APPARATUS FOR PRODUCING SEMICONDUCTOR DEVICES

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Fig.1

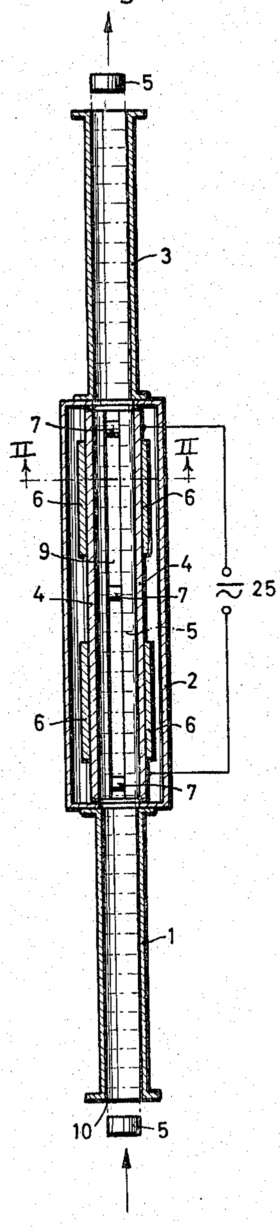


Fig.2

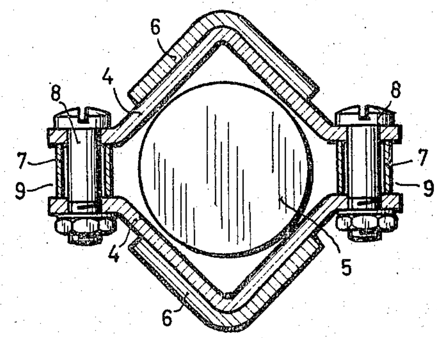
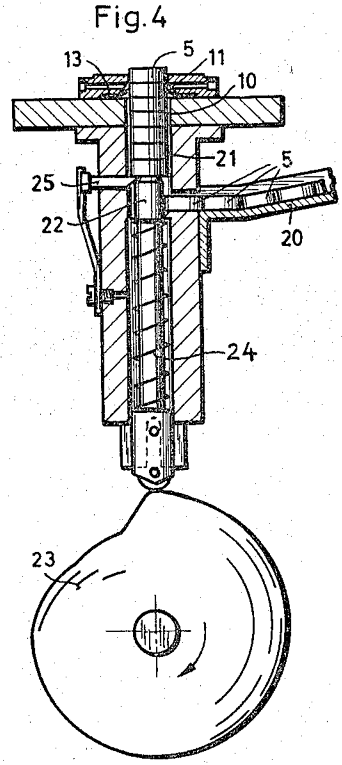


Fig.4



APPARATUS FOR PRODUCING SEMICONDUCTOR DEVICES

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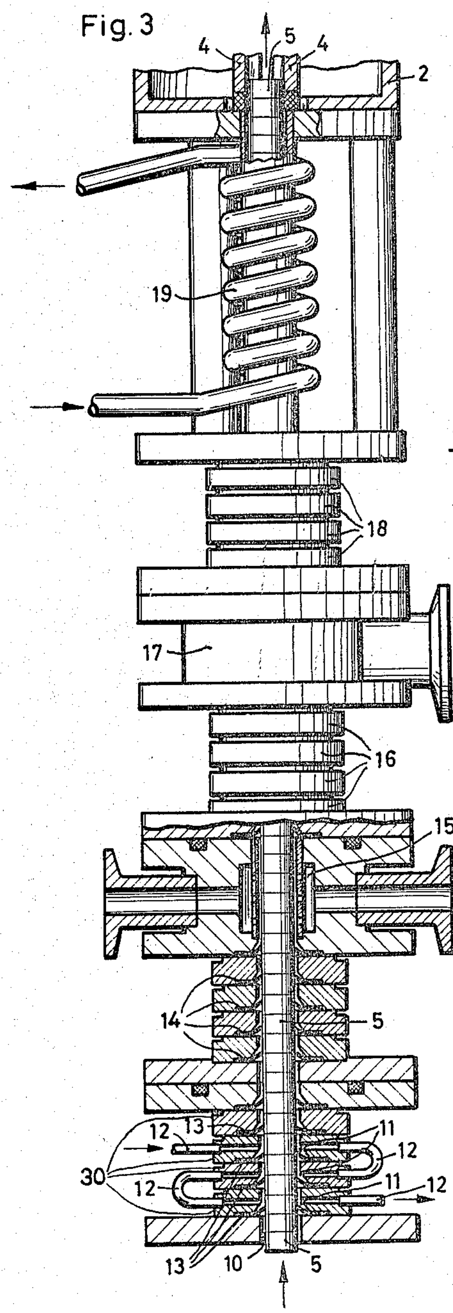
Fig. 3



