

REPLACED SHEETS SG

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TITLE OF THE INVENTION

Method of and Apparatus for Molding Resin to Seal
Electronic Parts

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to improvements in a
 method of and an apparatus for molding resin to seal
 electronic parts, such as ICs, LSIs, diodes or capacitors
 which are mounted on lead frames, for example, with
 10 thermosetting resin materials, and more particularly, it
 relates to improvements for preventing electronic parts
 molded and sealed with resin (mold packages) from
 formation of voids in the interior and the exterior
 thereof, as well as for preventing bonding wires from a
 15 wire sweep phenomenon caused by the resin and attaining
 improvement in adhesiveness (adhesion) between the lead
 frames and the resin.

Description of the Background Art

In general, an electronic part is molded and sealed
 20 with resin by a transfer mold method, which is generally
 carried out through a resin sealing/molding apparatus, for
 example, in the following manner:

A fixed upper mold section and a movable lower mold
 section provided in the resin sealing/molding apparatus
 25 are previously heated to a resin molding temperature by



heating means, and opened (there is also known an apparatus having an inverse structure, which is provided with a movable upper mold section and a fixed lower mold section).

5 Then, a lead frame which is provided with an electronic part is set on a prescribed position of a die surface of the lower mold section, while a resin tablet is supplied in a pot of the lower mold section.

10 Then, the lower mold section is upwardly moved so that the upper mold section and the lower mold section are closed. Thus, the electronic part and the lead frame provided with the same are set between upper and lower cavities which are oppositely provided in the die surfaces of the lower mold section and the upper mold section,
15 while the resin tablet stored in the pot is heated to be gradually melted.

20 Then, the resin tablet stored in the pot is pressurized by a plunger so that the resin material as melted is injected into/charged in the cavities, whereby the electronic part and the lead frame set in the cavities are sealed in a resin molded member which is molded in response to the shapes of the cavities.

25 After a lapse of a time which is required for hardening the melted resin material, the upper mold section and the lower mold section may be so opened as to



release the resin molded member and the lead frame from the cavities while releasing the hardened resin from a resin passage portion through a mold releasing mechanism.

When the upper mold section and the lower mold
5 section are closed, air containing moisture such as that in the atmosphere, for example, remains in a space portion which is defined by the pot, the resin passage portion and the cavities. Such residual air may enter the melted resin material to cause a problem in resin molding such as
10 formation of voids in the interior and the exterior of the resin molded member.

In order to cope with this problem, the cavities are made to communicate with the exterior through proper air vents and the melted resin material which is stored in the
15 pot is transferred through the resin passage portion and injected into/charged in the cavities, so that the aforementioned residual air and the like are naturally discharged to the exterior through the air vents.

While the air remaining in the pot, the resin passage
20 portion and the cavities can be naturally discharged through the air vents as hereinabove described, it is impossible to effectively inhibit the resin molded member from formation of internal voids and defects on its outer surface in practice. Thus, it is impossible to reliably
25 solve a problem of deterioration in moisture resistance



and appearance of the product.

When internal voids are formed in the resin molded member, adhesion between the lead frame and the resin is deteriorated and moisture easily infiltrates into the product through a clearance defined between the resin and the lead frame to deteriorate moisture resistance of the product, for example. Further, the resin molded member is easily cracked or chipped by force which is applied to a base portion of an outer lead portion projecting from the resin molded member to bend the same. Thus, it is impossible to attain high quality and high reliability which are strongly required for this product.

The internal voids which are formed in the resin molded member mainly result from air and/or moisture contained in the resin tablet.

The resin tablet, which is formed by merely compacting resin powder into a prescribed shape, generally contains a large quantity of air containing moisture in the atmosphere. Further, the large quantity of air contained in the resin tablet is present in the form of a number of independent bubbles, being isolated from each other, which cannot communicate with each other and with the surface of the resin tablet for ventilation.

When the resin tablet is heated to a resin molding temperature of at least 175°C, for example, the air and/or



moisture contained in the resin tablet forms water vapor,
which enters the melted resin material with the air
remaining in the aforementioned internal die space
portion. Thus, the resin material is injected
5 into/charged in the cavities in this state, and hence
voids are formed in the interior and the exterior of the
resin molded member due to the air and/or moisture
contained in the resin tablet.

Further, gas such as combustion gas which is
10 generated upon heating of the resin tablet also serves as
a cause for forming voids in the interior and the exterior
of the resin molded member.

In order to prevent formation of the voids in the
interior and the exterior of the resin molded member, the
15 following countermeasure may be employed:

For example, the air remaining in the aforementioned
internal die space portion between the upper mold section
and the lower mold section may be discharged to the
exterior through a vacuum pump, thereby preventing the
20 residual air from entering the melted resin material.

When ordinary air discharge means such as the vacuum
pump is employed, however, the overall resin
sealing/molding time is disadvantageously lengthened since
a long time is generally required for increasing the
25 degree of vacuum in the internal die space portion to a



prescribed level.

In general, an electronic part is molded and sealed with thermosetting resin such as epoxy resin, for example, and hence the resin tablet which is supplied in the
5 aforementioned internal die space portion (pot) is hardened with time after the same is heated and melted.

When the internal die space portion is evacuated through ordinary air discharge means for a long time, therefore, hardening of the melted resin material is
10 facilitated to deteriorate its flowability. Thus, the evacuating operation is preferably carried out in a short time in consideration of this point.

As hereinabove described, gas such as combustion gas which is generated upon heating of the resin tablet also
15 serves as a cause for forming voids and defects in the interior and the exterior of the resin molded member. Such gas is generated by a coupling agent, a mold release agent, a flexible agent etc. contained in the resin
20 tablet, which are heated and vaporized when the resin tablet is heated to a resin molding temperature of 175°C, for example, and melted.

In another conventional countermeasure for preventing the resin molded member from formation of voids, the melted resin material which is injected into the cavities
25 is pressurized to be increased in resin pressure for



compressing voids contained therein, thereby compressing voids which are formed in the interior of the resin molded member to a negligible degree.

However, the conventional method of compressing the voids under a high pressure has the following problems:

(1) This method is disadvantageous in consideration of durability of the apparatus, dangerousness in operation, the cost and the like, due to requirement for a large-sized press machine which can carry out high-pressure compression molding.

(2) Viscous resin which starts to be hardened in the cavities in a final stage of the compression step is made to flow in such high-pressure compression molding. Thus, a bonding wire for electrically coupling an electrode of a semiconductor element and the outer lead portion is inclined toward the direction of resin flowing in the so-called wire sweep phenomenon. This may lead to a serious problem such as contact between the bonding wire and an adjacent one, disengagement of a bonding pad wire from the electrode, or wire breaking.

In the aforementioned conventional countermeasure for preventing formation of voids, further, it is impossible to make effective use of multistage injection for preventing the problem of the wire sweeping phenomenon of the bonding wire, electrode disengagement, wire breaking



or the like. This problem is now described with reference to Fig. 5.

In a conventional method of injecting a melted resin material into cavities with no employment of multistage injection, a plunger which is engaged with a pot 109 is first upwardly moved to pressurize and inject a melted resin material into cavities 110 and 120 which are oppositely formed in a lower mold section 108 and an upper mold section 118 through a cull portion 119 and a gate 121, as shown in Fig. 5. The speed for injecting the resin in the cavities 110 and 120 can be adjusted by controlling the speed for upwardly moving the plunger.

If the resin injection speed is at a high level, the resin is injected into the cavities 110 and 120 to spout from a port 121a. Thus, the injected resin entrains air which is present around the port 121a, to form voids and defects in the vicinity of the port 121a. Further, a spiral flow of the resin is caused in the cavities 110 and 120 and entrains air remaining therein to form voids and defects, while causing a wire sweep phenomenon of a bonding wire 152, electrode disengagement, wire breaking or the like. When multistage injection, i.e., a molding method of adjusting the speed or pressure for injecting the melted resin material into the cavities 110 and 120 under constant conditions, is employed, on the other hand,



the following action is obtained:

The speed for injecting the resin through the port 121a is relatively reduced in a range (A in Fig. 5) where the resin is completely charged around the port 121a and the time therefor, and a range (C in Fig. 5) where the resin is charged around the wire 152 and the time therefor. In the remaining ranges (B and D in Fig. 5), the resin is injected at an ordinary injection speed, which is higher than that in the ranges A and C.

10 In this case, it is possible to suppress spouting of the resin which is injected from the port 121a into the cavities 110 and 120 by reducing the injection speed therefor in the range A shown in Fig. 5, thereby preventing the injected resin from entrainment of air and
15 occurrence of a spiral flow in the vicinity of the port 121a.

In the range B shown in Fig. 5, on the other hand, it is possible to inject the resin at an ordinary injection speed since no bonding wire 152 is provided in this range
20 B. While the resin is injected at the ordinary injection speed also in the range A at this time, neither entrainment of air nor occurrence of a spiral flow is caused in the injected resin in the vicinity of the port 121a since the range A is already charged with the resin.

25 Then, the injection speed for the resin is reduced



since the range C shown in Fig. 5 is provided with the bonding wire 152, for inhibiting a forward end portion, shown by broken lines in Fig. 5, of the injected resin which is charged in the cavities 110 and 120 from coming
5 into contact with the bonding wire 152 and forcibly bending the same, thereby preventing a wire sweep phenomenon of the bonding wire 152, electrode disengagement and wire breaking caused by such bending action.

10 Then, the resin can be injected at an ordinary injection speed in the range D shown in Fig. 5, which is provided with no bonding wire 152. While the resin is injected at the ordinary injection speed also in the ranges A to C at this time, neither entrainment of air nor
15 occurrence of a spiral flow is caused in the injected resin in the vicinity of the port 121a since the ranges A to C are already charged with the resin.

Due to employment of such multistage injection, it is possible to solve the aforementioned problems of formation
20 of voids and defects, a wire sweeping phenomenon of the bonding wire 152 and the like which are caused by the resin spouting from the port 121a into the cavities 110 and 120.

The aforementioned countermeasure for preventing
25 occurrence of voids by high-pressure compression molding



and the multistage injection are in the following relations:

5 The aforementioned high-pressure compression molding is effective means in consideration of a countermeasure for preventing occurrence of voids, while the same has problems of a wire sweep phenomenon of a bonding wire, electrode disengagement and wire breaking.

10 While the multistage injection can prevent a wire sweep phenomenon of a bonding wire, electrode disengagement and wire breaking, this method is not effective in consideration of a countermeasure for preventing occurrence of voids.

15 It may be possible to carry out the high-pressure compression molding after carrying out the multistage injection. However, the aforementioned problems following the high-pressure compression molding cannot be solved by such means.

20 Consequently, it is impossible to make effective use of the multistage injection when the conventional countermeasure for preventing occurrence of voids is employed.

SUMMARY OF THE INVENTION

25 An object of the present invention is to enable molding of products having high quality and reliability by efficiently and reliably discharging air and/or moisture



remaining in an internal die space portion, air and/or moisture contained in resin tablets and gas generated upon heating of the resin tablets to the exterior of the internal die space portion in a short time thereby preventing occurrence of voids and defects in resin molded members resulting from infiltration of the gas in melted resin materials while improving adhesiveness between lead frames and the resin.

Another object of the present invention is to provide a method of preventing occurrence of voids and defects which can make effective use of multistage injection, and a method of thereby preventing bonding wires from a wire sweep phenomenon caused by resin.

In order to attain the aforementioned objects, the inventive method of molding resin to seal electronic parts comprises the following steps:

First, resin tablets are supplied in a plurality of pots which are arranged in a die for resin molding consisting of an upper mold section and a lower mold section, and electronic parts which are mounted on lead frames are supplied to and set in prescribed positions of cavities defined in the die. Then, the resin tablets which are supplied in the pots are heated. The upper mold section and the lower mold section are closed to engage the electronic parts which are provided on the lead frames



in the prescribed positions of the cavities.

Then, an internal die space portion, which is defined by at least the pots, resin passages and the cavities when the die is closed, is cut off from the exterior. In this state, evacuation is carried out for forcibly sucking air and moisture remaining in the internal die space portion, air and moisture flowing out from the resin tablets and gas generated by heating and discharging the same to the exterior of the internal die space portion, and instantaneous evacuation is carried out for forcibly sucking and discharging the same in a short time.

Thereafter the resin tablets which are received in the pots of the die are pressurized to inject resin materials which are heated and melted in the pots into the cavities which are arranged on side positions of the pots through the respective resin passages, thereby molding resin to seal the electronic parts provided on the lead frames, which are engaged in the cavities.

According to this method, it is possible to improve the degree of vacuum in the internal die space portion in a short time, by discharging the air, moisture and gas from the internal die space portion through evacuation and instantaneous evacuation while cutting off the internal die space portion which is defined upon closing of the die from the exterior.



Further, it is possible to improve the degree of vacuum in the internal die space portion by a synergistic effect of evacuation and instantaneous evacuation.

Therefore, it is possible to prevent the air,
5 moisture and gas which are contained in the internal die space portion from infiltrating into or being entrained in the melted resin materials. Consequently, it is possible to reliably prevent formation of voids and defects,
10 resulting from presence of the air, moisture and gas, in the interior and exterior of resin molded members.

The lead frames and the resin molded members so strongly adhere to each other that no voids and clearances are defined between the lead frames and the resin, and the products are improved in moisture resistance to attain
15 high quality and high reliability.

Further, the air and/or moisture remaining in the internal die space portion, the air and/or moisture contained in the resin tablets and the gas generated upon heating of the resin tablets, which are main causes
20 forming voids in the interior and the exterior of the resin molded members, can be efficiently and reliably discharged to the exterior of the internal die space portion in a short time, whereby it is not necessary to carry out the conventional high-pressure compression
25 molding, which is employed as a countermeasure for



preventing occurrence of voids. Therefore, it is possible to make effective use of the aforementioned multistage injection as a countermeasure for protecting bonding wires in resin molding.

5 In the inventive method of molding resin to seal electronic parts, evacuation and instantaneous evacuation steps can be continuously carried out in this order or vice versa, while it is also possible to simultaneously carry out these steps.

10 In a preferred embodiment of the inventive method of molding resin to seal electronic parts, the resin tablets are thermally expanded through a step of heating the resin tablets so that the interior and the exterior of the resin tablets are communicative and ventilative, so that the
15 instantaneous evacuation step is thereafter carried out.

 In order to attain the aforementioned objects, the inventive apparatus for molding resin to seal electronic parts comprises a resin molding die consisting of an upper mold section and a lower mold section which are arranged
20 oppositely to each other and having a plurality of pots, a plurality of cavities and a plurality of resin passages for making the same communicate with each other, means for supplying resin tablets to the respective pots, means for supplying and setting electronic parts provided on lead
25 frames to and in prescribed positions of the cavities,



means for closing the die while receiving the resin tablets in the pots and setting the electronic parts in the cavities and heating the resin tablets for melting the same, and means for injecting melted resin materials into the cavities through the resin passages for molding resin to seal the electronic parts. The inventive apparatus for molding resin to seal electronic parts further comprises means for cutting off an internal space portion, which is defined upon closing of the die, including at least the respective pots, the respective resin passages and the respective cavities from the exterior, evacuation means for forcibly sucking/discharging air, moisture and gas contained in the internal die space portion to the exterior thereof for improving the degree of vacuum in the internal die space portion, and instantaneous evacuation means for forcibly sucking/discharging the air, moisture and gas contained in the internal die space to the exterior thereof in a short time for quickly improving the degree of vacuum in the internal die space portion.

In a preferred embodiment of the inventive apparatus for molding resin to seal electronic parts, the evacuation means includes a vacuum source and the instantaneous evacuation means includes a vacuum tank, while three end portions of a vacuum path having three branch portions are connected to the vacuum source, the vacuum tank and the



internal die space portion to communicate with the same, while switching valves are provided between the branch portions and the vacuum tank as well as the internal space portion.

5 Due to the aforementioned structure, it is possible to bring the vacuum tank into a prescribed vacuum state by driving the vacuum source while closing the switching valve provided between the branch portion and the internal die space portion and opening that provided between the
10 branch portion and the vacuum tank, and to instantaneously suck air etc. contained in the internal die space portion into the vacuum tank by opening both switching valves when it is necessary to carry out instantaneous evacuation. Therefore, it is possible to carry out evacuation and
15 instantaneous evacuation through a single vacuum source. Consequently, it is possible to implement the inventive method of molding resin to seal electronic parts by an apparatus having a relatively simple structure.

20 The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

25 Fig. 1 is a partially fragmented sectional view



showing a principal part of a die, provided in an apparatus for molding resin to seal electronic parts, which is in an opened state;

Fig. 2 is a partially fragmented sectional view of the die, shown in Fig. 1, which is in an intermediately closed state;

Fig. 3 is a partially fragmented sectional view of the die, shown in Fig. 1, which is in a completely closed state for molding resin to seal electronic parts;

Fig. 4 is a partially fragmented bottom plan view showing a principal part of a die surface of an upper mold section which is provided in the die shown in Fig. 1;

Fig. 5 is a partially fragmented sectional view showing a portion of a die around cavities, for illustrating a state of injecting a melted resin material into the cavities from a pot through a resin passage; and

Fig. 6 is a graph showing exemplary evacuation efficiency levels in ordinary evacuation and instantaneous evacuation carried out in an internal die space portion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention is now described in detail with reference to Figs. 1 to 4.

Fig. 1 is a partially fragmented sectional view showing a principal part of a die, provided in an apparatus for molding resin to seal electronic parts



according to the present invention, which is in an opened state.

Fig. 2 is a partially fragmented sectional view corresponding to Fig. 1, showing the principal part of the die which is in an intermediately closed state in advance of complete closing.

Fig. 3 is a partially fragmented sectional view corresponding to Fig. 1, showing the principal part of the die which is in a completely closed state.

Fig. 4 shows a die surface of an upper mold section provided in the die shown in Fig. 1.

