end
portions of the electromagnetic vibrating feeders F1
and F4 at both ends, downstream side end portions of
20 similar electromagnetic vibrating feeders F2 and F5 are
placed with a level difference therebetween. Needless
to say, a hopper to accommodate MgO or the deposition
material supply chamber 10 such as shown in Fig. 1 may
be provided at an upstream side end portion of each of
25 the electromagnetic vibrating feeders F2, F3, and F5.
In this case, the characteristic of the electromagnetic
vibrating feeder can be sufficiently exploited. The

height of the entire deposition apparatus can be made
far lower than in the above embodiment. Moreover, the
vacuum chamber space limited by placement, connection,
and so on in an orthogonal or oblique direction can be
5 effectively used with the level difference between the
electromagnetic vibrating feeders as shown in Fig. 20.

CLAIMS

[1] A deposition material supply system of a vacuum deposition apparatus, wherein in the vacuum deposition apparatus which evaporates a film forming material supplied from a deposition material supply chamber accommodating a large quantity of the deposition material lasting long-period continuous running on a ring hearth in a deposition chamber to thereby form a film on a substrate transferred above the ring hearth, three or more of the ring hearths are arranged side by side in a width direction of the transferred substrate, and the deposition material is supplied to at least a middle ring hearth other than ring hearths at both ends by an electromagnetic vibrating feeder allowed to adjust a supply quantity of the deposition material.

[2] The deposition material supply system as set forth in claim 1, wherein the electromagnetic vibrating feeder is constituted of a linear trough and an electromagnetic coil which drives the trough.

[3] The deposition material supply system as set forth in claim 2, wherein a classifying means is provided in the electromagnetic vibrating feeder.

[4] The deposition material supply system as set forth in claim 3, wherein wire netting is stretched in the

trough of the electromagnetic vibrating feeder.

[5] The deposition material supply system as set forth in claim 2, wherein a coil main body of the
5 electromagnetic coil is vacuum-sealed and fixed to a base of the electromagnetic vibrating feeder by a sealed casing, an electric lead wire to supply power to the electromagnetic coil is inserted in the base, and a cooling medium supply pipe of a cooling coil to cool
10 the main body of the electromagnetic coil and a discharge pipe are led out to an atmosphere side.

[6] The deposition material supply system as set forth in claim 2, wherein a carrying quantity of the
15 deposition material is adjusted by changing a magnitude of a current to be passed through a main body of the electromagnetic coil.

[7] The deposition material supply system as set forth
20 in claim 1, wherein the electromagnetic vibrating feeder is constituted of a plurality of electromagnetic vibrating feeder portions with a level difference being provided therebetween.

[8] A deposition material supply system of a vacuum
25 deposition apparatus, wherein in the vacuum deposition apparatus which evaporates a deposition material

supplied from a deposition material supply chamber
accommodating a large quantity of the deposition
material lasting long-period continuous running on a
ring hearth in a deposition chamber to thereby form a
5 film on a substrate transferred above the ring hearth,
a deposition material hopper, a weighing hopper which
receives a fixed quantity of the deposition material
discharged from the deposition material hopper, and a
funnel-shaped hopper which receives the deposition
10 material discharged from the weighing hopper and
discharges it downward are provided in the deposition
material supply chamber, a quantitative transfer means
for supplying the deposition material discharged from
the funnel-shaped hopper to the ring hearth at a
15 predetermined supply speed is provided in the
deposition chamber, and as the quantitative transfer
means for supplying the deposition material to at least
a middle ring hearth other than ring hearths at both
ends of three or more ring hearths arranged side by
20 side in a width direction of the substrate transferred
in the deposition chamber, an electromagnetic vibrating
feeder is used.