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3,290,738
APPARATUS FOR PRODUCING SEMICONDUCTOR DEVICES

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14 Claims. (Cl. 22—75)

Our invention relates to apparatus for producing semiconductor devices, and more particularly to alloying apparatus for that purpose.

An alloying apparatus of this type used in mass production includes a furnace through which the semiconductor devices are fed continuously. Bodies of alloying systems, consisting of semiconductor crystals and alloying metals, which are housed in capsular alloying or contact molds serving mainly to mechanically protect the sensitive semiconductor crystals, are thus fed through the furnaces. Molds of this type are described for example in U.S. Patent No. 2,960,419. They are generally cylindrical but may also be in the form of prismatic bodies which are passed through the apparatus. They consist of temperature-resistant materials, particularly metal, metallic oxide or graphite. These molds are often not completely covered in order to permit access of treatment gases to the alloying systems and also facilitate complete removal of gas residues from semiconductor surfaces by vacuum.

In a known apparatus of the type to which our invention relates, at least three cylindrical or prismatic bodies of equal cross section are conveyed guidingly one directly behind the other through an air-tight treatment zone such as for example a container that has been evacuated or filled with protective gas, and which has moreover been heated. These bodies are superimposed face to face in columnar form and at least one of them serves as a container for semiconductors, semiconductor alloying systems or similar intermediate or partly manufactured semiconductor products that are to be processed.

It is an object of our present invention to improve such semiconductor production apparatus toward expediting and facilitating the charging and discharging of the semiconductor devices without contamination thereof and without loss of vacuum or protective gas.

To this end, and in accordance with a feature of our invention, we provide at the place where the bodies, which are displaceable in the direction of their axes, enter and leave the apparatus, at least three sealing lips placed one behind the other coaxially with the bodies. The lips have a flat ring shape and are made of plastic material. Their outer edges are gas-tightly connected to the wall of the treatment container while their inner edges lie closely against the surface of the bodies passing through them and are so spaced one behind the other with respect to the height of the bodies that are being passed through them that, during the operation of the apparatus, a gas-tight seal is always formed at the places of entry and discharge of the bodies by one of the bodies and at least one of the sealing lips.

According to another aspect of our invention, we provide an apparatus through which a column of bodies consisting usually of a plurality of similar, equally dimensioned alloying molds of substantially equal volume are being advanced for processing. The first and last of the bodies being processed may advantageously consist of blank molds or similarly shaped auxiliary bodies; by blank molds, we mean molds that are not provided with semiconductor devices that are to be processed. The apparatus is provided with a special drive mechanism for displacing the bodies which operates advantageosuly by simply pushing up one body after another into a heating region of the apparatus.

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According to another feature of our invention, the treatment container or alloying furnace is provided with a system of straight guides engaging the outer surfaces of the mold bodies and extending from the inlet to the outlet for the molds. The molds enter the apparatus at a point vertically below the point at which they emerge from the apparatus, and are advanced by being pushed from the bottom to the top of the apparatus.

Other features which are considered as characteristic for the invention are set forth in the appended claims. The construction and method of operation of the invention, however, together with additional objects and advantages thereof, will be best understood from the following description of a specific embodiment when read in connection with the accompanying drawings. Although the invention has been illustrated and described as embodied in apparatus for producing semiconductor devices, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims. In the figures:

FIG. 1 shows partly schematically and partly in section an alloying furnace for the continuous processing of semiconductor devices constructed in accordance with our invention;

FIG. 2 is a sectional view taken along the line II—II in FIG. 1 in the direction of the arrows;

FIG. 3 is a longitudinal view of the semiconductor production apparatus constructed in accordance with our invention; and

FIG. 4 is a fragmentary view of the apparatus of our invention showing the drive mechanism for displacing the molds.