This resin sealing/molding apparatus is oppositely provided with an upper mold section 1 (fixed type) which is mounted on an upper fixed plate and a lower mold section 2 (movable type) which is mounted on a lower movable plate.

Further, die bases 3 and 4 of the upper mold section 1 and the lower mold section 2 are provided with heating means 5 and 6 such as heaters respectively.

A fixed chase block 7 is detachably mounted on the fixed die base 3 by proper engaging means such as a dovetail groove and a dovetail portion.

On the other hand, a movable chase block 8 is detachably mounted on the movable die base 4 by engaging means which are similar to those provided on the fixed



side.

The chase blocks 7 and 8 which are engaged in the die bases 3 and 4 are set in prescribed positions by proper fixing blocks (not shown) for fixing the same on
5 horizontal end portions thereof.

Proper seal members (not shown) are preferably inserted between the chase blocks 7 and 8 and the fixing blocks.

The movable chase block 8 is provided with a
10 plurality of pots 9, while a required number of resin molding cavities 10 are arranged on side positions of the respective pots 9.

The movable chase block 8 is also provided with dedicated heating means 11 such as heaters.

15 The movable chase block 8 is further provided on its lower position with a lower ejector plate 12 comprising ejector pins 12a for ejecting and releasing resin molded members which are molded in the cavities 10, and a plunger holder 13 (see Fig. 3) comprising plungers 13a (resin
20 pressurizing means) for pressurizing resin tablets R which are supplied in the pots 9 respectively.

Upper end portions of the ejector pins 13a are engaged in pin holes 14 communicating with the cavities
10.

25 Further, upper portions of the plungers 13a are



engaged in the respective pots 9 through insertion holes 15 and 16 which are provided in the movable die base 4 and the ejector plate 12.

5 Proper seal members (not shown) are preferably inserted between an engaging space for the lower ejector plate 12 which is provided in the movable die base 4 and the exterior of this space as well as between the plungers 13a and the engaging space.

10 On the other hand, the fixed chase block 7 is provided with cavities 20 in correspondence to the positions and the number of the cavities 10 provided in the movable chase block 8.

15 The fixed chase block 7 is further provided with cull portions 25, oppositely to the pots 9 of the movable chase block 8.

20 The cull portions 25 and the cavities 20 communicate with each other through resin passages 26, whereby the pots 9 and the cavities 10 and 20 communicate with each other through the short resin passages 26 including the cul portions 25 when the upper mold section 1 and the lower mold section 2 are closed. Further, the plungers 13a which are engaged in the pots 9 are vertically driven by a proper driving mechanism (not shown) such as a hydraulic or pneumatic motor or an electric motor.

25 When the plungers 13a pressurize the resin tablets R



which are received in the pots 9, resin materials heated and melted in the pots 9 are injected into the cavities 10 and 20 through the resin passages 26 including the cull portions 25.

5 The upper cavities 20 are provided with air vents 43 (see Fig. 4) for making the cavities 10 and 20 communicate with the exterior upon closing thereof.

 The fixed chase block 7 is further provided with dedicated heating means 21 such as heaters.

10 The fixed chase block 7 is further provided on its upper position with a support pin 22b for an upper ejector plate 22 comprising ejector pins 22a for ejecting and releasing resin molded members which are molded in the cavities 20, and an elastic member 23 such as a spring for
15 downwardly pressing the upper ejector plate 22 through the support pin 22b.

 Lower end portions of the ejector pins 22a are engaged with pin holes 24 communicating with the cavities 20 and pin holes 24a communicating with the cull portions
20 25 respectively.

 The upper ejector plate 22 is downwardly pressed by elasticity of the elastic member 23 when the upper mold section 1 and the lower mold section 2 are opened as shown in Fig. 1, so that hardened resin members in the resin
25 passages 26 which are provided between the cull portions



25 and the cavities 20 and the resin molded members hardened in the cavities 20 can be downwardly ejected and released.

When the upper mold section 1 and the lower mold section 2 are opened, further, the lower ejector plate 12 is upwardly pressed by an ejector bar 12b, so that the ejector pins 12a upwardly eject and release the resin molded members from the cavities 10.

When the upper mold section 1 and the lower mold section 2 are completely closed as shown in Fig. 3, the ejector plates 22 and 12 are upwardly and downwardly retracted respectively through upper and lower return pins (not shown) which are oppositely provided on the ejector plates 22 and 12.

An outside air blocking member 30 which is in the form of a circular or rectangular cylinder is engaged with the movable die base 4 for covering at least outer peripheries of the pots 9 and the cavities 10 in a die surface of the lower mold section 2. This outside air blocking member 30 is slidable along the direction for opening/closing the upper mold section 1 and the lower mold section 2 through a required driving mechanism 31.

Further, a proper seal member 32 is interposed between the engaging surfaces of the movable die base 4 and the outside air blocking member 30.



Another outside air blocking member 33 which is in the form of a circular or rectangular cylinder is engaged with the fixed base 3 for covering outer peripheries of the resin passages 25 and 26 and the cavities 20 in a die surface of the upper mold section 1. This outside air blocking member 33 is slidable along the direction for opening/closing the upper mold section 1 and the lower mold section 2 through a proper driving mechanism 34.

Further, a proper seal member 35 is interposed between the engaging surfaces of the fixed die base 3 and the outside air blocking member 33.

When the outside air blocking members 30 and 33 are moved to close the upper mold section 1 and the lower mold section 2 through the driving mechanisms 31 and 34 respectively, forward ends of these outside air blocking members 30 and 33 are engaged with each other (see Figs. 2 and 3).

Referring to Fig. 3, an upper end of the outside air blocking member 30 which is engaged with the movable die base 4 is upwardly moved to a portion close to the die surface of the lower mold section 2, while the outside air blocking member 33 which is engaged with the fixed die base 3 is engaged an outer peripheral surface of the outside air blocking member 30 engaged with the movable die base 4.



While the engaging surfaces of the outside air blocking members 30 and 33 are vertically perpendicular in the figures, other proper engaging surfaces may be employed in place of such a structure.

5 Further, a proper seal member 36 is interposed between the engaging surfaces of the outside air blocking members 30 and 33.

10 In addition, proper seal members 37 are also interposed between the die bases 3 and 4 and the chase blocks 7 and 8, between the chase blocks 7 and 8 and the ejector pins 22a and 12a, and between the movable chase block 8 and the pots 9 and the plungers 13a.

15 When the upper mold section 1 and the lower mold section 2 are closed, therefore, the forward ends of the outside air blocking members 30 and 33 are so engaged as to define an outside air blocking space portion 38 (see Figs. 2 and 3), which is cut off from the outside air by the outside air blocking members 30 and 33 and the seal members 32, 35, 36 and 37.

20 The seal members 32, 35, 36 and 37 may simply define the space portion 38 which requires a proper vacuum state between the upper mold section 1 and the lower mold section 2.

25 The outside air blocking members 30 and 33 can be retracted through the driving mechanisms 31 and 34 to



positions not inhibiting operations for detaching the chase blocks 7 and 8 from the die bases 3 and 4 and exchanging the same.

Thus, it is possible to open and close the upper mold section 1 and the lower mold section 2 while locating the outside air blocking members 30 and 33 in the positions shown in Figs. 2 and 3, for example, whereby the outside air blocking members 30 and 33 may not be retracted every molding cycle time in ordinary resin molding.

The driving mechanisms 31 and 34 for the outside air blocking members 30 and 33 may be prepared from mechanical driving mechanisms such as proper rack and pinion mechanisms, electric driving mechanisms such as electric motors, or hydraulic or pneumatic fluid driving mechanisms, while the aforementioned electric driving mechanisms or pneumatic driving mechanisms are preferable in consideration of the operation for molding resin to seal electronic parts.

Concave portions 29 for setting lead frames 27 provided with electronic parts 27a are provided in the die surface of the movable chase block 8.

Referring to Fig. 1, numeral 28 denotes lead frame supply/discharge mechanisms for supplying/setting the lead frames 27 in the concave portions 29.

The space portion 38 which is defined upon engagement



of the outside air blocking members 30 and 33 is connected with an end of a vacuum path 39 such as a vacuum pipe to communicate with the same, while the other end of the vacuum path 39 is connected with a vacuum source 40 consisting of a vacuum pump or the like, and an instantaneous evacuation mechanism 45 consisting of a vacuum tank or the like, to communicate with the same.

Namely, the space portion 38 is connected with the vacuum source 40 through a switching valve 47 such as an electromagnetic valve which is provided in the vacuum path 39, to communicate with the same.

Further, the space portion 38 is connected with the instantaneous evacuation mechanism 45 through the switching valve 47 provided in the vacuum path 39 and another switching valve 48 such as an electromagnetic valve, to communicate with the same.

The vacuum source 40 is connected between the switching valves 47 and 48 in a communicative manner. Therefore, when the vacuum source 40 is driven while opening the switching valve 47 by an opening signal D and closing the other switching valve 48 by a closing signal e, for example, it is possible to evacuate the space portion 38 through the switching valve 47 and the vacuum path 39.

When the vacuum source 40 is driven while closing the



switching valve 47 by a closing signal d and opening the other switching signal 48 by an opening signal E, on the other hand, it is possible to bring the instantaneous evacuation mechanism (vacuum tank) 45 into a prescribed vacuum state by evacuation through the switching valve 48 and the vacuum path 39.

Description is now made on evacuation of the space portion 38 which is defined when the upper mold section 1 and the lower mold section 2 are closed as shown in Fig. 2 or 3 and an internal die space portion defined by at least the pots 9, the resin passages 25 and 26 and the cavities 10 and 20 is cut off from the exterior, and instantaneous evacuation for quickly improving the degree of vacuum in the space portion 38.

First, the vacuum source 40 is driven while closing the switching valve 47 by the closing signal d and opening the switching valve 48 by the opening signal E, thereby bringing the instantaneous evacuation mechanism 45 into a prescribed vacuum state. At this time, the degree of vacuum in the instantaneous evacuation mechanism (vacuum tank) 45 can be arbitrarily set at a proper level.

Then, the switching valve 47 is opened by the opening signal D so that the space portion 38 communicates with the instantaneous evacuation mechanism 45 through the switching valves 47 and 48 and the vacuum path 39, whereby



air remaining in the space portion 38 is instantaneously and forcibly sucked/discharged to the exterior in a short time by the instantaneous evacuation mechanism 45 which is maintained in the prescribed degree of vacuum. Thus, it is possible to carry out instantaneous evacuation for quickly increasing the degree of vacuum in the space portion 38. At this time, a high degree of vacuum can be attained in the space portion 38 in several seconds.

The space portion 38 communicates with the vacuum source 40 through the switching valve 47 and the vacuum path 39. Therefore, it is possible to carry out evacuation for forcibly sucking/discharging the air remaining in the space portion 38 to the exterior in continuation to the aforementioned instantaneous evacuation, driving the vacuum source 40 while closing the switching valve 48 by the closing signal e.

Due to the evacuation through the vacuum source 40, it is possible to maintain or further increase the degree of vacuum in the space portion 38 which is attained by the instantaneous evacuation. Thus, it is possible to instantaneously set the space portion 38 in a high vacuum state in a short time, by carrying out the instantaneous evacuation through the instantaneous evacuation mechanism 45 and the evacuation through the vacuum source 40.

The evacuation is carried out while closing the



switching valve 48, so that only the vacuum source 40 and the space portion 38 communicate with each other for efficiently carrying out the evacuation without reducing the function of the vacuum source 40.

5 In the instantaneous evacuation and the evacuation of the space portion 38, it is possible to forcibly suck/discharge air and/or moisture remaining in the space portion 38, air and/moisture flowing out from the resin tablets R heated and expanded in the pots 9 into the space
10 portion 38, and gas generated by heating to the exterior of the space portion 38.

Description is now made on operation for molding resin to seal the electronic parts 27a which are mounted on the lead frames 27 with resin through the apparatus
15 having the aforementioned structure.

First, the vacuum source 40 is driven while previously closing the switching valve 47 by the closing signal d and opening the switching valve 48 by the opening signal E, thereby bringing the instantaneous evacuation
20 mechanism (vacuum tank) 45 into a prescribed vacuum state through the switching valve 48 and the vacuum path 39.

Then, the lower mold section 2 is downwardly moved to open the upper mold section 1 and the lower mold section 2, as shown in Fig. 1. Then, the resin tablets R are
25 supplied into the pots 9 which are provided in the lower



mold section 2, while the lead frames 27 are supplied/set in the concave portions 29 which are provided in the die surface of the movable chase block 8 through the lead frame supply/discharge mechanisms 28.

5 The resin tablets R which are supplied in the pots 9 are heated and expanded/softened by the heating means 5, 6, 11 and 21 provided in the upper mold section 1 and the lower mold section 2, to be gradually melted.

10 Then, the lower mold section 2 is upwardly moved so that the upper mold section 1 and the lower mold section 2 are closed while the outside air blocking members 30 and 33 are slid to be engaged with each other, thereby defining the outside air blocking space portion 38 covering a space portion between the die surfaces of the upper mold section 1 and the lower mold section 2 and at
15 least the outer peripheries of the pots 9, the resin passages 25 and 26 and the cavities 10 and 20, as shown in Figs. 2 and 3.

20 The upper mold section 1 and the lower mold section 2 are intermediately closed to define a required space S between the die surfaces thereof as shown in Fig. 2, and then completely closed to join the die surfaces with each other as shown in Fig. 3. Such intermediate closing and complete closing are carried out in continuation.

25 In the aforementioned closing, particularly in the



intermediate closing of the upper mold section 1 and the lower mold section 2, an instantaneous evacuation step is carried out by the instantaneous evacuation mechanism 45.

5 Namely, the switching valve 47 is opened by the opening signal D so that the space portion 38 communicates with the instantaneous evacuation mechanism 45 through the switching valves 47 and 48 and the vacuum path 39, thereby instantaneously and forcibly sucking/discharging the air remaining in the space portion 38 and the like to the
10 exterior in a short time.

At this time, therefore, the degree of vacuum in the space portion 38 is quickly improved to attain a high degree of vacuum in several seconds.

15 Then, the switching valve 48 is closed by the closing signal e and the vacuum source 40 is driven to carry out an evacuation step of forcibly sucking/discharging the air remaining in the space portion 38 and the like to the exterior in continuation to the instantaneous evacuation step by the instantaneous evacuation mechanism 45.

20 At this time, therefore, it is possible to maintain the degree of vacuum in the space portion 38 which is attained by the instantaneous evacuation, or further improve the degree of vacuum.

25 The resin tablets R which are supplied in the pots 9 are heated and expanded/softened by the heating means 5,



6, 11 and 21 provided in the upper mold section 1 and the lower mold section 2, while the interior and the exterior of the resin tablets R are brought into ventilative states so that air and/or moisture contained therein flow out into the pots 9. Namely, the resin tablets R supplied into the pots 9 which are in heated states are efficiently and quickly expanded by thermal expansion through heating by radiation heat and conduction heat received from the pots 9, expansion through the evacuation in the pots 9 and synergistic action/effect of these actions. Even if the resin tablets R which are supplied in the pots 9 contain a number of fine independent bubbles, therefore, such independent bubbles are reliably broken by the aforementioned expansion of the resin tablets 9.

Therefore, the interior and the exterior of the resin tablets R communicate with each other to be in ventilative states, whereby air and moisture contained in the number of independent bubbles reliably flow out into the pots 9 (space portion 38).

Further, the resin tablets R supplied in the pots 9 generate gas upon heating. Therefore, it is possible to instantaneously set the space portion 38 in a high vacuum state in a short time by carrying out the instantaneous evacuation through the instantaneous evacuation mechanism 45 and the evacuation through the vacuum source 40.



Consequently, all of the air and/or moisture remaining in the space portion 38, the air and/or moisture flowing out from the resin tablets R into the space portion 38 (pots 9) and the gas generated by heating of the resin tablets R can be forcibly sucked/discharged to the exterior of the space portion 38.

The resin tablets R which are supplied in the pots 9 contain moist air in states of a number of independent bubbles, which cannot communicate with each other and with the surfaces of the resin tablets R. When the resin tablets R are heated to a resin molding temperature in the pots 9, therefore, the resin tablets R are expanded/softened to be finally melted as follows:

In the resin tablets R which are received in the pots 9, bottom surfaces are placed on upper end surfaces of the plungers 13a and clearances are defined between the side surfaces and inner wall surfaces of the pots 9, while open space portions are defined between the upper surfaces and the cull portions 25.

In this state, therefore, conduction heat and radiation heat are applied to the bottom surface portions and the side surface portions of the resin tablets R respectively. Therefore, heating values on the bottom portions of the resin tablets R which are in contact with the upper end surfaces of the plungers 13a are first



increased, so that the bottom portions are softened successively from central portions. Consequently, upper central portions of the resin tablets R are upwardly pressed from the interior to be expanded toward upper portions in the pots 9 (i.e., toward the cull portions 25) in advance of other portions.

At this time, the interior and the exterior of the resin tablets R communicate with each other to enter ventilative states, whereby the air and/or moisture which is trapped in the independent bubbles easily flow out into the space portion 38 (pots 9).

Since the space portion 38 is set under a high vacuum state at this time, the air and/or moisture contained in the resin tablets R is forcibly sucked to flow into the space portion 38 (pots 9), and is efficiently and reliably discharged to the exterior by evacuation.

Then, the upper mold section 1 and the lower mold section 2 are completely closed, to thereafter carry out a resin molding step of sealing the electronic parts 27a which are provided on the lead frames 27 in resin molded members.

When the upper mold section 1 and the lower mold section 2 are completely closed, the resin tablets R received in the pots 9 are pressurized by the plungers 13a so that melted resin materials which are heated and melted



in the pots 9 are injected/charged into required numbers of the cavities 10 and 20 which are arranged on side positions of the pots 9. Thus, the electronic parts 27a provided on the lead frames 27 which are engaged/set in the respective cavities 10 and 20 can be sealed in the resin molded members.