Referring to the drawings and first particularly to FIG. 1, there is shown an alloying furnace which consists of three vertically superimposed tubular containers **1**, **2**, **3** of which the middle container **2** is heatable and is where the heat treatment actually takes place. The two end containers **1** and **3** serve as locks or gates for alloying molds **5** and also have additional functions described hereinbelow.

The container **2** is either evacuated or scavenged by a protective flow of gas. Evacuation pumps or devices for producing the protective gas flows or instruments for controlling evacuation or feeding of the protective gas flow or for controlling the temperature (all not shown) are provided in a manner well known in the art and form no part of our invention. Lines for feeding protective gas streams or evacuating the container **2** should be directly connected to the container **2** and not to the containers **1** and **3** which serve solely as locking or gating devices.

The middle container **2** is internally provided with at least two guide rails **4** that are formed of conductive, heat-resistant material such as molybdenum or any suitable heat-conducting substance simultaneously acting as means for heating the container **2**. The guide rails **4** are accordingly connected to an electric power source **25** of suitable intensity for heating the furnace (container **2**) substantially along its entire length. By providing suitable branching of the electric current or by suitably varying the electrically effective cross section of the rails **4**, the temperature field in the interior of the furnace can be adjusted as desired.

The arrangement of the rails **4** in the container **2**, i.e. the furnace, is shown in greater detail in FIG. 2 which consists of a cross section through both guide rails **4** along the line II—II in FIG. 1. Both rails 4 are of equal cross section and equal length, and can be connected in series or parallel to the source of current 25 for heating the same. A parallel connection is shown diagrammatically in FIG. 1.

As illustrated in FIG. 2, the rails 4 are connected to each other both mechanically and electrically by screws 8 and spacers 7 so that they are supplied with the same amount of electric current. The distance between the two rails 4 that are arranged parallel to each other, is adjustable by the spacers 7 and screws 8 so as to firmly hold between them the alloying molds 5 to prevent tilting or jamming of the molds between the rails. The distance between the rails is adjusted, however, so as not to prevent sliding of the alloying molds 5 in the direction of their longitudinal axes between and along the rails. It is furthermore also expedient as shown in FIG. 2 to select rails of such a cross section as to at least partially surround the periphery of the alloying molds.

It is additionally advisable that ample space be provided between the rails 4, i.e. the gaps 9 shown in FIG. 2, to prevent any hindrance to the evacuation of the container 2 or to access of treating gases to the alloying mold. This purpose is also served by providing the alloying molds with ducts or other openings that lead to the alloying systems in the interior of the molds.

The tubular containers 1 and 3 which serve as locks or gates for the alloying molds 5 are shown in FIG. 1 as being of similar construction, the structural elements of both being mere mirror image arrangements of each other as viewed from the middle container 2. An explanation of the details of construction of container 1 suffices for explaining the corresponding details of container 3 in accordance with FIG. 3.

The containers 1 and 3 serve primarily to prevent penetration of atmospheric air into the middle container 2 as much as possible so that the supply of protective gas or the vacuum provided in the middle container 2 is adequate for producing the necessary atmospheric or vacuum conditions, respectively, that are required in the interior of the container 2 during the operation of the apparatus.

As is shown in FIG. 3, the container 1 and the container 3 accordingly as aforesaid, include several ring-shaped members 30 that are tightly pressed against each other, thereby sandwiching between themselves the outer edges of a plurality of sealing lips 13. The inner wall surfaces of these ring-shaped members 30 simultaneously serve as guides for the molds 5 that are passed through them. If the molds are to be preheated or after-heated in addition to being heated in the container 2, the ring-shaped bodies can be made of electrically conductive material which can be heated in containers 1 and 3 in the same manner as the guides 4 of container 2. In a preferred embodiment the sealing lips 13 consist of elastic material, however preheating or after-heating is not recommended where the elastic material is of an organic nature, such as rubber, silicon rubber, and like materials which lend themselves very well for sealing purposes. In the embodiment illustrated in the figures, the two containers 1 and 3 serving as locks or gates for the container 2 are not heated.

The sealing lips 13 are in the shape of flat rings and are made of resilient, heat-resistant material or of elastic, smoothly sliding synthetic material, such as Teflon or rubber. The central openings of the sealing lips 13 must be somewhat smaller in diameter than the cross section of the alloying molds 5 and must correspond also to their shape. The sealing lips 13 consequently fit tightly against the peripheral surface of the alloying molds 5 as the latter pass through the central openings of the lips in the longitudinally extending direction of the apparatus.

The locking or gating process occurs as the alloying molds 5 which are inserted into the inlet 10 of the lower container 1, reach one or more of the antechambers 11 that are filled with the protective gas. The antechambers and their sealing lips 13, respectively, provide a scavenging lock or gate which prevents the escape of the protective gas. Since the heat treatment inside the furnace chamber 2 is carried out in a protective gas atmosphere, it is sufficient to provide several, i.e. at least three, scavenging chambers 11 in container 1 and a similar number accordingly, if desired, in container 3. A stream of hydrogen gas or inert gas is employed in a scavenging process within the chambers 11. The scavenging chambers 11 are connected in series with respect to the gas flow by a tube system 12 disposed in such a manner that the protective gas first enters the innermost of the chambers 11 and subsequently flows through all of the chambers until it finally reaches the outermost antechamber 11 adjacent the inlet 10. After the oxygen of the air in the antechambers 11 has been displaced by the protective gas, the alloying molds 5 continue to advance upwardly until they enter the furnace chamber 2 proper through a sealing lock or gate system which also consists of one or more sealing lips (not shown), when the heat treatment in chamber 2 is carried out with the same protective gas. Container 3 is of similar construction as the container 1, however the order in which the component elements of the container are arranged, as well as the direction of flow of the protective gas in the scavenging lock, are opposite to that of the container 1. In the event the heat treatment of the semiconductor crystals in the molds is to be carried out under vacuum rather than under protective gas, the hydrogen or inert gas which has displaced the air in the antechambers 11 is pumped out by a pump which is not illustrated in the drawings. At least one evacuation lock is accordingly provided in conjunction with the scavenging lock in container 1 and an additional evacuation lock is also provided before the scavenging lock of container 3. In light of our experimentation and observations it is recommended that evacuation of the alloying molds be effected in at least two stages, provided the furnace chamber 2 proper has a low gas pressure under 10^{-2} torr.

As shown in FIG. 3, a pre-evacuation stage 15 and an additional fine evacuation stage 17 are provided accordingly in contaniers 1 and 3 which serve as inlet or outlet lock, in opposite sequences, respectively. After the alloying molds 5 leave the innermost of the scavenging chambers 11 they enter the pre-evacuation chamber 15 through a sealing lock comprised of a plurality of sealing lips 14 arranged one above the other in a manner similar to those of the scavenging lock. A pressure of approximately 10^{-1} torr is effected by a vacuum pump (not shown) in the pre-evacuation chamber 15. The alloying molds 5 are then advanced upwardly into a chamber 17 which provides fine evacuation of the alloying molds and in which a pressure of approximately 10^{-3} torr is maintained by continuous pumping. Between the pre-evacuation chamber and the fine evacuation chamber, the alloying molds 5 pass through another sealing lock 16 also provided with sealing lips (not shown). The pressure in the fine evacuation stage 17 corresponds approximately to the pressure in the middle container 2 which is also maintained by continuous evacuation. Immediately preceding the entrance to the container 2 there is provided a cooling stage 19 for protecting the sensitive material of the sealing rings from the heat generated in the middle container 2. As shown, the cooling stage consists of a cooling coil through which a liquid coolant is pumped. Between the cooling stage 19 and the fine evacuation chamber 17 an additional lock 18 is provided with corresponding sealing lips (not shown). After the alloying molds 5 pass through the systems of locks provided in the container 1, they reach the furnace chamber 2 and pass through the temperature field present in that chamber. The speed at which the alloying molds travel through the furnace chamber 2 can be adjusted so that the alloying molds remain within the chamber 2 as long as is required for the alloying process.