As hereinabove described, the evacuation step of forcibly sucking/discharging the air remaining in the space portion 38 etc. to the exterior is continuously carried out also when the upper mold section 1 and the lower mold section 2 are intermediately and completely closed.

The residual air and/or moisture can be relatively easily discharged from the space portion 38 to the exterior due to the required space S defined in the space portion 38 particularly between the die surfaces of the upper mold section 1 and the lower mold section 2 when the same are intermediately closed, while it is relatively difficult to discharge the residual air and/or moisture from the space portion 38 when the upper mold section 1 and the lower mold section 2 are completely closed since no space S is defined between the die surfaces at this time.

Also when the upper mold section 1 and the lower mold section 2 are completely closed, however, the vacuum



source 40 or the instantaneous evacuation mechanism 45 communicates with the pots 9, the resin passages 25 and 26 and the cavities 10 and 20 through the air vents 43 and the vacuum path 39, whereby the function for discharging the residual air etc. from the space portion 38 to the exterior is not deteriorated. Thus, it is possible to discharge the residual air etc. from the space portion 38 whether the upper mold section 1 and the lower mold section 2 are intermediately or completely closed.

Then, the upper mold section 1 and the lower mold section 2 may be again opened after a required curing time, so that the resin molded members and hardened resin are released from the cavities 10 and 20 and the resin passages 25 and 26 respectively by the ejector plates 22 and 12 and the ejector pins 22a and 12a.

According to a graph of evacuation efficiency in the internal die space portion shown in Fig. 6, it is possible to attain a high vacuum state in several seconds (about 2 to 3 seconds) when only instantaneous evacuation is carried out (see the solid line 1). Further, it is understood that about six to seven seconds are required for attaining a high vacuum state only by ordinary evacuation (see the broken line 2). Therefore, it is possible to set a long evacuation time in the internal die space portion by carrying out instantaneous evacuation for



bringing the internal die space portion into a high vacuum state in a short time. Thus, it is possible to efficiently and reliably discharge air remaining in the internal die space portion, air flowing out from the
5 aforementioned resin tablets and gas generated upon heating and melting of the resin tablets to the exterior before the resin tablets are completely heated and melted in the pots.

10 The present invention is not restricted to the aforementioned embodiment, but modifications can be arbitrarily and properly selected and employed at need within the scope of the present invention.

15 For example, the lower mold section 2 may not be completely stopped in intermediate closing, but the closing speed (speed for upwardly moving the lower mold section 2) may be reduced between the intermediate closing state shown in Fig. 2 and the complete closing state shown in Fig. 3, to continuously carry out the intermediate closing and the complete closing.

20 The evacuation step and the instantaneous evacuation step for the outside air blocking space portion 38 may be arbitrarily and properly modified/selected on the basis of resin molding conditions and the like.

25 For example, the instantaneous evacuation step for the space portion 38 may be continuously carried out



following the evacuation step therefor, and vice versa.

Further, the instantaneous evacuation step for the space portion 38 may be carried out simultaneously with the evacuation step.

5 Further, air holes communicating with the engaging space portions for the ejector plates 12 and 22 may be provided to communicate with the outside air blocking space portion 38 or with another vacuum path, to discharge residual air etc. from the engaging space portions to the
10 exterior.

Further, air holes communicating with the outside air blocking space portion 38 may be provided in sliding portions of the pots 9 and the plungers 13a or such air holes may communicate with another vacuum path, to
15 discharge the residual air etc. from the pots 9 to the exterior.

Further, a plurality of vacuum sources 40 such as vacuum pumps may be combined with a plurality of instantaneous evacuation mechanisms 45 such as vacuum
20 tanks, while such members may be combined independently of each other.

While the chase blocks 7 and 8 are frequently detached in the aforementioned embodiment, the present invention is also applicable to an apparatus for molding
25 resin to seal electronic parts having an ordinary die



structure.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not
5 to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

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WHAT IS CLAIMED IS:

1. A method of molding resin to seal electronic parts, comprising:

5 a resin tablet supplying step of supplying resin tablets (R) into respective ones of a plurality of pots (9) being arranged in a die (1, 2) for resin molding consisting of an upper mold section (1) and a lower mold section (2);

10 a lead frame supplying step of supplying and setting electronic parts (27a) being mounted on lead frames (27) in prescribed positions of cavities (10, 20) being arranged in said die (1, 2);

a resin tablet heating step of heating said resin tablets (R) being supplied in respective said pots (9) of said die (1, 2);

15 a die closing step of closing said upper mold section (1) and said lower mold section (2) for engaging said electronic parts (27a) being provided on said lead frames (27) in prescribed positions of said cavities (10, 20);

20 an outside air blocking step of cutting off an internal die space portion (25, 26), being defined in said die closing step for said die (1, 2) by at least said pots (9), said cavities (10, 20) and resin passages (25, 26) making said pots (9) communicate with said cavities (10,



20), from the exterior;

25 an evacuation step of forcibly sucking/discharging
air and/or moisture remaining in said internal die space
portion (25, 26), air and/or moisture flowing out from
said resin tablets (R) being heated and expanded in said
resin tablet heating step into said internal die space
30 portion (25, 26), and gas being generated by said heating
to the exterior of said internal die space portion (25,
26) in said outside air blocking step;

 an instantaneous evacuation step of forcibly
sucking/discharging said air and/or moisture remaining in
35 said internal die space portion (25, 26), said air and/or
moisture flowing out from said resin tablets (R) being
heated and expanded in said resin tablet heating step into
said internal die space portion (25, 26), and said gas
being generated by said heating to the exterior of said
40 internal die space portion (25, 26) in a short time in
said outside air blocking step, thereby quickly increasing
the degree of vacuum in said internal die space portion
(25, 26); and

 a resin molding step of pressurizing said resin
45 tablets (R) being supplied in said pots (9) of said die
(1, 2) for injecting melted resin materials being heated
and melted in said pots (9) into said cavities (10, 20)
being arranged on side positions of said pots (9) through



said resin passages (25, 26), thereby sealing said
50 electronic parts (27a), being provided on said lead frames
(27) engaged in said cavities (10, 20), with resin.

2. A method of molding resin to seal electronic
parts in accordance with claim 1, wherein
said instantaneous evacuation step is carried out
after said evacuation step.

3. A method of molding resin to seal electronic
parts in accordance with claim 1, wherein
said evacuation step is carried out after said
instantaneous evacuation step.

4. A method of molding resin to seal electronic
parts in accordance with claim 1, wherein
said instantaneous evacuation step is carried out
simultaneously with said evacuation step.

5. A method of molding resin to seal electronic
parts in accordance with claim 1, wherein
said instantaneous evacuation step is carried out
after said resin tablets (R) being supplied in said pots
5 (9) are heated and expanded in said resin tablet heating
step so that the interior and the exterior of said resin



tablets (R) are brought into ventilative states.

6. A method of molding resin to seal electronic parts in accordance with claim 1, wherein

said instantaneous evacuation step includes a step of releasing a vacuum tank (45), being previously brought
5 into a prescribed vacuum state in interception of communication with said internal die space portion (25, 26), from said interception of communication with said internal die space portion (25, 26).

7. A method of molding resin to seal electronic parts in accordance with claim 1, wherein

said die closing step includes:

an intermediate closing step of defining a prescribed
5 clearance between die surfaces of said upper mold section (1) and said lower mold section (2), and

a complete closing step of joining said die surfaces of said upper mold section (1) and said lower mold section (2) to each other,

10 both of said evacuation step and said instantaneous evacuation step being carried out in both of said intermediate closing step and said complete closing step.

8. An apparatus for molding resin to seal electronic



parts, comprising:

a die (1, 2) for resin molding including an upper mold section (1) and a lower mold section (2) being
5 arranged oppositely to each other and having a plurality of pots (9), a plurality of cavities (10, 20) and a plurality of resin passages (25, 26) for making said pots (9) and said cavities (10, 20) communicate with each other;

10 means for supplying resin tablets (R) into respective ones of said plurality of pots (9);

means for supplying and setting electronic parts (27a) being mounted on lead frames (27) in prescribed positions of said cavities (10, 20) of said die (1, 2);

15 means for closing said die (1, 2) while receiving said resin tablets (R) in said pots (9) and setting said electronic parts (27a) in said cavities (10, 20) and heating said resin tablets (R) for melting the same; and

means for injecting melted resin materials into said
20 cavities (10, 20) through said resin passages (25, 26), thereby sealing said electronic parts (27a) with resin, said apparatus for molding resin to seal electronic parts further comprising:

means for cutting off an internal die space portion
25 (25, 26) being defined upon closing of said die (1, 2) by at least said pots (9), said resin passages (25, 26) and



said cavities (10, 20);

30 evacuation means for forcibly sucking and discharging
air, moisture and gas being contained in said internal die
space portion (25, 26) to the exterior thereby improving
the degree of vacuum in said internal die space portion
(25, 26); and

35 instantaneous evacuation means for forcibly sucking
and discharging said air, said moisture and said gas being
contained in said internal die space portion (25, 26) to
the exterior in a short time thereby quickly improving the
degree of vacuum in said internal die space portion (25,
26).

9. An apparatus for molding resin to seal electronic
parts in accordance with claim 8, wherein

said evacuation means includes a vacuum source (40),
said instantaneous evacuation means (45) includes a
5 vacuum tank, and

three end portions of a vacuum path having three
branch portions are connected with said vacuum source
(40), said vacuum tank and said internal die space portion
(25, 26) respectively to communicate with the same,

10 switching valves (47, 48) being provided between said
branch portions and said vacuum tank as well as said
internal die space portion (25, 26) respectively.



10. An apparatus for molding resin to seal electronic parts in accordance with claim 8, further comprising means for controlling opening/closing of said switching valves (47, 48) in linkage.

11. An apparatus for molding resin to seal electronic parts in accordance with claim 8, wherein said means for sealing/molding said electronic parts with resin includes multistage injection means capable of changing the speed for injecting said melted resin materials into said cavities (10, 20).

12. An apparatus for molding resin to seal electronic parts in accordance with claim 8, wherein said means (30, 33) for cutting off said internal die space portion (25, 26) from the exterior includes a pair of outside air blocking members (30, 33) covering outer peripheries of said upper mold section (1) and said lower mold section (2) in positions provided with said internal die space portion (25, 26) and being engaged to be slidable along said outer peripheries to be engageable with each other upon closing of said upper mold section (1) and said lower mold section (2).



13. An apparatus for molding resin to seal
electronic parts in accordance with claim 8, further
comprising a pair of chase blocks (7, 8), obtained by
bringing principal parts for carrying out resin molding
5 into blocks, being detachably engaged with said upper mold
section (1) and said lower mold section (2) respectively.

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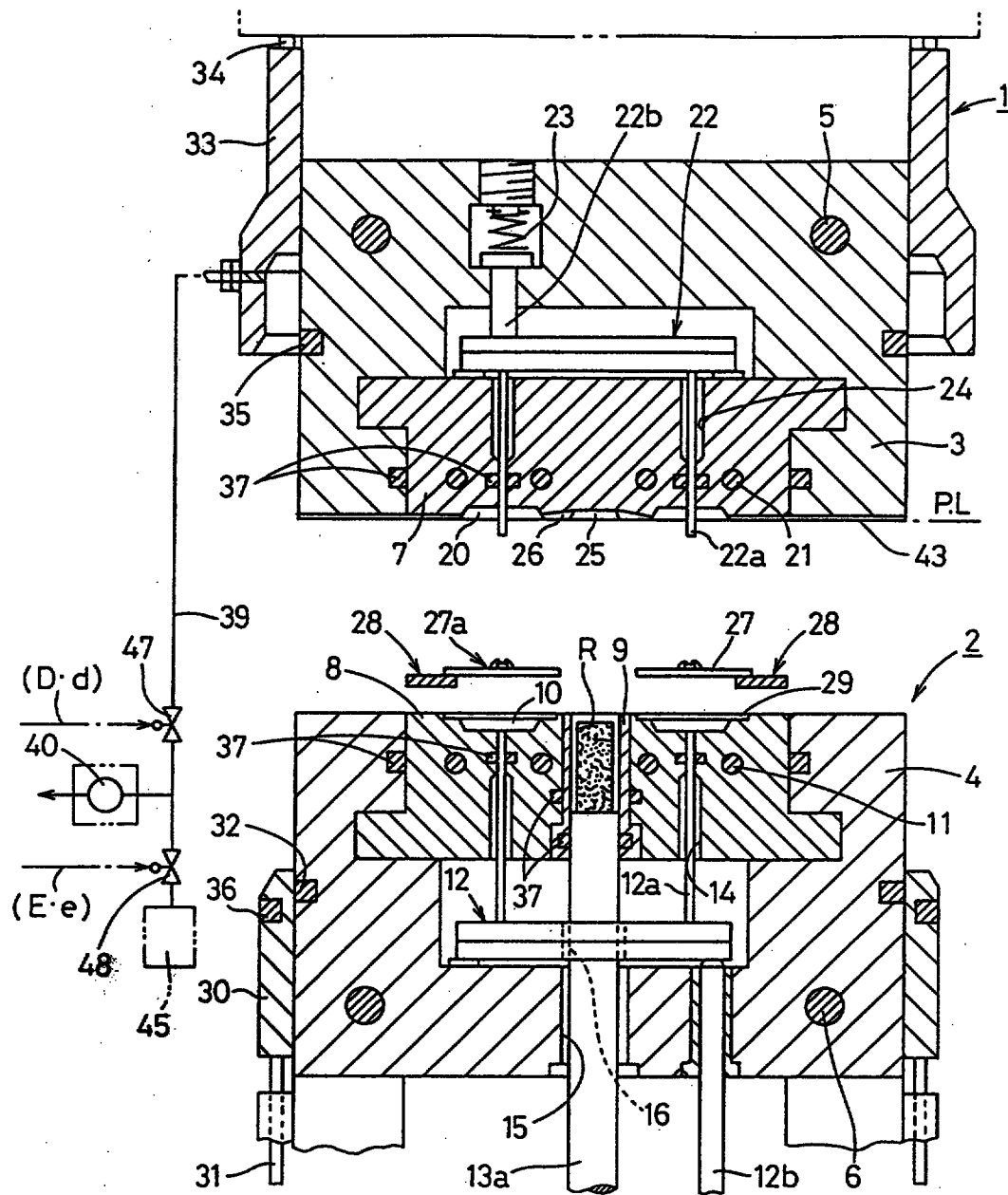


ABSTRACT OF THE DISCLOSURE

In a method of molding resin to seal electronic parts, an internal die space portion (38) which is defined at least by pots (9), cull portions (25), resin passages (26) and cavities (10, 20) when an upper mold section (1) and a lower mold section (2) are closed is cut off from the exterior to carry out evacuation by a vacuum source (40) and instantaneous evacuation by an instantaneous evacuation mechanism (45). According to this method, it is possible to quickly improve the degree of vacuum in the internal die space portion (38) by efficiently and reliably discharging air, moisture and gas from the internal die space portion (38) to the exterior due to synergistic action of the evacuation and the instantaneous evacuation. Consequently, resin molded members are prevented from formation of voids.