The alloying molds are discharged from the furnace container 2 through a system of locks in container 3 whose construction corresponds to that of the container **1**, however, the various corresponding elements in container **3** are arranged opposite to those of container **1** so that the alloying molds emerging from the furnace chamber into the container **3** pass through the corresponding separate chambers in reverse sequence until they reach the outlet of container **3**. The scavenging lock at the outlet of container **3** may be omitted.

In FIG. 4 there is shown a device for mechanically feeding alloying molds **5** through an inlet lock of the container **1**, the device being suitably mounted directly below the inlet to the container **1**. The alloying molds **5** are delivered by a conveyor chute **20** or by any other suitable conveyor means such as a rotary conveyor table, into a vertically extending tube **21** leading directly to the inlet **10** of container **1**. A plunger **22** retractable at predetermined equal intervals permits each alloying mold **5** successively to enter the tube **21** and subsequently raises it together with the previously inserted column of alloying molds **5** by pushing upwardly thereon to a distance equal to the height of a single mold each time. The plunger **22** is accordingly retracted periodically by a rotating eccentric cam **23** in cooperation with a tension spring **24** which permits an alloying mold at a time to slide in front of the upper end face of the plunger. A blocking device **25** consisting of a resiliently mounted pin prevents the alloying molds **5** from dropping back downwardly when the plunger **22** is retracted.

For operating the described apparatus constructed in accordance with our invention, a column of alloying molds preferably not containing semiconductor crystals is inserted in the guides **4** of the apparatus or in lieu thereof one or more auxiliary bodies having a cross section substantially the same as that of the alloying molds is inserted in a like manner. The column of alloying molds or auxiliary bodies thus completely fills the tubular containers from the inlet **10** of the container **1** to the outlet of the container **3**. The middle container **2** is subsequently placed under vacuum or filled with a protective gas atmosphere as desired. Although the sealing lips in cooperation with the alloying molds **5** do prevent to a great extent the entry of atmospheric gases from the surroundings into the container **2**, the prevention of changes in the protective gas pressure conditions or vacuum conditions, respectively, that are present in the heat treatment container **2** proper due to contamination by the surrounding air is unavoidable. It is consequently advisable to provide a continuous supply of fresh protective gas or to continuously evacuate the container **2**.

The heating of container **2** is commenced either after or while the atmospheric conditions therein are being regulated. Temperature regulation is effected by suitably provided shunts **6** that have been previously installed as are shown in FIGS. 1 and 2. The simplest means of controlling the temperature is by suitable thermocontacts distributed along the rail system **4**. After the alloying molds which are preferably blank molds at first, i.e., without semiconductor devices, are inserted in the apparatus, the gas or vacuum conditions in the containers **1** and **3** are then adjusted, and subsequently the corresponding conditions in the interior of container **2** are adjusted. While the gas or vacuum conditions in container **2** are being adjusted, the rails **4** can be heated. After the temperature and gas or vacuum conditions have been adjusted in all of the containers **1**, **2**, **3**, additional alloying molds containing semiconductor devices that are to be treated are then inserted into the container **1** gradually at appropriate intervals by the feeding mechanism illustrated in FIG. 4. The period during which the individual molds **5** are in the furnace container **2**, and thereby the actual treatment time for each of the molds, is determined simultaneously by the number of alloying molds that are inserted by the feeding mechanism of FIG. 4 into the inlet **10** of the container **1** per unit of time.

We have described in the foregoing three different types of locks or gates, each of which corresponds to a particular novel feature of the invention. One type is the so-called "vacuum" or "evacuation" locks, typical examples of which are the locks **15** and **17** shown in FIG. 3. Other types are the "scavenging" locks, the "flood" locks and the "sealing" locks. As shown in FIG. 3, the "scavenging" locks are formed by the scavenging chambers **11** adjacent the inlet **10** of the container **1**, while the locks **14**, **16** and **18** constitute the so-called "sealing" locks. The characteristics of these types of locks are as follows:

All of the locks have sealing lips that are spaced at predetermined distances from one another depending upon the height of the alloying molds. The relationship of the height of the alloying molds to the spacing of the sealing lips is such that at least one of the sealing lips should be closely engaged by the peripheral surface of one of the alloying molds. If the alloying molds proper are gas-tight, the interchange of gas between both sides of the particular sealing lips that engage the alloying molds is thus prevented. However, if the alloying mold is not gas-tight (a characteristic of the alloying mold which is exploited by the scavenging locks to permit communication between one antechamber **13** and the next), gas flows through the alloying mold and consequently penetrates from one side of the sealing lip in engagement therewith to the other side thereof.