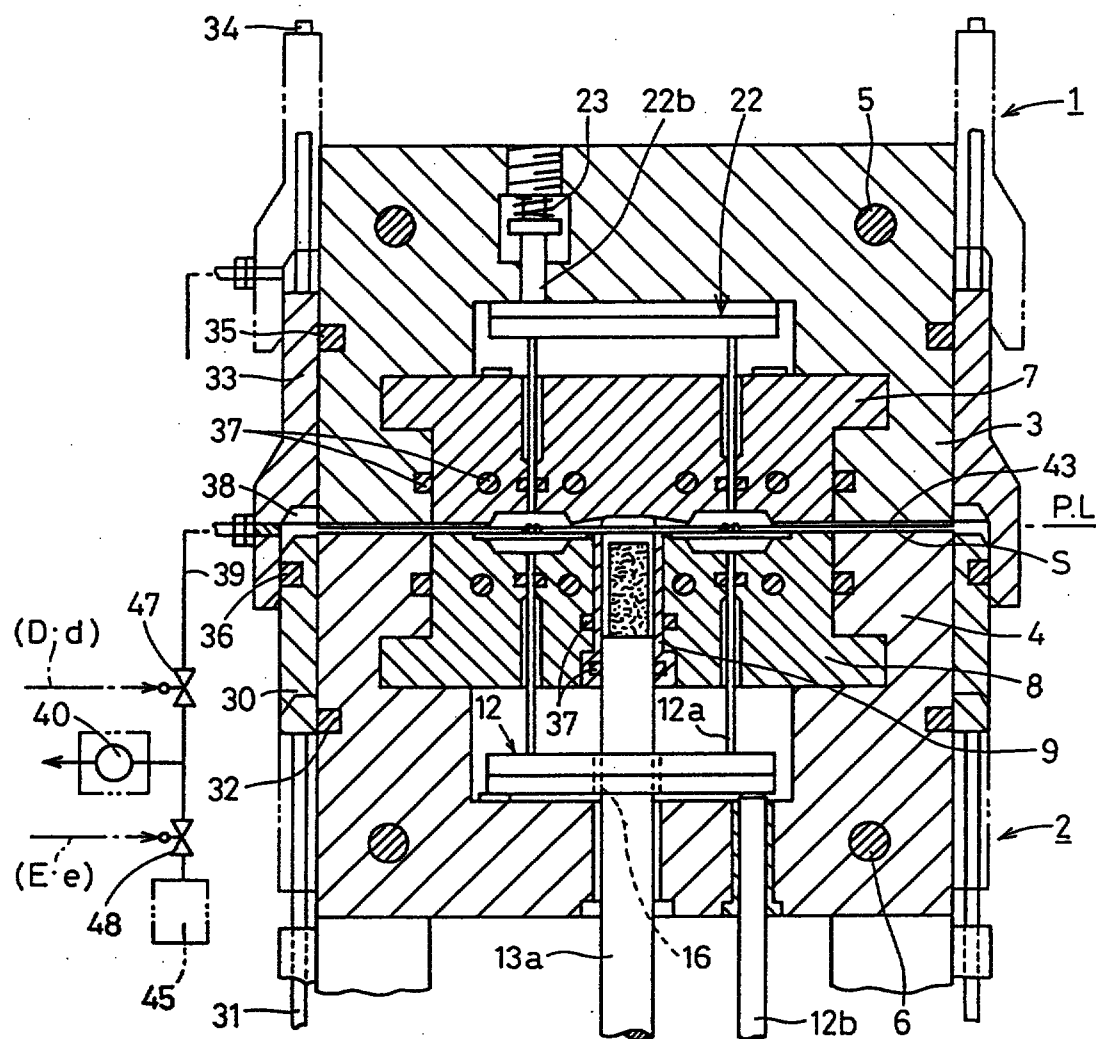
FIG.1



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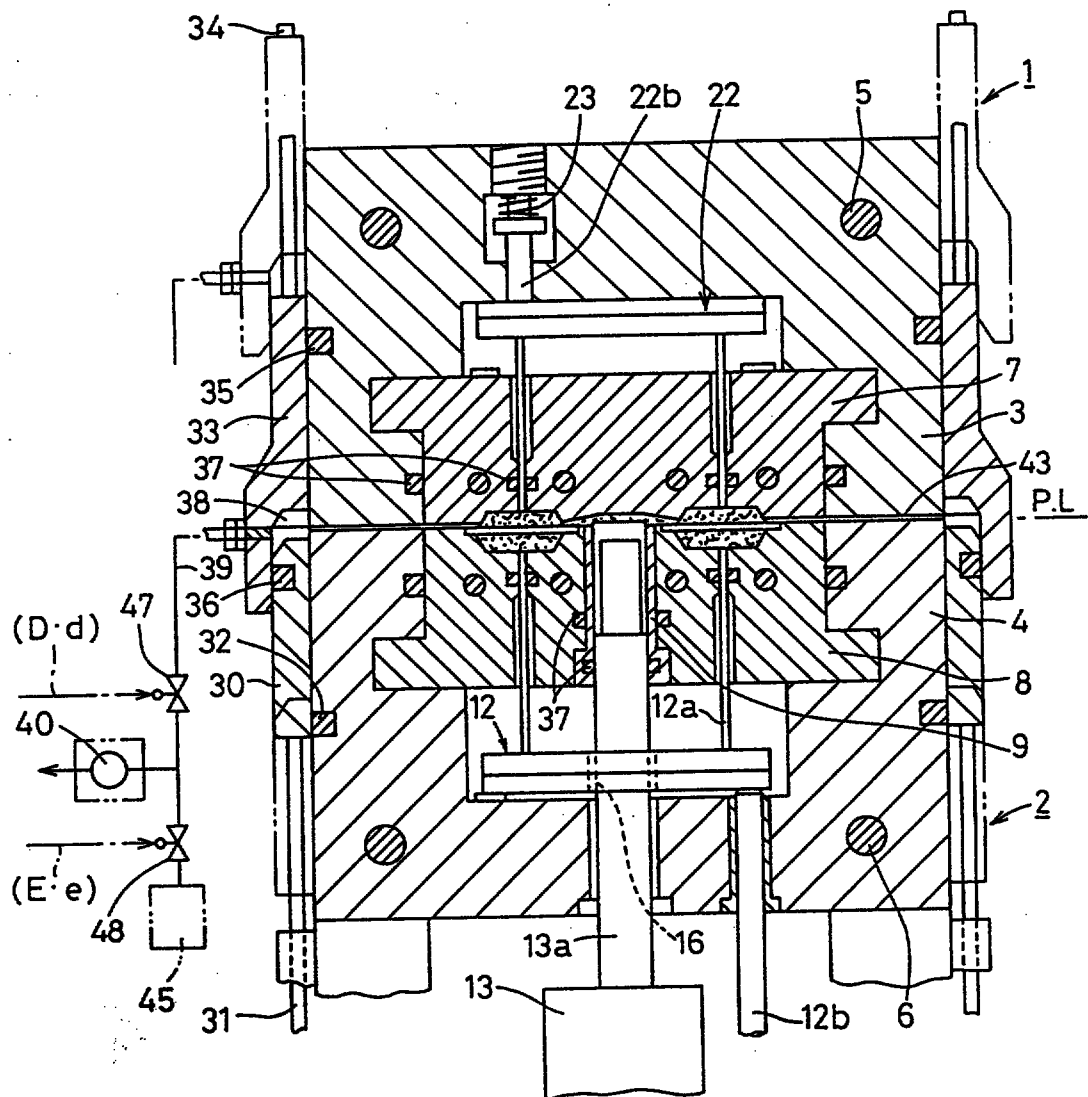
FIG.2



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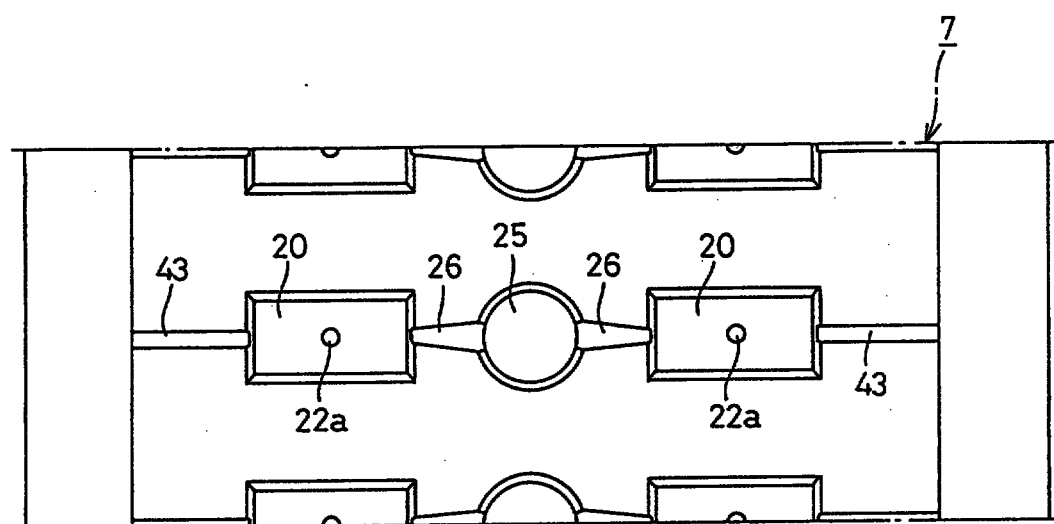
FIG.3



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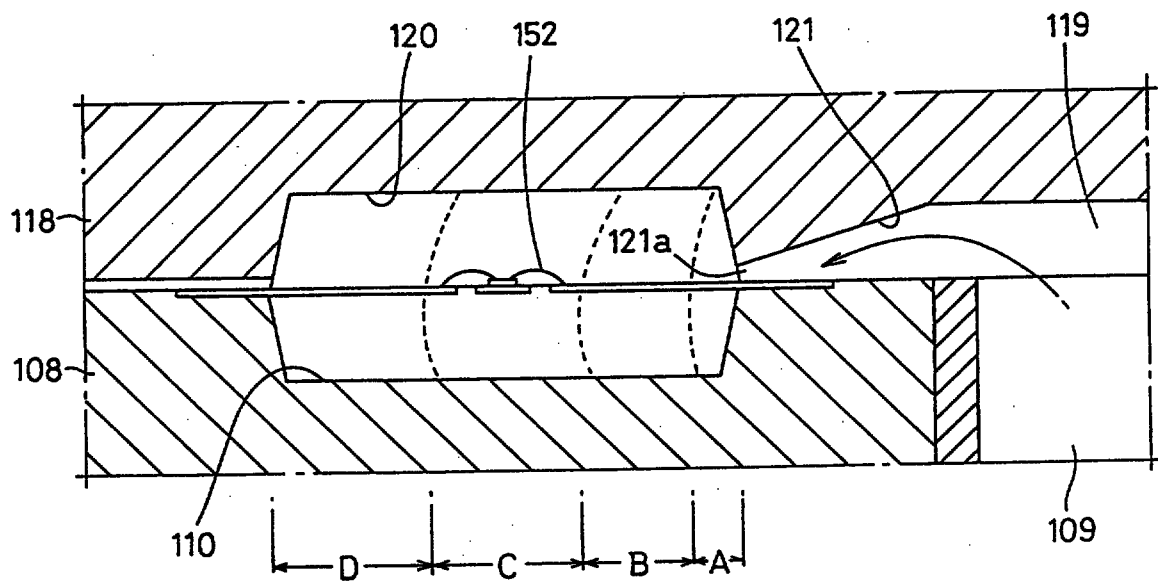
FIG.4



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FIG.5

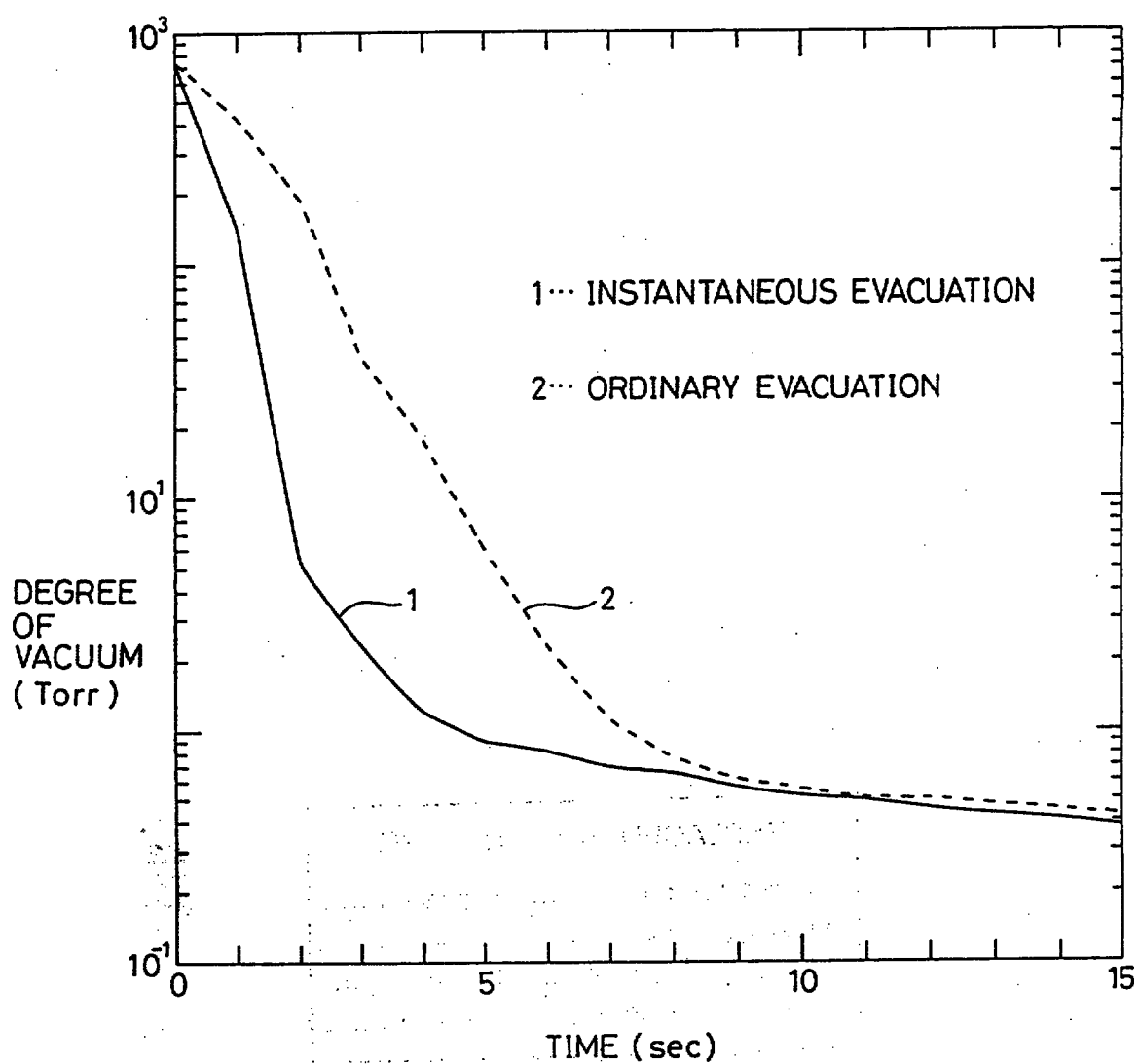


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FIG.6

EVACUATION EFFICIENCY



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REPLACEMENT SHEETS		SG
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DATE OF RECEIPT		29 AUG 1996

TITLE OF THE INVENTION

Method of and Apparatus for Molding Resin to Seal
Electronic Parts

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to improvements in a method of and an apparatus for molding resin to seal electronic parts, such as ICs, LSIs, diodes or capacitors which are mounted on lead frames, for example, with thermosetting resin materials, and more particularly, it relates to improvements for preventing electronic parts molded and sealed with resin (mold packages) from formation of voids in the interior and the exterior thereof, as well as for preventing bonding wires from a wire sweep phenomenon caused by the resin and attaining improvement in adhesiveness (adhesion) between the lead frames and the resin.

Description of the Background Art

In general, an electronic part is molded and sealed with resin by a transfer mold method, which is generally carried out through a resin sealing/molding apparatus, for example, in the following manner:

A fixed upper mold section and a movable lower mold section provided in the resin sealing/molding apparatus are previously heated to a resin molding temperature by

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heating means, and opened (there is also known an apparatus having an inverse structure, which is provided with a movable upper mold section and a fixed lower mold section).

Then, a lead frame which is provided with an electronic part is set on a prescribed position of a die surface of the lower mold section, while a resin tablet is supplied in a pot of the lower mold section.

Then, the lower mold section is upwardly moved so that the upper mold section and the lower mold section are closed. Thus, the electronic part and the lead frame provided with the same are set between upper and lower cavities which are oppositely provided in the die surfaces of the lower mold section and the upper mold section, while the resin tablet stored in the pot is heated to be gradually melted.

Then, the resin tablet stored in the pot is pressurized by a plunger so that the resin material as melted is injected into/charged in the cavities, whereby the electronic part and the lead frame set in the cavities are sealed in a resin molded member which is molded in response to the shapes of the cavities.

After a lapse of a time which is required for hardening the melted resin material, the upper mold section and the lower mold section may be so opened as to

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release the resin molded member and the lead frame from the cavities while releasing the hardened resin from a resin passage portion through a mold releasing mechanism.

When the upper mold section and the lower mold section are closed, air containing moisture such as that in the atmosphere, for example, remains in a space portion which is defined by the pot, the resin passage portion and the cavities. Such residual air may enter the melted resin material to cause a problem in resin molding such as formation of voids in the interior and the exterior of the resin molded member.

In order to cope with this problem, the cavities are made to communicate with the exterior through proper air vents and the melted resin material which is stored in the pot is transferred through the resin passage portion and injected into/charged in the cavities, so that the aforementioned residual air and the like are naturally discharged to the exterior through the air vents.

While the air remaining in the pot, the resin passage portion and the cavities can be naturally discharged through the air vents as hereinabove described, it is impossible to effectively inhibit the resin molded member from formation of internal voids and defects on its outer surface in practice. Thus, it is impossible to reliably solve a problem of deterioration in moisture resistance

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and appearance of the product.

When internal voids are formed in the resin molded member, adhesion between the lead frame and the resin is deteriorated and moisture easily infiltrates into the product through a clearance defined between the resin and the lead frame to deteriorate moisture resistance of the product, for example. Further, the resin molded member is easily cracked or chipped by force which is applied to a base portion of an outer lead portion projecting from the resin molded member to bend the same. Thus, it is impossible to attain high quality and high reliability which are strongly required for this product.

The internal voids which are formed in the resin molded member mainly result from air and/or moisture contained in the resin tablet.

The resin tablet, which is formed by merely compacting resin powder into a prescribed shape, generally contains a large quantity of air containing moisture in the atmosphere. Further, the large quantity of air contained in the resin tablet is present in the form of a number of independent bubbles, being isolated from each other, which cannot communicate with each other and with the surface of the resin tablet for ventilation.

When the resin tablet is heated to a resin molding temperature of at least 175°C, for example, the air and/or

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moisture contained in the resin tablet forms water vapor, which enters the melted resin material with the air remaining in the aforementioned internal die space portion. Thus, the resin material is injected into/charged in the cavities in this state, and hence voids are formed in the interior and the exterior of the resin molded member due to the air and/or moisture contained in the resin tablet.

Further, gas such as combustion gas which is generated upon heating of the resin tablet also serves as a cause for forming voids in the interior and the exterior of the resin molded member.

In order to prevent formation of the voids in the interior and the exterior of the resin molded member, the following countermeasure may be employed:

For example, the air remaining in the aforementioned internal die space portion between the upper mold section and the lower mold section may be discharged to the exterior through a vacuum pump, thereby preventing the residual air from entering the melted resin material.

When ordinary air discharge means such as the vacuum pump is employed, however, the overall resin sealing/molding time is disadvantageously lengthened since a long time is generally required for increasing the degree of vacuum in the internal die space portion to a

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prescribed level.

In general, an electronic part is molded and sealed with thermosetting resin such as epoxy resin, for example, and hence the resin tablet which is supplied in the aforementioned internal die space portion (pot) is hardened with time after the same is heated and melted.

When the internal die space portion is evacuated through ordinary air discharge means for a long time, therefore, hardening of the melted resin material is facilitated to deteriorate its flowability. Thus, the evacuating operation is preferably carried out in a short time in consideration of this point.

As hereinabove described, gas such as combustion gas which is generated upon heating of the resin tablet also serves as a cause for forming voids and defects in the interior and the exterior of the resin molded member. Such gas is generated by a coupling agent, a mold release agent, a flexible agent etc. contained in the resin tablet, which are heated and vaporized when the resin tablet is heated to a resin molding temperature of 175°C, for example, and melted.

In another conventional countermeasure for preventing the resin molded member from formation of voids, the melted resin material which is injected into the cavities is pressurized to be increased in resin pressure for

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compressing voids contained therein, thereby compressing voids which are formed in the interior of the resin molded member to a negligible degree.

However, the conventional method of compressing the voids under a high pressure has the following problems:

(1) This method is disadvantageous in consideration of durability of the apparatus, dangerousness in operation, the cost and the like, due to requirement for a large-sized press machine which can carry out high-pressure compression molding.

(2) Viscous resin which starts to be hardened in the cavities in a final stage of the compression step is made to flow in such high-pressure compression molding. Thus, a bonding wire for electrically coupling an electrode of a semiconductor element and the outer lead portion is inclined toward the direction of resin flowing in the so-called wire sweep phenomenon. This may lead to a serious problem such as contact between the bonding wire and an adjacent one, disengagement of a bonding pad wire from the electrode, or wire breaking.

In the aforementioned conventional countermeasure for preventing formation of voids, further, it is impossible to make effective use of multistage injection for preventing the problem of the wire sweeping phenomenon of the bonding wire, electrode disengagement, wire breaking

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or the like. This problem is now described with reference to Fig. 5.

In a conventional method of injecting a melted resin material into cavities with no employment of multistage injection, a plunger which is engaged with a pot 109 is first upwardly moved to pressurize and inject a melted resin material into cavities 110 and 120 which are oppositely formed in a lower mold section 108 and an upper mold section 118 through a cull portion 119 and a gate 121, as shown in Fig. 5. The speed for injecting the resin in the cavities 110 and 120 can be adjusted by controlling the speed for upwardly moving the plunger.

If the resin injection speed is at a high level, the resin is injected into the cavities 110 and 120 to spout from a port 121a. Thus, the injected resin entrains air which is present around the port 121a, to form voids and defects in the vicinity of the port 121a. Further, a spiral flow of the resin is caused in the cavities 110 and 120 and entrains air remaining therein to form voids and defects, while causing a wire sweep phenomenon of a bonding wire 152, electrode disengagement, wire breaking or the like. When multistage injection, i.e., a molding method of adjusting the speed or pressure for injecting the melted resin material into the cavities 110 and 120 under constant conditions, is employed, on the other hand,

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the following action is obtained:

The speed for injecting the resin through the port 121a is relatively reduced in a range (A in Fig. 5) where the resin is completely charged around the port 121a and the time therefor, and a range (C in Fig. 5) where the resin is charged around the wire 152 and the time therefor. In the remaining ranges (B and D in Fig. 5), the resin is injected at an ordinary injection speed, which is higher than that in the ranges A and C.

In this case, it is possible to suppress spouting of the resin which is injected from the port 121a into the cavities 110 and 120 by reducing the injection speed therefor in the range A shown in Fig. 5, thereby preventing the injected resin from entrainment of air and occurrence of a spiral flow in the vicinity of the port 121a.

In the range B shown in Fig. 5, on the other hand, it is possible to inject the resin at an ordinary injection speed since no bonding wire 152 is provided in this range B. While the resin is injected at the ordinary injection speed also in the range A at this time, neither entrainment of air nor occurrence of a spiral flow is caused in the injected resin in the vicinity of the port 121a since the range A is already charged with the resin.

Then, the injection speed for the resin is reduced

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since the range C shown in Fig. 5 is provided with the bonding wire 152, for inhibiting a forward end portion, shown by broken lines in Fig. 5, of the injected resin which is charged in the cavities 110 and 120 from coming into contact with the bonding wire 152 and forcibly bending the same, thereby preventing a wire sweep phenomenon of the bonding wire 152, electrode disengagement and wire breaking caused by such bending action.

Then, the resin can be injected at an ordinary injection speed in the range D shown in Fig. 5, which is provided with no bonding wire 152. While the resin is injected at the ordinary injection speed also in the ranges A to C at this time, neither entrainment of air nor occurrence of a spiral flow is caused in the injected resin in the vicinity of the port 121a since the ranges A to C are already charged with the resin.

Due to employment of such multistage injection, it is possible to solve the aforementioned problems of formation of voids and defects, a wire sweeping phenomenon of the bonding wire 152 and the like which are caused by the resin spouting from the port 121a into the cavities 110 and 120.

The aforementioned countermeasure for preventing occurrence of voids by high-pressure compression molding

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and the multistage injection are in the following relations:

The aforementioned high-pressure compression molding is effective means in consideration of a countermeasure for preventing occurrence of voids, while the same has problems of a wire sweep phenomenon of a bonding wire, electrode disengagement and wire breaking.

While the multistage injection can prevent a wire sweep phenomenon of a bonding wire, electrode disengagement and wire breaking, this method is not effective in consideration of a countermeasure for preventing occurrence of voids.

It may be possible to carry out the high-pressure compression molding after carrying out the multistage injection. However, the aforementioned problems following the high-pressure compression molding cannot be solved by such means.

Consequently, it is impossible to make effective use of the multistage injection when the conventional countermeasure for preventing occurrence of voids is employed.

SUMMARY OF THE INVENTION

An object of the present invention is to enable molding of products having high quality and reliability by efficiently and reliably discharging air and/or moisture

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remaining in an internal die space portion, air and/or moisture contained in resin tablets and gas generated upon heating of the resin tablets to the exterior of the internal die space portion in a short time thereby preventing occurrence of voids and defects in resin molded members resulting from infiltration of the gas in melted resin materials while improving adhesiveness between lead frames and the resin.

Another object of the present invention is to provide a method of preventing occurrence of voids and defects which can make effective use of multistage injection, and a method of thereby preventing bonding wires from a wire sweep phenomenon caused by resin.

In order to attain the aforementioned objects, the inventive method of molding resin to seal electronic parts comprises the following steps:

First, resin tablets are supplied in a plurality of pots which are arranged in a die for resin molding consisting of an upper mold section and a lower mold section, and electronic parts which are mounted on lead frames are supplied to and set in prescribed positions of cavities defined in the die. Then, the resin tablets which are supplied in the pots are heated. The upper mold section and the lower mold section are closed to engage the electronic parts which are provided on the lead frames



in the prescribed positions of the cavities.

Then, an internal die space portion, which is defined by at least the pots, resin passages and the cavities when the die is closed, is cut off from the exterior. In this state, evacuation is carried out for forcibly sucking air and moisture remaining in the internal die space portion, air and moisture flowing out from the resin tablets and gas generated by heating and discharging the same to the exterior of the internal die space portion, and instantaneous evacuation is carried out for forcibly sucking and discharging the same in a short time.

Thereafter the resin tablets which are received in the pots of the die are pressurized to inject resin materials which are heated and melted in the pots into the cavities which are arranged on side positions of the pots through the respective resin passages, thereby molding resin to seal the electronic parts provided on the lead frames, which are engaged in the cavities.

According to this method, it is possible to improve the degree of vacuum in the internal die space portion in a short time, by discharging the air, moisture and gas from the internal die space portion through evacuation and instantaneous evacuation while cutting off the internal die space portion which is defined upon closing of the die from the exterior.

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Further, it is possible to improve the degree of vacuum in the internal die space portion by a synergistic effect of evacuation and instantaneous evacuation.

Therefore, it is possible to prevent the air, moisture and gas which are contained in the internal die space portion from infiltrating into or being entrained in the melted resin materials. Consequently, it is possible to reliably prevent formation of voids and defects, resulting from presence of the air, moisture and gas, in the interior and exterior of resin molded members.

The lead frames and the resin molded members so strongly adhere to each other that no voids and clearances are defined between the lead frames and the resin, and the products are improved in moisture resistance to attain high quality and high reliability.

Further, the air and/or moisture remaining in the internal die space portion, the air and/or moisture contained in the resin tablets and the gas generated upon heating of the resin tablets, which are main causes forming voids in the interior and the exterior of the resin molded members, can be efficiently and reliably discharged to the exterior of the internal die space portion in a short time, whereby it is not necessary to carry out the conventional high-pressure compression molding, which is employed as a countermeasure for



preventing occurrence of voids. Therefore, it is possible to make effective use of the aforementioned multistage injection as a countermeasure for protecting bonding wires in resin molding.

In the inventive method of molding resin to seal electronic parts, evacuation and instantaneous evacuation steps can be continuously carried out in this order or vice versa, while it is also possible to simultaneously carry out these steps.

In a preferred embodiment of the inventive method of molding resin to seal electronic parts, the resin tablets are thermally expanded through a step of heating the resin tablets so that the interior and the exterior of the resin tablets are communicative and ventilative, so that the instantaneous evacuation step is thereafter carried out.

In order to attain the aforementioned objects, the inventive apparatus for molding resin to seal electronic parts comprises a resin molding die consisting of an upper mold section and a lower mold section which are arranged oppositely to each other and having a plurality of pots, a plurality of cavities and a plurality of resin passages for making the same communicate with each other, means for supplying resin tablets to the respective pots, means for supplying and setting electronic parts provided on lead frames to and in prescribed positions of the cavities,

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means for closing the die while receiving the resin tablets in the pots and setting the electronic parts in the cavities and heating the resin tablets for melting the same, and means for injecting melted resin materials into the cavities through the resin passages for molding resin to seal the electronic parts. The inventive apparatus for molding resin to seal electronic parts further comprises means for cutting off an internal space portion, which is defined upon closing of the die, including at least the respective pots, the respective resin passages and the respective cavities from the exterior, evacuation means for forcibly sucking/discharging air, moisture and gas contained in the internal die space portion to the exterior thereof for improving the degree of vacuum in the internal die space portion, and instantaneous evacuation means for forcibly sucking/discharging the air, moisture and gas contained in the internal die space to the exterior thereof in a short time for quickly improving the degree of vacuum in the internal die space portion.

In a preferred embodiment of the inventive apparatus for molding resin to seal electronic parts, the evacuation means includes a vacuum source and the instantaneous evacuation means includes a vacuum tank, while three end portions of a vacuum path having three branch portions are connected to the vacuum source, the vacuum tank and the

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internal die space portion to communicate with the same, while switching valves are provided between the branch portions and the vacuum tank as well as the internal space portion.

Due to the aforementioned structure, it is possible to bring the vacuum tank into a prescribed vacuum state by driving the vacuum source while closing the switching valve provided between the branch portion and the internal die space portion and opening that provided between the branch portion and the vacuum tank, and to instantaneously suck air etc. contained in the internal die space portion into the vacuum tank by opening both switching valves when it is necessary to carry out instantaneous evacuation. Therefore, it is possible to carry out evacuation and instantaneous evacuation through a single vacuum source. Consequently, it is possible to implement the inventive method of molding resin to seal electronic parts by an apparatus having a relatively simple structure.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partially fragmented sectional view

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showing a principal part of a die, provided in an apparatus for molding resin to seal electronic parts, which is in an opened state;

Fig. 2 is a partially fragmented sectional view of the die, shown in Fig. 1, which is in an intermediately closed state;

Fig. 3 is a partially fragmented sectional view of the die, shown in Fig. 1, which is in a completely closed state for molding resin to seal electronic parts;

Fig. 4 is a partially fragmented bottom plan view showing a principal part of a die surface of an upper mold section which is provided in the die shown in Fig. 1;

Fig. 5 is a partially fragmented sectional view showing a portion of a die around cavities, for illustrating a state of injecting a melted resin material into the cavities from a pot through a resin passage; and

Fig. 6 is a graph showing exemplary evacuation efficiency levels in ordinary evacuation and instantaneous evacuation carried out in an internal die space portion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention is now described in detail with reference to Figs. 1 to 4.

Fig. 1 is a partially fragmented sectional view showing a principal part of a die, provided in an apparatus for molding resin to seal electronic parts

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according to the present invention, which is in an opened state.

Fig. 2 is a partially fragmented sectional view corresponding to Fig. 1, showing the principal part of the die which is in an intermediately closed state in advance of complete closing.

Fig. 3 is a partially fragmented sectional view corresponding to Fig. 1, showing the principal part of the die which is in a completely closed state.

Fig. 4 shows a die surface of an upper mold section provided in the die shown in Fig. 1.

This resin sealing/molding apparatus is oppositely provided with an upper mold section 1 (fixed type) which is mounted on an upper fixed plate and a lower mold section 2 (movable type) which is mounted on a lower movable plate.

Further, die bases 3 and 4 of the upper mold section 1 and the lower mold section 2 are provided with heating means 5 and 6 such as heaters respectively.

A fixed chase block 7 is detachably mounted on the fixed die base 3 by proper engaging means such as a dovetail groove and a dovetail portion.

On the other hand, a movable chase block 8 is detachably mounted on the movable die base 4 by engaging means which are similar to those provided on the fixed



side.

The chase blocks 7 and 8 which are engaged in the die bases 3 and 4 are set in prescribed positions by proper fixing blocks (not shown) for fixing the same on horizontal end portions thereof.

Proper seal members (not shown) are preferably inserted between the chase blocks 7 and 8 and the fixing blocks.

The movable chase block 8 is provided with a plurality of pots 9, while a required number of resin molding cavities 10 are arranged on side positions of the respective pots 9.

The movable chase block 8 is also provided with dedicated heating means 11 such as heaters.

The movable chase block 8 is further provided on its lower position with a lower ejector plate 12 comprising ejector pins 12a for ejecting and releasing resin molded members which are molded in the cavities 10, and a plunger holder 13 (see Fig. 3) comprising plungers 13a (resin pressurizing means) for pressurizing resin tablets R which are supplied in the pots 9 respectively.

Upper end portions of the ejector pins 13a are engaged in pin holes 14 communicating with the cavities 10.

Further, upper portions of the plungers 13a are

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engaged in the respective pots 9 through insertion holes 15 and 16 which are provided in the movable die base 4 and the ejector plate 12.

Proper seal members (not shown) are preferably inserted between an engaging space for the lower ejector plate 12 which is provided in the movable die base 4 and the exterior of this space as well as between the plungers 13a and the engaging space.

On the other hand, the fixed chase block 7 is provided with cavities 20 in correspondence to the positions and the number of the cavities 10 provided in the movable chase block 8.

The fixed chase block 7 is further provided with cull portions 25, oppositely to the pots 9 of the movable chase block 8.

The cull portions 25 and the cavities 20 communicate with each other through resin passages 26, whereby the pots 9 and the cavities 10 and 20 communicate with each other through the short resin passages 26 including the cul portions 25 when the upper mold section 1 and the lower mold section 2 are closed. Further, the plungers 13a which are engaged in the pots 9 are vertically driven by a proper driving mechanism (not shown) such as a hydraulic or pneumatic motor or an electric motor.

When the plungers 13a pressurize the resin tablets R

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which are received in the pots 9, resin materials heated and melted in the pots 9 are injected into the cavities 10 and 20 through the resin passages 26 including the cull portions 25.

The upper cavities 20 are provided with air vents 43 (see Fig. 4) for making the cavities 10 and 20 communicate with the exterior upon closing thereof.

The fixed chase block 7 is further provided with dedicated heating means 21 such as heaters.

The fixed chase block 7 is further provided on its upper position with a support pin 22b for an upper ejector plate 22 comprising ejector pins 22a for ejecting and releasing resin molded members which are molded in the cavities 20, and an elastic member 23 such as a spring for downwardly pressing the upper ejector plate 22 through the support pin 22b.

Lower end portions of the ejector pins 22a are engaged with pin holes 24 communicating with the cavities 20 and pin holes 24a communicating with the cull portions 25 respectively.

The upper ejector plate 22 is downwardly pressed by elasticity of the elastic member 23 when the upper mold section 1 and the lower mold section 2 are opened as shown in Fig. 1, so that hardened resin members in the resin passages 26 which are provided between the cull portions

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25 and the cavities 20 and the resin molded members hardened in the cavities 20 can be downwardly ejected and released.

When the upper mold section 1 and the lower mold section 2 are opened, further, the lower ejector plate 12 is upwardly pressed by an ejector bar 12b, so that the ejector pins 12a upwardly eject and release the resin molded members from the cavities 10.

When the upper mold section 1 and the lower mold section 2 are completely closed as shown in Fig. 3, the ejector plates 22 and 12 are upwardly and downwardly retracted respectively through upper and lower return pins (not shown) which are oppositely provided on the ejector plates 22 and 12.

An outside air blocking member 30 which is in the form of a circular or rectangular cylinder is engaged with the movable die base 4 for covering at least outer peripheries of the pots 9 and the cavities 10 in a die surface of the lower mold section 2. This outside air blocking member 30 is slidable along the direction for opening/closing the upper mold section 1 and the lower mold section 2 through a required driving mechanism 31.

Further, a proper seal member 32 is interposed between the engaging surfaces of the movable die base 4 and the outside air blocking member 30.

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Another outside air blocking member 33 which is in the form of a circular or rectangular cylinder is engaged with the fixed base 3 for covering outer peripheries of the resin passages 25 and 26 and the cavities 20 in a die surface of the upper mold section 1. This outside air blocking member 33 is slidable along the direction for opening/closing the upper mold section 1 and the lower mold section 2 through a proper driving mechanism 34.

Further, a proper seal member 35 is interposed between the engaging surfaces of the fixed die base 3 and the outside air blocking member 33.

When the outside air blocking members 30 and 33 are moved to close the upper mold section 1 and the lower mold section 2 through the driving mechanisms 31 and 34 respectively, forward ends of these outside air blocking members 30 and 33 are engaged with each other (see Figs. 2 and 3).

Referring to Fig. 3, an upper end of the outside air blocking member 30 which is engaged with the movable die base 4 is upwardly moved to a portion close to the die surface of the lower mold section 2, while the outside air blocking member 33 which is engaged with the fixed die base 3 is engaged an outer peripheral surface of the outside air blocking member 30 engaged with the movable die base 4.