The individual sealing lips, as aforementioned, are flat rings or washers made of springy, heat-resistant material such as heat-resistant metal or elastic synthetic material that is mechanically resistant such as Teflon or silicon rubber. The sealing lips may also consist of natural caoutchouc or rubber. The central openings of the sealing lips which provide passage for the alloying molds **5** are somewhat smaller than the cross section of the alloying molds and correspond substantially to their outline so that the inner edge of the sealing lips lies tightly against the alloying molds **5** as they pass through the central opening of the sealing lips in an axial direction.

It is also desirable that both in containers **1** and **3** at least two of the sealing lips should have a smaller spacing between them than the distance or height of a single alloying mold. Thus, one of the sealing lips is always closed by one of the alloying molds. There are, however, many other possibilities of establishing the intervals or spacing between individual sealing lips relative to the height of the alloying molds thereby assuring that at least one of the sealing lips is in gas-sealing engagement with one of the alloying molds.

The "sealing" locks solely utilize the sealing ability of the sealing lips. As shown by reference numeral **14** in FIG. 3, for example, several sealing lips are provided (five being shown in this embodiment) for the sealing lock. These lips are maintained under tension and in a suitable position by a corresponding number of tightly and mutually engaging rings. Thus suitably constructed molds substantially completely prevent gas exchange between both sides of corresponding sealing lips that are in engagement with the molds or compel the gas exchange to take place within the alloying molds.

A further construction is exemplified by the "scavenging" locks which, as shown in FIG. 3, comprise scavenging chambers **11**, formed by adjacent rings between which sealing lips **13** are secured. A duct system connecting the individual antechambers **11** one after the other, i.e., in series, connects the flow of gas from one chamber to the next. This duct system, when in operation, is scavenged by a protective gas transversely to the axial direction of the containers **1**, **2**, **3** and so that the protective gas does not flow in the direction toward the heat treatment container **2** but rather in a direction toward the inlet **10** and to the outer atmosphere. These "scavenging" locks are particularly effective if the alloying molds are equipped with ducts, as is the case with many of them, to permit gas exchange between the two spaces on both sides of the sealing lip engaging the alloying mold, even when the sealing lips are tightly fitted to the surface of the mold. In such cases, the gas exchange occurs through the alloying mold when the flow resistance of the duct system which connects the scavenging chambers is sufficiently high, as shown for example in the duct system **12** shown in FIG. 3. For "scavenging" locks the recommended spacing of the corresponding sealing lips is such that they will be half the height of a single alloying mold or a multiple of that amount. The force of the gas flow in the "scavenging" lock causes entrainment of atmospheric gases that are inside the antechambers **11** and their consequent displacement. The duct system which forms part of the scavenging chambers can be suitably provided also with relief pressure valves that will permit transport of the gas by the duct system to the next succeeding scavenging chamber while the scavenging openings (provided in the alloying molds) are momentarily closed by the sealing lips.

In FIG. 3 is also shown a "vacuum" lock **15, 17** which permits advancement of the alloying molds through one or more pressure stages into the treatment container **2** which has a different gas pressure or is evacuated, or such a "vacuum" lock excludes the alloying molds from such heat treatment container. Consequently, at least one sealing lock must be associated with the "evacuation" lock, and at least one of the sealing lips of each pressure stage must simultaneously lie closely against the peripheral surface of an alloying mold that is present in the particular pressure stage. It is therefore expedient to arrange the sealing lips directly behind one another so as to increase the flow resistance in the spaces on both sides of such a sealing lip.