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While the engaging surfaces of the outside air blocking members 30 and 33 are vertically perpendicular in the figures, other proper engaging surfaces may be employed in place of such a structure.

Further, a proper seal member 36 is interposed between the engaging surfaces of the outside air blocking members 30 and 33.

In addition, proper seal members 37 are also interposed between the die bases 3 and 4 and the chase blocks 7 and 8, between the chase blocks 7 and 8 and the ejector pins 22a and 12a, and between the movable chase block 8 and the pots 9 and the plungers 13a.

When the upper mold section 1 and the lower mold section 2 are closed, therefore, the forward ends of the outside air blocking members 30 and 33 are so engaged as to define an outside air blocking space portion 38 (see Figs. 2 and 3), which is cut off from the outside air by the outside air blocking members 30 and 33 and the seal members 32, 35, 36 and 37.

The seal members 32, 35, 36 and 37 may simply define the space portion 38 which requires a proper vacuum state between the upper mold section 1 and the lower mold section 2.

The outside air blocking members 30 and 33 can be retracted through the driving mechanisms 31 and 34 to



positions not inhibiting operations for detaching the chase blocks 7 and 8 from the die bases 3 and 4 and exchanging the same.

Thus, it is possible to open and close the upper mold section 1 and the lower mold section 2 while locating the outside air blocking members 30 and 33 in the positions shown in Figs. 2 and 3, for example, whereby the outside air blocking members 30 and 33 may not be retracted every molding cycle time in ordinary resin molding.

The driving mechanisms 31 and 34 for the outside air blocking members 30 and 33 may be prepared from mechanical driving mechanisms such as proper rack and pinion mechanisms, electric driving mechanisms such as electric motors, or hydraulic or pneumatic fluid driving mechanisms, while the aforementioned electric driving mechanisms or pneumatic driving mechanisms are preferable in consideration of the operation for molding resin to seal electronic parts.

Concave portions 29 for setting lead frames 27 provided with electronic parts 27a are provided in the die surface of the movable chase block 8.

Referring to Fig. 1, numeral 28 denotes lead frame supply/discharge mechanisms for supplying/setting the lead frames 27 in the concave portions 29.

The space portion 38 which is defined upon engagement

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of the outside air blocking members 30 and 33 is connected with an end of a vacuum path 39 such as a vacuum pipe to communicate with the same, while the other end of the vacuum path 39 is connected with a vacuum source 40 consisting of a vacuum pump or the like, and an instantaneous evacuation mechanism 45 consisting of a vacuum tank or the like, to communicate with the same.

Namely, the space portion 38 is connected with the vacuum source 40 through a switching valve 47 such as an electromagnetic valve which is provided in the vacuum path 39, to communicate with the same.

Further, the space portion 38 is connected with the instantaneous evacuation mechanism 45 through the switching valve 47 provided in the vacuum path 39 and another switching valve 48 such as an electromagnetic valve, to communicate with the same.

The vacuum source 40 is connected between the switching valves 47 and 48 in a communicative manner. Therefore, when the vacuum source 40 is driven while opening the switching valve 47 by an opening signal D and closing the other switching valve 48 by a closing signal e, for example, it is possible to evacuate the space portion 38 through the switching valve 47 and the vacuum path 39.

When the vacuum source 40 is driven while closing the

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switching valve 47 by a closing signal d and opening the other switching signal 48 by an opening signal E, on the other hand, it is possible to bring the instantaneous evacuation mechanism (vacuum tank) 45 into a prescribed vacuum state by evacuation through the switching valve 48 and the vacuum path 39.

Description is now made on evacuation of the space portion 38 which is defined when the upper mold section 1 and the lower mold section 2 are closed as shown in Fig. 2 or 3 and an internal die space portion defined by at least the pots 9, the resin passages 25 and 26 and the cavities 10 and 20 is cut off from the exterior, and instantaneous evacuation for quickly improving the degree of vacuum in the space portion 38.

First, the vacuum source 40 is driven while closing the switching valve 47 by the closing signal d and opening the switching valve 48 by the opening signal E, thereby bringing the instantaneous evacuation mechanism 45 into a prescribed vacuum state. At this time, the degree of vacuum in the instantaneous evacuation mechanism (vacuum tank) 45 can be arbitrarily set at a proper level.

Then, the switching valve 47 is opened by the opening signal D so that the space portion 38 communicates with the instantaneous evacuation mechanism 45 through the switching valves 47 and 48 and the vacuum path 39, whereby

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air remaining in the space portion 38 is instantaneously and forcibly sucked/discharged to the exterior in a short time by the instantaneous evacuation mechanism 45 which is maintained in the prescribed degree of vacuum. Thus, it is possible to carry out instantaneous evacuation for quickly increasing the degree of vacuum in the space portion 38. At this time, a high degree of vacuum can be attained in the space portion 38 in several seconds.

The space portion 38 communicates with the vacuum source 40 through the switching valve 47 and the vacuum path 39. Therefore, it is possible to carry out evacuation for forcibly sucking/discharging the air remaining in the space portion 38 to the exterior in continuation to the aforementioned instantaneous evacuation, driving the vacuum source 40 while closing the switching valve 48 by the closing signal e.

Due to the evacuation through the vacuum source 40, it is possible to maintain or further increase the degree of vacuum in the space portion 38 which is attained by the instantaneous evacuation. Thus, it is possible to instantaneously set the space portion 38 in a high vacuum state in a short time, by carrying out the instantaneous evacuation through the instantaneous evacuation mechanism 45 and the evacuation through the vacuum source 40.

The evacuation is carried out while closing the

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switching valve 48, so that only the vacuum source 40 and the space portion 38 communicate with each other for efficiently carrying out the evacuation without reducing the function of the vacuum source 40.

In the instantaneous evacuation and the evacuation of the space portion 38, it is possible to forcibly suck/discharge air and/or moisture remaining in the space portion 38, air and/moisture flowing out from the resin tablets R heated and expanded in the pots 9 into the space portion 38, and gas generated by heating to the exterior of the space portion 38.

Description is now made on operation for molding resin to seal the electronic parts 27a which are mounted on the lead frames 27 with resin through the apparatus having the aforementioned structure.

First, the vacuum source 40 is driven while previously closing the switching valve 47 by the closing signal d and opening the switching valve 48 by the opening signal E, thereby bringing the instantaneous evacuation mechanism (vacuum tank) 45 into a prescribed vacuum state through the switching valve 48 and the vacuum path 39.

Then, the lower mold section 2 is downwardly moved to open the upper mold section 1 and the lower mold section 2, as shown in Fig. 1. Then, the resin tablets R are supplied into the pots 9 which are provided in the lower

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mold section 2, while the lead frames 27 are supplied/set in the concave portions 29 which are provided in the die surface of the movable chase block 8 through the lead frame supply/discharge mechanisms 28.

The resin tablets R which are supplied in the pots 9 are heated and expanded/softened by the heating means 5, 6, 11 and 21 provided in the upper mold section 1 and the lower mold section 2, to be gradually melted.

Then, the lower mold section 2 is upwardly moved so that the upper mold section 1 and the lower mold section 2 are closed while the outside air blocking members 30 and 33 are slid to be engaged with each other, thereby defining the outside air blocking space portion 38 covering a space portion between the die surfaces of the upper mold section 1 and the lower mold section 2 and at least the outer peripheries of the pots 9, the resin passages 25 and 26 and the cavities 10 and 20, as shown in Figs. 2 and 3.

The upper mold section 1 and the lower mold section 2 are intermediately closed to define a required space S between the die surfaces thereof as shown in Fig. 2, and then completely closed to join the die surfaces with each other as shown in Fig. 3. Such intermediate closing and complete closing are carried out in continuation.

In the aforementioned closing, particularly in the

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intermediate closing of the upper mold section 1 and the lower mold section 2, an instantaneous evacuation step is carried out by the instantaneous evacuation mechanism 45.

Namely, the switching valve 47 is opened by the opening signal D so that the space portion 38 communicates with the instantaneous evacuation mechanism 45 through the switching valves 47 and 48 and the vacuum path 39, thereby instantaneously and forcibly sucking/discharging the air remaining in the space portion 38 and the like to the exterior in a short time.

At this time, therefore, the degree of vacuum in the space portion 38 is quickly improved to attain a high degree of vacuum in several seconds.

Then, the switching valve 48 is closed by the closing signal e and the vacuum source 40 is driven to carry out an evacuation step of forcibly sucking/discharging the air remaining in the space portion 38 and the like to the exterior in continuation to the instantaneous evacuation step by the instantaneous evacuation mechanism 45.

At this time, therefore, it is possible to maintain the degree of vacuum in the space portion 38 which is attained by the instantaneous evacuation, or further improve the degree of vacuum.

The resin tablets R which are supplied in the pots 9 are heated and expanded/softened by the heating means 5,



6, 11 and 21 provided in the upper mold section 1 and the lower mold section 2, while the interior and the exterior of the resin tablets R are brought into ventilative states so that air and/or moisture contained therein flow out into the pots 9. Namely, the resin tablets R supplied into the pots 9 which are in heated states are efficiently and quickly expanded by thermal expansion through heating by radiation heat and conduction heat received from the pots 9, expansion through the evacuation in the pots 9 and synergistic action/effect of these actions. Even if the resin tablets R which are supplied in the pots 9 contain a number of fine independent bubbles, therefore, such independent bubbles are reliably broken by the aforementioned expansion of the resin tablets 9. Therefore, the interior and the exterior of the resin tablets R communicate with each other to be in ventilative states, whereby air and moisture contained in the number of independent bubbles reliably flow out into the pots 9 (space portion 38).

Further, the resin tablets R supplied in the pots 9 generate gas upon heating. Therefore, it is possible to instantaneously set the space portion 38 in a high vacuum state in a short time by carrying out the instantaneous evacuation through the instantaneous evacuation mechanism 45 and the evacuation through the vacuum source 40.

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Consequently, all of the air and/or moisture remaining in the space portion 38, the air and/or moisture flowing out from the resin tablets R into the space portion 38 (pots 9) and the gas generated by heating of the resin tablets R can be forcibly sucked/discharged to the exterior of the space portion 38.

The resin tablets R which are supplied in the pots 9 contain moist air in states of a number of independent bubbles, which cannot communicate with each other and with the surfaces of the resin tablets R. When the resin tablets R are heated to a resin molding temperature in the pots 9, therefore, the resin tablets R are expanded/softened to be finally melted as follows:

In the resin tablets R which are received in the pots 9, bottom surfaces are placed on upper end surfaces of the plungers 13a and clearances are defined between the side surfaces and inner wall surfaces of the pots 9, while open space portions are defined between the upper surfaces and the cull portions 25.

In this state, therefore, conduction heat and radiation heat are applied to the bottom surface portions and the side surface portions of the resin tablets R respectively. Therefore, heating values on the bottom portions of the resin tablets R which are in contact with the upper end surfaces of the plungers 13a are first

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increased, so that the bottom portions are softened successively from central portions. Consequently, upper central portions of the resin tablets R are upwardly pressed from the interior to be expanded toward upper portions in the pots 9 (i.e., toward the cull portions 25) in advance of other portions.

At this time, the interior and the exterior of the resin tablets R communicate with each other to enter ventilative states, whereby the air and/or moisture which is trapped in the independent bubbles easily flow out into the space portion 38 (pots 9).

Since the space portion 38 is set under a high vacuum state at this time, the air and/or moisture contained in the resin tablets R is forcibly sucked to flow into the space portion 38 (pots 9), and is efficiently and reliably discharged to the exterior by evacuation.

Then, the upper mold section 1 and the lower mold section 2 are completely closed, to thereafter carry out a resin molding step of sealing the electronic parts 27a which are provided on the lead frames 27 in resin molded members.

When the upper mold section 1 and the lower mold section 2 are completely closed, the resin tablets R received in the pots 9 are pressurized by the plungers 13a so that melted resin materials which are heated and melted

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in the pots 9 are injected/charged into required numbers of the cavities 10 and 20 which are arranged on side positions of the pots 9. Thus, the electronic parts 27a provided on the lead frames 27 which are engaged/set in the respective cavities 10 and 20 can be sealed in the resin molded members.

As hereinabove described, the evacuation step of forcibly sucking/discharging the air remaining in the space portion 38 etc. to the exterior is continuously carried out also when the upper mold section 1 and the lower mold section 2 are intermediately and completely closed.

The residual air and/or moisture can be relatively easily discharged from the space portion 38 to the exterior due to the required space S defined in the space portion 38 particularly between the die surfaces of the upper mold section 1 and the lower mold section 2 when the same are intermediately closed, while it is relatively difficult to discharge the residual air and/or moisture from the space portion 38 when the upper mold section 1 and the lower mold section 2 are completely closed since no space S is defined between the die surfaces at this time.

Also when the upper mold section 1 and the lower mold section 2 are completely closed, however, the vacuum

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source 40 or the instantaneous evacuation mechanism 45 communicates with the pots 9, the resin passages 25 and 26 and the cavities 10 and 20 through the air vents 43 and the vacuum path 39, whereby the function for discharging the residual air etc. from the space portion 38 to the exterior is not deteriorated. Thus, it is possible to discharge the residual air etc. from the space portion 38 whether the upper mold section 1 and the lower mold section 2 are intermediately or completely closed.

Then, the upper mold section 1 and the lower mold section 2 may be again opened after a required curing time, so that the resin molded members and hardened resin are released from the cavities 10 and 20 and the resin passages 25 and 26 respectively by the ejector plates 22 and 12 and the ejector pins 22a and 12a.

According to a graph of evacuation efficiency in the internal die space portion shown in Fig. 6, it is possible to attain a high vacuum state in several seconds (about 2 to 3 seconds) when only instantaneous evacuation is carried out (see the solid line 1). Further, it is understood that about six to seven seconds are required for attaining a high vacuum state only by ordinary evacuation (see the broken line 2). Therefore, it is possible to set a long evacuation time in the internal die space portion by carrying out instantaneous evacuation for

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bringing the internal die space portion into a high vacuum state in a short time. Thus, it is possible to efficiently and reliably discharge air remaining in the internal die space portion, air flowing out from the aforementioned resin tablets and gas generated upon heating and melting of the resin tablets to the exterior before the resin tablets are completely heated and melted in the pots.

The present invention is not restricted to the aforementioned embodiment, but modifications can be arbitrarily and properly selected and employed at need within the scope of the present invention.

For example, the lower mold section 2 may not be completely stopped in intermediate closing, but the closing speed (speed for upwardly moving the lower mold section 2) may be reduced between the intermediate closing state shown in Fig. 2 and the complete closing state shown in Fig. 3, to continuously carry out the intermediate closing and the complete closing.

The evacuation step and the instantaneous evacuation step for the outside air blocking space portion 38 may be arbitrarily and properly modified/selected on the basis of resin molding conditions and the like.

For example, the instantaneous evacuation step for the space portion 38 may be continuously carried out

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following the evacuation step therefor, and vice versa.

Further, the instantaneous evacuation step for the space portion 38 may be carried out simultaneously with the evacuation step.

Further, air holes communicating with the engaging space portions for the ejector plates 12 and 22 may be provided to communicate with the outside air blocking space portion 38 or with another vacuum path, to discharge residual air etc. from the engaging space portions to the exterior.

Further, air holes communicating with the outside air blocking space portion 38 may be provided in sliding portions of the pots 9 and the plungers 13a or such air holes may communicate with another vacuum path, to discharge the residual air etc. from the pots 9 to the exterior.

Further, a plurality of vacuum sources 40 such as vacuum pumps may be combined with a plurality of instantaneous evacuation mechanisms 45 such as vacuum tanks, while such members may be combined independently of each other.

While the chase blocks 7 and 8 are frequently detached in the aforementioned embodiment, the present invention is also applicable to an apparatus for molding resin to seal electronic parts having an ordinary die

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structure.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

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WHAT IS CLAIMED IS:

1. A method of molding resin to seal electronic parts, comprising:

a resin tablet supplying step of supplying resin tablets (R) into respective ones of a plurality of pots (9) being arranged in a die (1, 2) for resin molding consisting of an upper mold section (1) and a lower mold section (2);

a lead frame supplying step of supplying and setting electronic parts (27a) being mounted on lead frames (27) in prescribed positions of cavities (10, 20) being arranged in said die (1, 2);

a resin tablet heating step of heating said resin tablets (R) being supplied in respective said pots (9) of said die (1, 2);

a die closing step of closing said upper mold section (1) and said lower mold section (2) for engaging said electronic parts (27a) being provided on said lead frames (27) in prescribed positions of said cavities (10, 20);

an outside air blocking step of cutting off an internal die space portion (25, 26), being defined in said die closing step for said die (1, 2) by at least said pots (9), said cavities (10, 20) and resin passages (25, 26) making said pots (9) communicate with said cavities (10,



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20), from the exterior;

an evacuation step of forcibly sucking/discharging air and/or moisture remaining in said internal die space portion (25, 26), air and/or moisture flowing out from said resin tablets (R) being heated and expanded in said resin tablet heating step into said internal die space portion (25, 26), and gas being generated by said heating to the exterior of said internal die space portion (25, 26) in said outside air blocking step;

an instantaneous evacuation step of forcibly sucking/discharging said air and/or moisture remaining in said internal die space portion (25, 26), said air and/or moisture flowing out from said resin tablets (R) being heated and expanded in said resin tablet heating step into said internal die space portion (25, 26), and said gas being generated by said heating to the exterior of said internal die space portion (25, 26) in a short time in said outside air blocking step, thereby quickly increasing the degree of vacuum in said internal die space portion (25, 26); and

a resin molding step of pressurizing said resin tablets (R) being supplied in said pots (9) of said die (1, 2) for injecting melted resin materials being heated and melted in said pots (9) into said cavities (10, 20) being arranged on side positions of said pots (9) through

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said resin passages (25, 26), thereby sealing said electronic parts (27a), being provided on said lead frames (27) engaged in said cavities (10, 20), with resin.