The aforementioned "flood" locks are a combination of vacuum and scavenging locks, having the advantage of being more effective than ordinary scavenging locks for keeping the treatment zone in container **2** free from undesirable instrusion of atmospheric gas. Such "flood" locks are therefore preferably employed for holding devices that are adapted to receive the material that is to be treated which are so closely fitted as to have only very small clearances, so that the desired atmosphere can be fed to the material to be treated only through small ducts, in other words, are employed when the desired purity of the atmosphere cannot be obtained by normal scavenging process. After an evacuation process, the scavenging locks are flooded with fresh gas and the process is repeated one or more additional times before the alloying molds are advanced into the container **2**. This process is analogous to decanting.

The invention was described in the foregoing essentially in relation to an alloying furnace through which molds are continuously fed. However, the alloying molds **5** can also be employed for otherwise processing semiconductor materials or workpieces required for producing semiconductor devices. In such cases, too, the apparatus constructed in accordance with our invention may also be used to advantage, requiring no changes as to the construction of the containers **1** and **3** which serve as inlet and outlet locks, whereas in the interior of the treatment container **2** proper the atmospheric and temperature conditions necessary for the particular treatment process are to be provided. In addition to performing an alloying process, the described apparatus constructed in accordance with our invention may also be used for so-called contact bonding processes in which a connecting wire or an electrode are soldered or welded to a semiconductor element without forming an alloy therewith (ohmic contact).

An apparatus constructed in accordance with the invention may also be used in so-called gas diffusion processes by osmosis for the production of p-n transitions in semiconductor crystals. Thus, a special treatment gas may be employed in container **2** that is suitable for this purpose and pure protective gas can be used for scavenging purposes.

Another suitable application of the apparatus constructed in accordance with our invention is its employment for so-called density testing of transistors or other semiconductor devices which have been previously placed in sealed housings or encapsulations. The encapsulated transistor should in such a case be placed in treatment capsules or containers which correspond to the alloying molds **5**. These encapsulated transistors are then fed through the aforementioned locks into highly evacuated (10^{-4} torr) container **2**, or removed from the same respectively. The container **2** is in turn connected to a device such as a mass spectograph which can detect the existence of gas escaping through leaks in the encapsulated transistors, if such are present, into the container **2**, the gas having been previously fed into the interior of the transistor housing of the encapsulated transistor before closing the same.

We claim:

1. In an apparatus for producing semiconductor devices, an airtight processing zone having an aligned inlet and outlet, guide means mounted in said processing zone and defining a path therethrough for a column of at least three superimposed mold members of which at least one member contains semiconductor material to be processed in said processing zone, at least three spaced annular sealing lips of resilient material aligned with said inlet and outlet respectively, said sealing lips being airtightly connected at their peripheries so as to define an airtight passage communicating with said processing zone, means for aligning the superimposed mold members with said annular sealing lips and said processing zone path, and means for successively displacing the mold members through said annular sealing lips and said processing zone path, the spacing between said sealing lips being predetermined in relation to the dimension of each mold member in the direction of displacement so that at least one of the mold members is sealingly engaged by at least one of said annular sealing lips at said inlet and outlet as the mold members are displaced through said annular sealing lips.

2. An apparatus according to claim **1** wherein said guide means comprise a plurality of straight guides extending from said inlet to said outlet and slidingly engageable by said mold members.

3. An apparatus according to claim **2** wherein said plurality of straight guides comprise at least two guide rails of electrically conductive, heat-resistant material, heatable along their entire length when electrically energized.

4. An apparatus according to claim **3** including electrically conductive means for connecting said rails in series with an electric power source.

5. An apparatus according to claim **3** including electrically conductive means for connecting said rails in parallel with an electric power source.

6. An apparatus according to claim **3** wherein said guide rails are of varying cross section so that heat gradients are formed in said rails when they are electrically energized.

7. An apparatus according to claim **3** including means electrically connected to said rails for providing a varied current density therein when said rails are energized so that predetermined heat gradients are formed in said rails.

8. An apparatus according to claim **7** wherein said means for providing a varied current density are shunt members mounted on said rails.