2. A method of molding resin to seal electronic parts in accordance with claim 1, wherein
said instantaneous evacuation step is carried out after said evacuation step.

3. A method of molding resin to seal electronic parts in accordance with claim 1, wherein
said evacuation step is carried out after said instantaneous evacuation step.

4. A method of molding resin to seal electronic parts in accordance with claim 1, wherein
said instantaneous evacuation step is carried out simultaneously with said evacuation step.

5. A method of molding resin to seal electronic parts in accordance with claim 1, wherein
said instantaneous evacuation step is carried out after said resin tablets (R) being supplied in said pots (9) are heated and expanded in said resin tablet heating step so that the interior and the exterior of said resin

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tablets (R) are brought into ventilative states.

6. A method of molding resin to seal electronic parts in accordance with claim 1, wherein

said instantaneous evacuation step includes a step of releasing a vacuum tank (45), being previously brought into a prescribed vacuum state in interception of communication with said internal die space portion (25, 26), from said interception of communication with said internal die space portion (25, 26).

7. A method of molding resin to seal electronic parts in accordance with claim 1, wherein

said die closing step includes:

an intermediate closing step of defining a prescribed clearance between die surfaces of said upper mold section (1) and said lower mold section (2), and

a complete closing step of joining said die surfaces of said upper mold section (1) and said lower mold section (2) to each other,

both of said evacuation step and said instantaneous evacuation step being carried out in both of said intermediate closing step and said complete closing step.

8. An apparatus for molding resin to seal electronic

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parts, comprising:

a die (1, 2) for resin molding including an upper mold section (1) and a lower mold section (2) being arranged oppositely to each other and having a plurality of pots (9), a plurality of cavities (10, 20) and a plurality of resin passages (25, 26) for making said pots (9) and said cavities (10, 20) communicate with each other;

means for supplying resin tablets (R) into respective ones of said plurality of pots (9);

means for supplying and setting electronic parts (27a) being mounted on lead frames (27) in prescribed positions of said cavities (10, 20) of said die (1, 2);

means for closing said die (1, 2) while receiving said resin tablets (R) in said pots (9) and setting said electronic parts (27a) in said cavities (10, 20) and heating said resin tablets (R) for melting the same; and

means for injecting melted resin materials into said cavities (10, 20) through said resin passages (25, 26), thereby sealing said electronic parts (27a) with resin,

said apparatus for molding resin to seal electronic parts further comprising:

means for cutting off an internal die space portion (25, 26) being defined upon closing of said die (1, 2) by at least said pots (9), said resin passages (25, 26) and



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said cavities (10, 20);

evacuation means for forcibly sucking and discharging air, moisture and gas being contained in said internal die space portion (25, 26) to the exterior thereby improving the degree of vacuum in said internal die space portion (25, 26); and

instantaneous evacuation means for forcibly sucking and discharging said air, said moisture and said gas being contained in said internal die space portion (25, 26) to the exterior in a short time thereby quickly improving the degree of vacuum in said internal die space portion (25, 26).

9. An apparatus for molding resin to seal electronic parts in accordance with claim 8, wherein

said evacuation means includes a vacuum source (40),

said instantaneous evacuation means (45) includes a vacuum tank, and

three end portions of a vacuum path having three branch portions are connected with said vacuum source (40), said vacuum tank and said internal die space portion (25, 26) respectively to communicate with the same,

switching valves (47, 48) being provided between said branch portions and said vacuum tank as well as said internal die space portion (25, 26) respectively.

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10. An apparatus for molding resin to seal electronic parts in accordance with claim 8, further comprising means for controlling opening/closing of said switching valves (47, 48) in linkage.

11. An apparatus for molding resin to seal electronic parts in accordance with claim 8, wherein said means for sealing/molding said electronic parts with resin includes multistage injection means capable of changing the speed for injecting said melted resin materials into said cavities (10, 20).

12. An apparatus for molding resin to seal electronic parts in accordance with claim 8, wherein said means (30, 33) for cutting off said internal die space portion (25, 26) from the exterior includes a pair of outside air blocking members (30, 33) covering outer peripheries of said upper mold section (1) and said lower mold section (2) in positions provided with said internal die space portion (25, 26) and being engaged to be slidable along said outer peripheries to be engageable with each other upon closing of said upper mold section (1) and said lower mold section (2).

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13. An apparatus for molding resin to seal electronic parts in accordance with claim 8, further comprising a pair of chase blocks (7, 8), obtained by bringing principal parts for carrying out resin molding into blocks, being detachably engaged with said upper mold section (1) and said lower mold section (2) respectively.



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METHOD OF AND APPARATUS FOR MOLDING RESIN TO SEAL ELECTRONIC PARTS

ABSTRACT OF THE DISCLOSURE

In a method of molding resin to seal electronic parts, an internal die space portion (38) which is defined at least by pots (9), cull portions (25), resin passages (26) and cavities (10, 20) when an upper mold section (1) and a lower mold section (2) are closed is cut off from the exterior to carry out evacuation by a vacuum source (40) and instantaneous evacuation by an instantaneous evacuation mechanism (45). According to this method, it is possible to quickly improve the degree of vacuum in the internal die space portion (38) by efficiently and reliably discharging air, moisture and gas from the internal die space portion (38) to the exterior due to synergistic action of the evacuation and the instantaneous evacuation. Consequently, resin molded members are prevented from formation of voids.

Figure 3

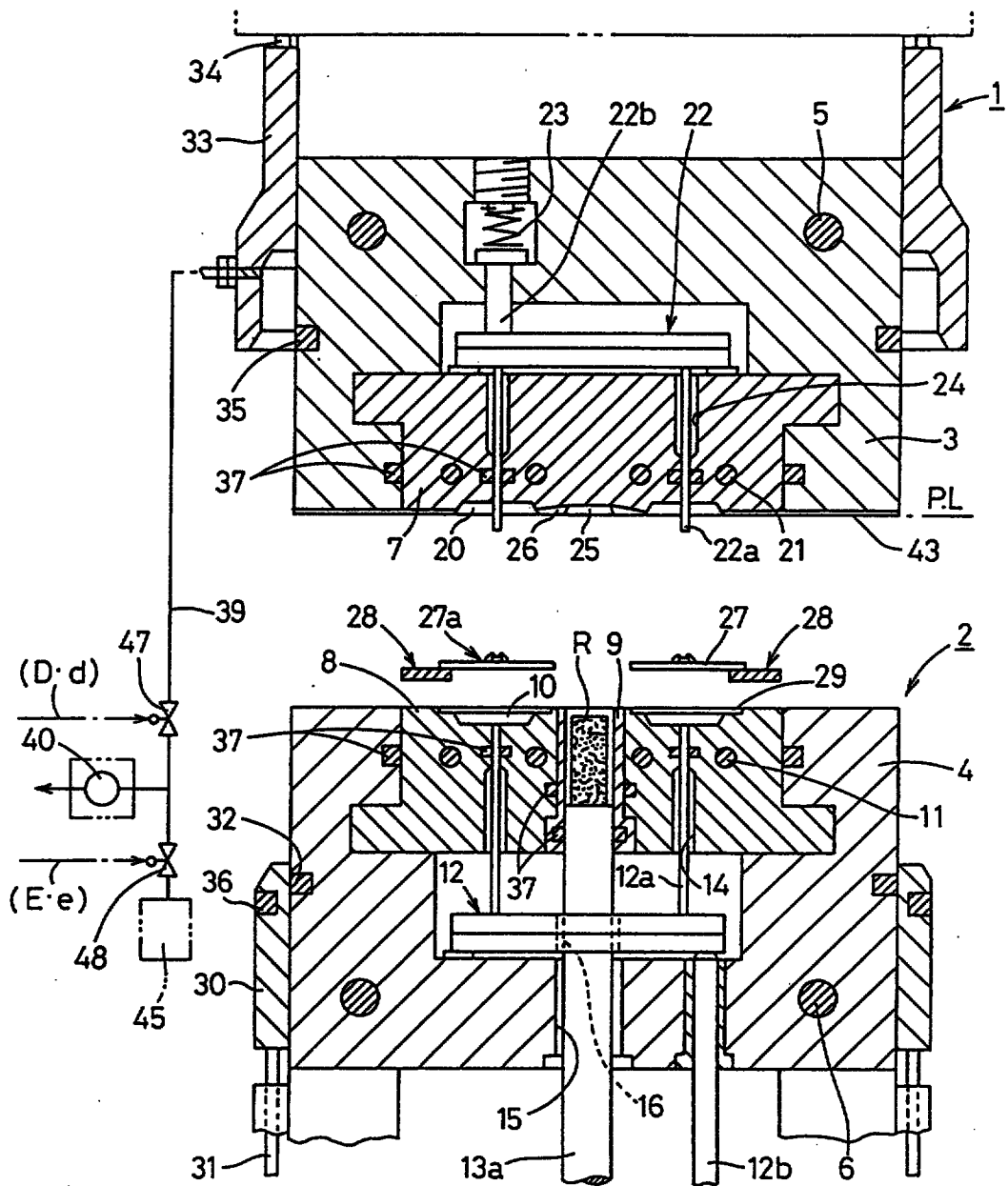
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FIG.1



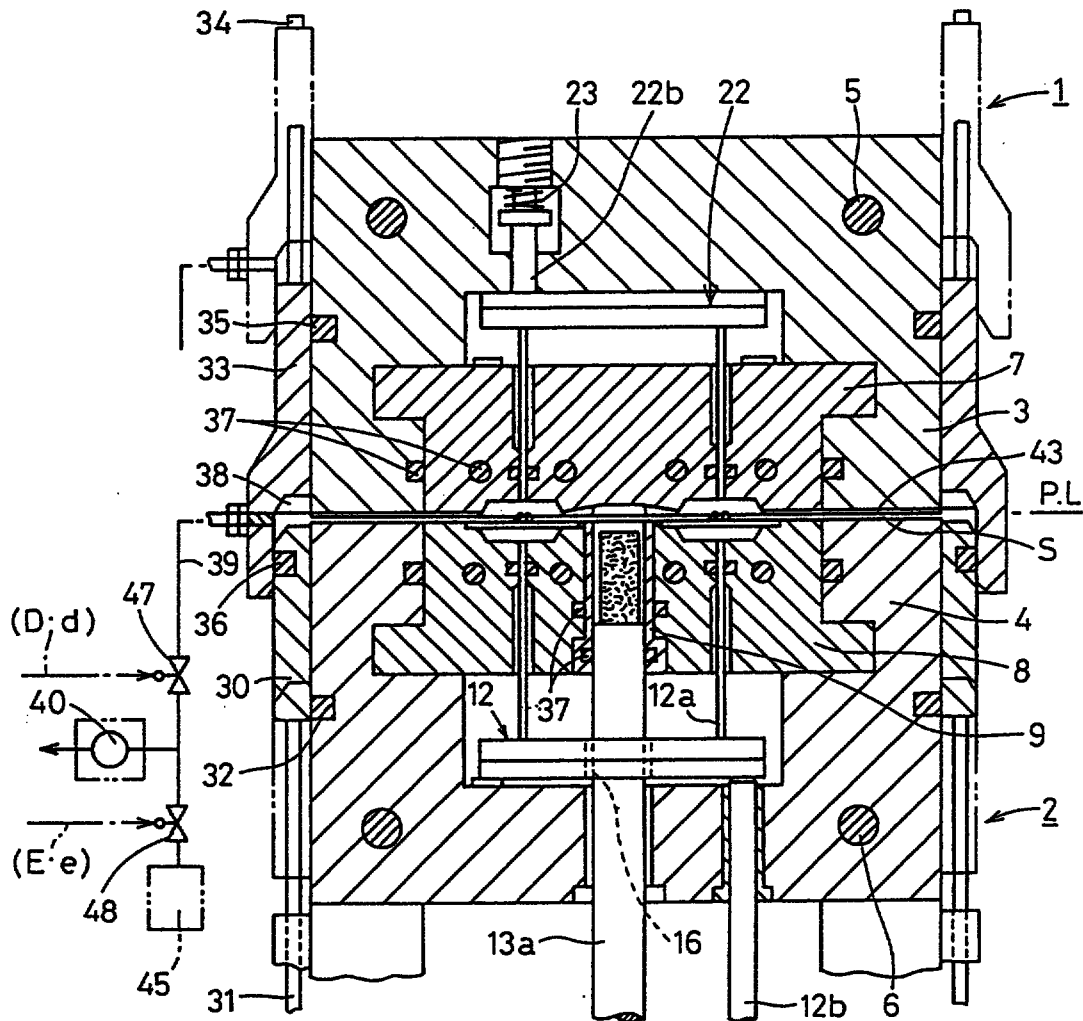
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FIG.2



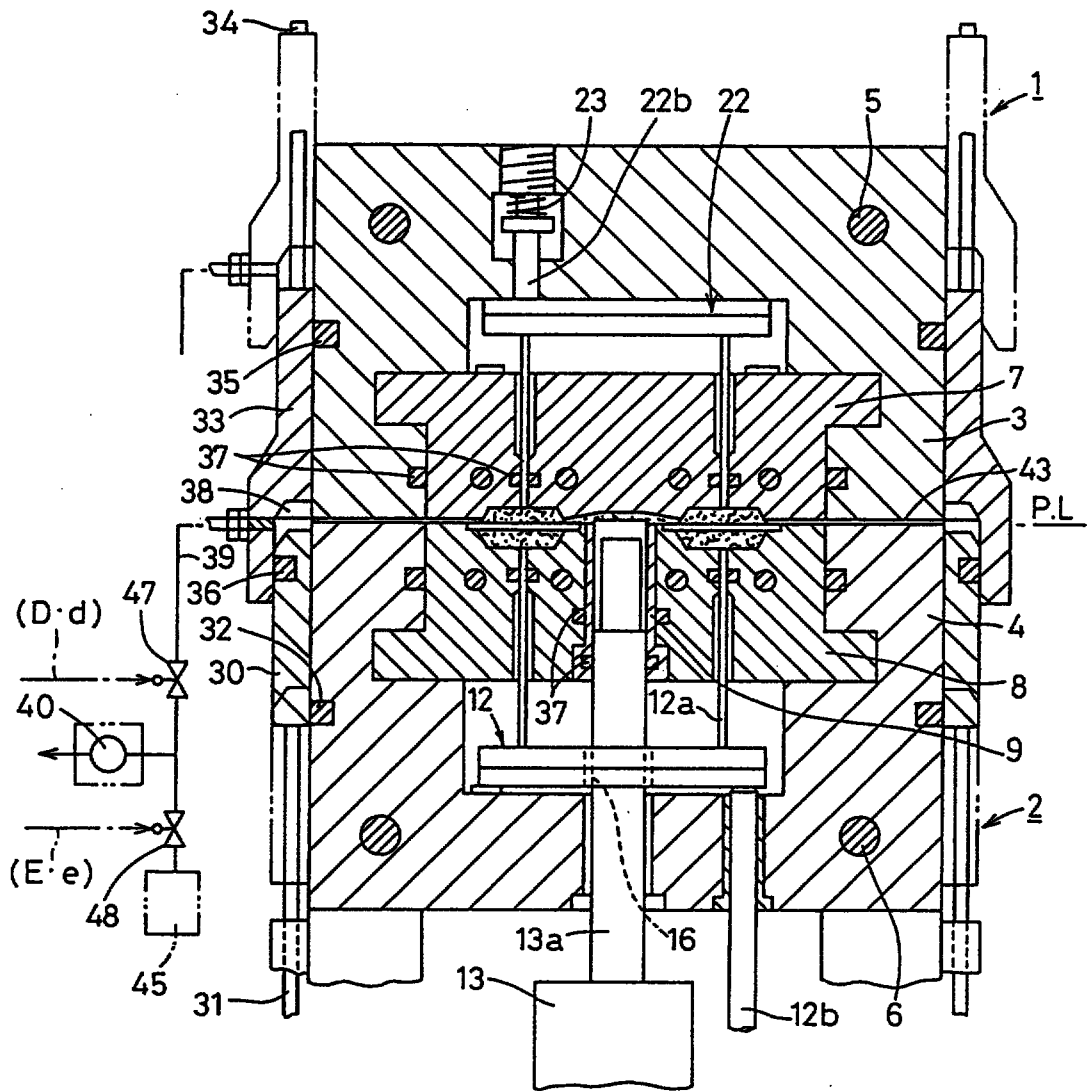
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FIG.3



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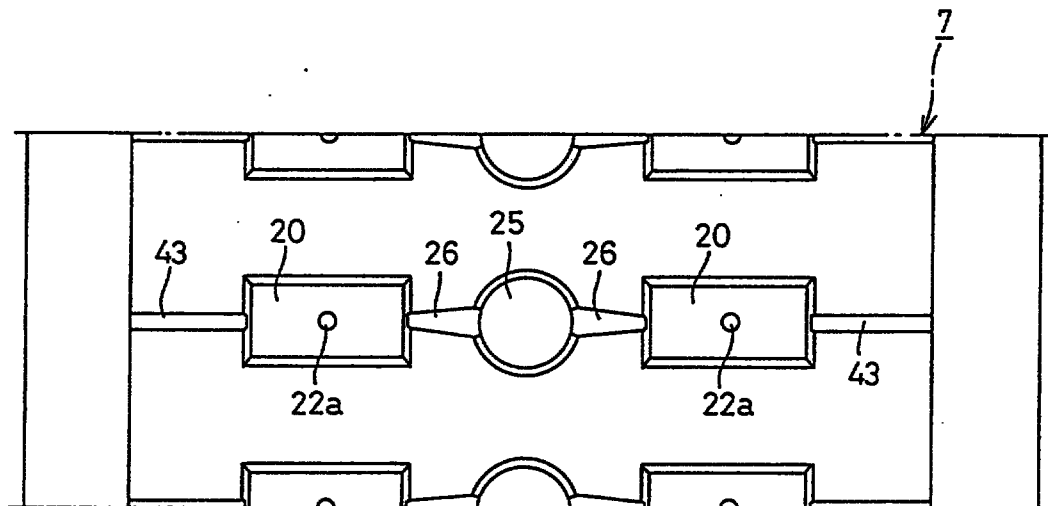