9. An apparatus according to claim **3** wherein said guide rails are of such a cross-sectional form as to partly enclose the mold members being displaced through said processing zone.

10. In an apparatus for producing semiconductor devices, an airtight processing zone under a predetermined pressure having an aligned inlet and outlet, a chamber communicating with said inlet and said outlet respectively outside of said processing zone and having a pressure corresponding substantially to the predetermined pressure in said processing zone, said chamber being partly defined by a pair of opposed annular sealing lips of resilient material aligned with said inlet and outlet, at least three spaced additional annular sealing lips of resilient material aligned with said inlet and outlet respectively, said adidtional sealing lips being airtightly connected at their peripheries so as to define an airtight passage communicating with said chamber and said processing zone, means for aligning with said annular sealing lips at least three superimposed mold members, at least one of which contains semiconductor material to be processed in said processing zone and means for displacing the mold members through said annular sealing lips, said chambers and said processing zone, the spacing between said additional sealing lips being predetermined in relation to the dimension of each mold member in the direction of displacement so that at least one of the mold members is sealingly engaged by at least one of said additional annular sealing lips at said inlet and outlet as the mold members are displaced through said additional annular sealing lips.

11. In an apparatus for producing semiconductor devices, three tubular containers vertically aligned with each other, the middle container comprising an airtight processing zone having an aligned inlet and outlet, the end containers comprising a plurality of coaxially aligned rings and at least three spaced annular sealing lips of resilient material aligned with said inlet and outlet respectively, said rings being pressed against each other, sandwiching said sealing lips airtightly between them at their peripheries so as to define an airtight passage communicating with said processing zone, means for aligning with said annular sealing lips at least three superimposed mold members, at least one of which contains semiconductor material to be processed in said processing zone, and means for successively displacing the mold members through said annular sealing lips and said processing zone, the spacing between said sealing lips being predetermined in relation to the dimension of each mold member in the direction of displacement so that at least one of the mold members is sealingly engaged by at least one of said annular sealing lips at said inlet and outlet as the mold members are displaced through said annular sealing lips.

12. In an apparatus for producing semiconductor devices, three coaxial vertically aligned tubular containers, the middle container comprising an airtight processing zone having an aligned lower inlet and upper outlet and guide means mounted in said zone and defining a path from said inlet to said outlet for a column of at least three superimposed mold members of which at least one member contains semiconductor material to be processed in said processing zone, the end containers each having at least three spaced annular sealing lips of resilient sheet material aligned with said inlet and outlet respectively,

said sealing lips being airtightly connected at their peripheries so as to define an airtight passage communicating with said processing zone, feeder means for supplying the mold members to a location below said lower inlet in which they are aligned with said vertically aligned containers, means located at said lower inlet for advancing the mold members through said aligned containers, said means comprising a cam-operated piston successively displacing the mold members through said annular sealing lips and said processing zone, the spacing between said sealing lips being predetermined in relation to the dimension of each mold member in the direction of displacement so that at least one of the mold members is sealingly engaged by at least one of said annular sealing lips at said inlet and outlet as the mold members are displaced through said annular sealing lips.

13. In an apparatus for producing semiconductor devices, an airtight processing zone having a substantially vertically aligned lower inlet and upper outlet, at least three spaced annular sealing lips of resilient sheet material aligned with said inlet and outlet respectively, said sealing lips being airtightly connected at their peripheries so as to define an airtight passage communicating with said processing zone, means for aligning with said annular sealing lips at least three superimposed mold members including at least one member containing semiconductor material to be processed in said processing zone, means mounted in said processing zone for guiding the mold members therethrough, and means for displacing the mold members in a column upwardly through said annular sealing lips and said processing zone, said displacing means being located at said lower inlet and being adapted to feed succeeding mold members to the underside of said column of mold members, the spacing between said sealing lips being predetermined in relation to the dimension of each mold member in the direction of displacement so that at least one of the mold members is sealingly engaged by at least one of said annular sealing lips at said inlet and outlet as the mold members are displaced through said annular sealing lips.

14. Apparatus according to claim **13**, wherein said guiding means comprise a plurality of substantially straight guides extending through said processing zone from said inlet to said outlet for slidable engagement by the column of mold members.

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