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FIG.4



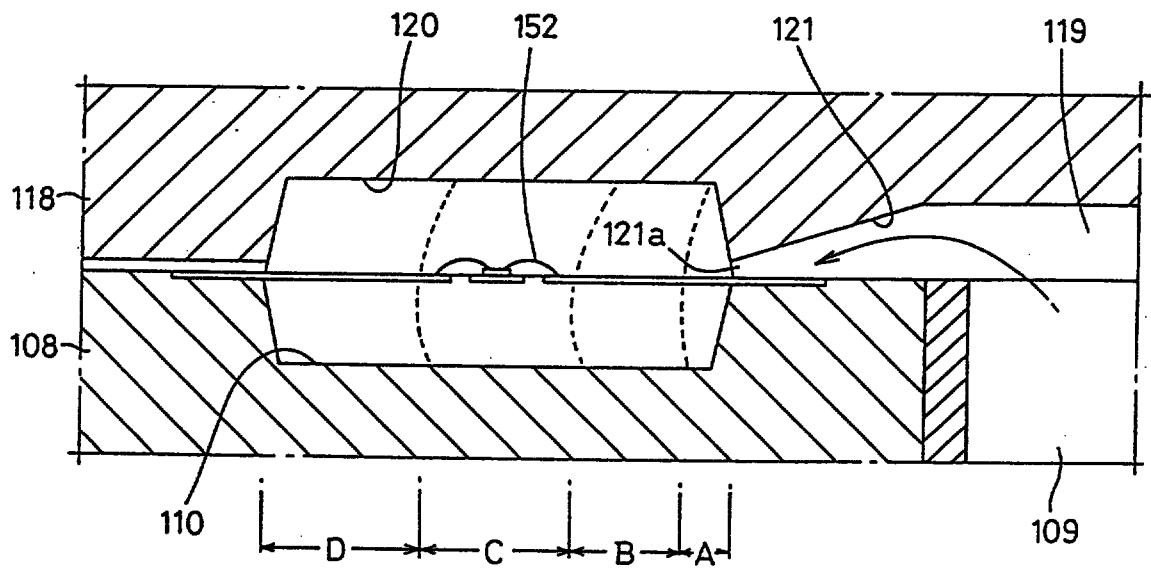
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FIG.5



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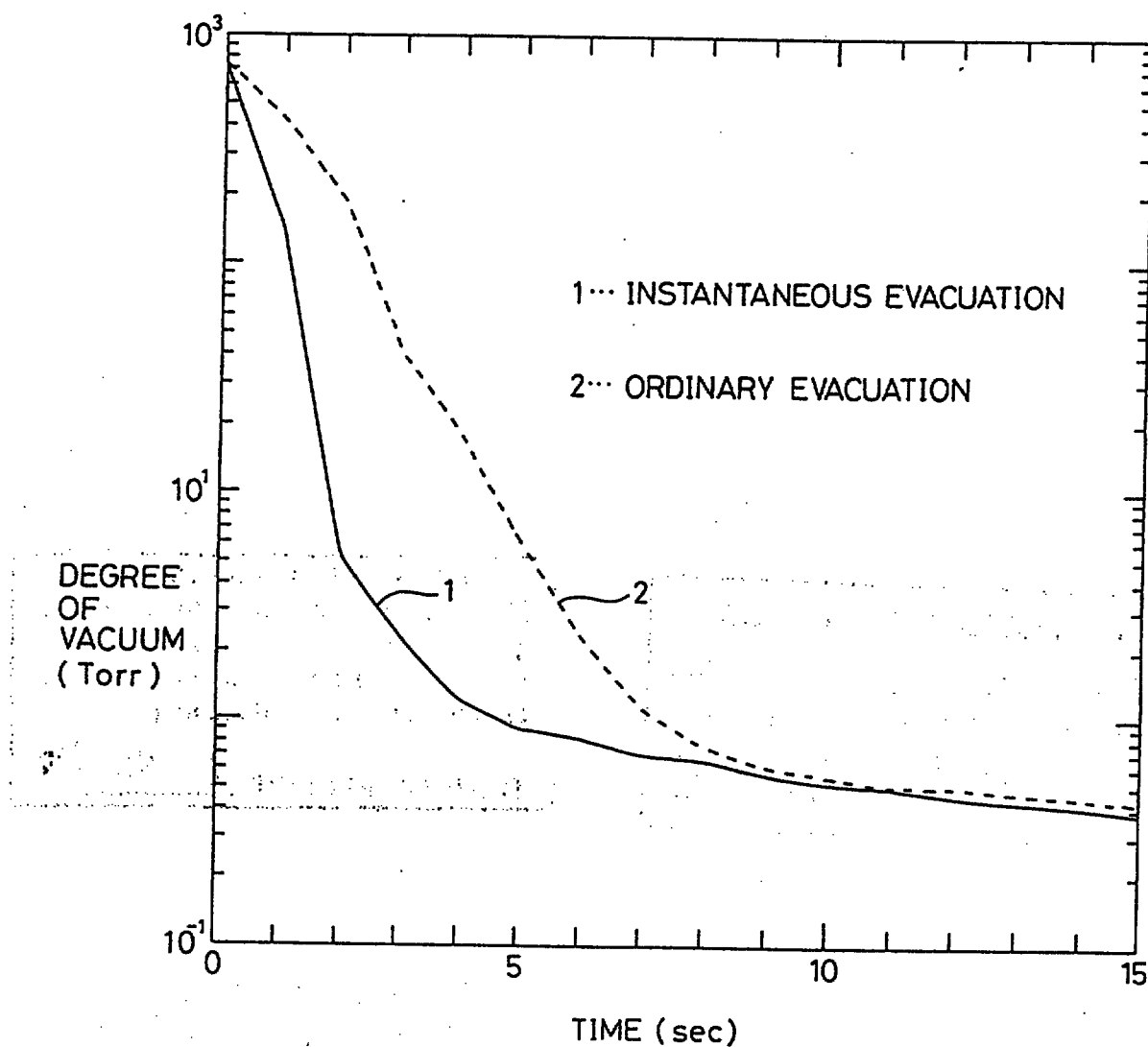


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FIG.6

EVACUATION EFFICIENCY



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REPLACEMENT SHEETS		SG
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TITLE OF THE INVENTION

Method of and Apparatus for Molding Resin to Seal
Electronic Parts

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to improvements in a method of and an apparatus for molding resin to seal electronic parts, such as ICs, LSIs, diodes or capacitors which are mounted on lead frames, for example, with thermosetting resin materials, and more particularly, it relates to improvements for preventing electronic parts molded and sealed with resin (mold packages) from formation of voids in the interior and the exterior thereof, as well as for preventing bonding wires from a wire sweep phenomenon caused by the resin and attaining improvement in adhesiveness (adhesion) between the lead frames and the resin.

Description of the Background Art

In general, an electronic part is molded and sealed with resin by a transfer mold method, which is generally carried out through a resin sealing/molding apparatus, for example, in the following manner:

A fixed upper mold section and a movable lower mold section provided in the resin sealing/molding apparatus are previously heated to a resin molding temperature by

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heating means, and opened (there is also known an apparatus having an inverse structure, which is provided with a movable upper mold section and a fixed lower mold section).

Then, a lead frame which is provided with an electronic part is set on a prescribed position of a die surface of the lower mold section, while a resin tablet is supplied in a pot of the lower mold section.

Then, the lower mold section is upwardly moved so that the upper mold section and the lower mold section are closed. Thus, the electronic part and the lead frame provided with the same are set between upper and lower cavities which are oppositely provided in the die surfaces of the lower mold section and the upper mold section, while the resin tablet stored in the pot is heated to be gradually melted.

Then, the resin tablet stored in the pot is pressurized by a plunger so that the resin material as melted is injected into/charged in the cavities, whereby the electronic part and the lead frame set in the cavities are sealed in a resin molded member which is molded in response to the shapes of the cavities.

After a lapse of a time which is required for hardening the melted resin material, the upper mold section and the lower mold section may be so opened as to

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release the resin molded member and the lead frame from the cavities while releasing the hardened resin from a resin passage portion through a mold releasing mechanism.

When the upper mold section and the lower mold section are closed, air containing moisture such as that in the atmosphere, for example, remains in a space portion which is defined by the pot, the resin passage portion and the cavities. Such residual air may enter the melted resin material to cause a problem in resin molding such as formation of voids in the interior and the exterior of the resin molded member.

In order to cope with this problem, the cavities are made to communicate with the exterior through proper air vents and the melted resin material which is stored in the pot is transferred through the resin passage portion and injected into/charged in the cavities, so that the aforementioned residual air and the like are naturally discharged to the exterior through the air vents.

While the air remaining in the pot, the resin passage portion and the cavities can be naturally discharged through the air vents as hereinabove described, it is impossible to effectively inhibit the resin molded member from formation of internal voids and defects on its outer surface in practice. Thus, it is impossible to reliably solve a problem of deterioration in moisture resistance

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and appearance of the product.

When internal voids are formed in the resin molded member, adhesion between the lead frame and the resin is deteriorated and moisture easily infiltrates into the product through a clearance defined between the resin and the lead frame to deteriorate moisture resistance of the product, for example. Further, the resin molded member is easily cracked or chipped by force which is applied to a base portion of an outer lead portion projecting from the resin molded member to bend the same. Thus, it is impossible to attain high quality and high reliability which are strongly required for this product.

The internal voids which are formed in the resin molded member mainly result from air and/or moisture contained in the resin tablet.

The resin tablet, which is formed by merely compacting resin powder into a prescribed shape, generally contains a large quantity of air containing moisture in the atmosphere. Further, the large quantity of air contained in the resin tablet is present in the form of a number of independent bubbles, being isolated from each other, which cannot communicate with each other and with the surface of the resin tablet for ventilation.

When the resin tablet is heated to a resin molding temperature of at least 175°C, for example, the air and/or

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moisture contained in the resin tablet forms water vapor, which enters the melted resin material with the air remaining in the aforementioned internal die space portion. Thus, the resin material is injected into/charged in the cavities in this state, and hence voids are formed in the interior and the exterior of the resin molded member due to the air and/or moisture contained in the resin tablet.

Further, gas such as combustion gas which is generated upon heating of the resin tablet also serves as a cause for forming voids in the interior and the exterior of the resin molded member.

In order to prevent formation of the voids in the interior and the exterior of the resin molded member, the following countermeasure may be employed:

For example, the air remaining in the aforementioned internal die space portion between the upper mold section and the lower mold section may be discharged to the exterior through a vacuum pump, thereby preventing the residual air from entering the melted resin material.

When ordinary air discharge means such as the vacuum pump is employed, however, the overall resin sealing/molding time is disadvantageously lengthened since a long time is generally required for increasing the degree of vacuum in the internal die space portion to a

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prescribed level.

In general, an electronic part is molded and sealed with thermosetting resin such as epoxy resin, for example, and hence the resin tablet which is supplied in the aforementioned internal die space portion (pot) is hardened with time after the same is heated and melted.

When the internal die space portion is evacuated through ordinary air discharge means for a long time, therefore, hardening of the melted resin material is facilitated to deteriorate its flowability. Thus, the evacuating operation is preferably carried out in a short time in consideration of this point.

As hereinabove described, gas such as combustion gas which is generated upon heating of the resin tablet also serves as a cause for forming voids and defects in the interior and the exterior of the resin molded member. Such gas is generated by a coupling agent, a mold release agent, a flexible agent etc. contained in the resin tablet, which are heated and vaporized when the resin tablet is heated to a resin molding temperature of 175°C, for example, and melted.

In another conventional countermeasure for preventing the resin molded member from formation of voids, the melted resin material which is injected into the cavities is pressurized to be increased in resin pressure for

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compressing voids contained therein, thereby compressing voids which are formed in the interior of the resin molded member to a negligible degree.

However, the conventional method of compressing the voids under a high pressure has the following problems:

(1) This method is disadvantageous in consideration of durability of the apparatus, dangerousness in operation, the cost and the like, due to requirement for a large-sized press machine which can carry out high-pressure compression molding.

(2) Viscous resin which starts to be hardened in the cavities in a final stage of the compression step is made to flow in such high-pressure compression molding. Thus, a bonding wire for electrically coupling an electrode of a semiconductor element and the outer lead portion is inclined toward the direction of resin flowing in the so-called wire sweep phenomenon. This may lead to a serious problem such as contact between the bonding wire and an adjacent one, disengagement of a bonding pad wire from the electrode, or wire breaking.

In the aforementioned conventional countermeasure for preventing formation of voids, further, it is impossible to make effective use of multistage injection for preventing the problem of the wire sweeping phenomenon of the bonding wire, electrode disengagement, wire breaking

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or the like. This problem is now described with reference to Fig. 5.

In a conventional method of injecting a melted resin material into cavities with no employment of multistage injection, a plunger which is engaged with a pot 109 is first upwardly moved to pressurize and inject a melted resin material into cavities 110 and 120 which are oppositely formed in a lower mold section 108 and an upper mold section 118 through a cull portion 119 and a gate 121, as shown in Fig. 5. The speed for injecting the resin in the cavities 110 and 120 can be adjusted by controlling the speed for upwardly moving the plunger.

If the resin injection speed is at a high level, the resin is injected into the cavities 110 and 120 to spout from a port 121a. Thus, the injected resin entrains air which is present around the port 121a, to form voids and defects in the vicinity of the port 121a. Further, a spiral flow of the resin is caused in the cavities 110 and 120 and entrains air remaining therein to form voids and defects, while causing a wire sweep phenomenon of a bonding wire 152, electrode disengagement, wire breaking or the like. When multistage injection, i.e., a molding method of adjusting the speed or pressure for injecting the melted resin material into the cavities 110 and 120 under constant conditions, is employed, on the other hand,

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the following action is obtained:

The speed for injecting the resin through the port 121a is relatively reduced in a range (A in Fig. 5) where the resin is completely charged around the port 121a and the time therefor, and a range (C in Fig. 5) where the resin is charged around the wire 152 and the time therefor. In the remaining ranges (B and D in Fig. 5), the resin is injected at an ordinary injection speed, which is higher than that in the ranges A and C.

In this case, it is possible to suppress spouting of the resin which is injected from the port 121a into the cavities 110 and 120 by reducing the injection speed therefor in the range A shown in Fig. 5, thereby preventing the injected resin from entrainment of air and occurrence of a spiral flow in the vicinity of the port 121a.

In the range B shown in Fig. 5, on the other hand, it is possible to inject the resin at an ordinary injection speed since no bonding wire 152 is provided in this range B. While the resin is injected at the ordinary injection speed also in the range A at this time, neither entrainment of air nor occurrence of a spiral flow is caused in the injected resin in the vicinity of the port 121a since the range A is already charged with the resin.

Then, the injection speed for the resin is reduced

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since the range C shown in Fig. 5 is provided with the bonding wire 152, for inhibiting a forward end portion, shown by broken lines in Fig. 5, of the injected resin which is charged in the cavities 110 and 120 from coming into contact with the bonding wire 152 and forcibly bending the same, thereby preventing a wire sweep phenomenon of the bonding wire 152, electrode disengagement and wire breaking caused by such bending action.

Then, the resin can be injected at an ordinary injection speed in the range D shown in Fig. 5, which is provided with no bonding wire 152. While the resin is injected at the ordinary injection speed also in the ranges A to C at this time, neither entrainment of air nor occurrence of a spiral flow is caused in the injected resin in the vicinity of the port 121a since the ranges A to C are already charged with the resin.

Due to employment of such multistage injection, it is possible to solve the aforementioned problems of formation of voids and defects, a wire sweeping phenomenon of the bonding wire 152 and the like which are caused by the resin spouting from the port 121a into the cavities 110 and 120.

The aforementioned countermeasure for preventing occurrence of voids by high-pressure compression molding

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and the multistage injection are in the following relations:

The aforementioned high-pressure compression molding is effective means in consideration of a countermeasure for preventing occurrence of voids, while the same has problems of a wire sweep phenomenon of a bonding wire, electrode disengagement and wire breaking.

While the multistage injection can prevent a wire sweep phenomenon of a bonding wire, electrode disengagement and wire breaking, this method is not effective in consideration of a countermeasure for preventing occurrence of voids.

It may be possible to carry out the high-pressure compression molding after carrying out the multistage injection. However, the aforementioned problems following the high-pressure compression molding cannot be solved by such means.

Consequently, it is impossible to make effective use of the multistage injection when the conventional countermeasure for preventing occurrence of voids is employed.

SUMMARY OF THE INVENTION

An object of the present invention is to enable molding of products having high quality and reliability by efficiently and reliably discharging air and/or moisture

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remaining in an internal die space portion, air and/or moisture contained in resin tablets and gas generated upon heating of the resin tablets to the exterior of the internal die space portion in a short time thereby preventing occurrence of voids and defects in resin molded members resulting from infiltration of the gas in melted resin materials while improving adhesiveness between lead frames and the resin.

Another object of the present invention is to provide a method of preventing occurrence of voids and defects which can make effective use of multistage injection, and a method of thereby preventing bonding wires from a wire sweep phenomenon caused by resin.

The Invention

According to the invention, there is provided a method of molding resin to seal electronic parts,

a resin tablet supplying step in which resin tablets are supplied into respective pots arranged in a resin molding die consisting of an upper mold section and a lower mold section;

a lead frame supplying step in which electronic parts mounted on lead frames are set into prescribed positions in cavities provided in said die;

a resin tablet heating step of heating said resin tablets;

a die closing step of closing said upper and lower mold sections to enclose said electronic parts on said lead frames in said cavities;

an outside air blocking step in which an internal die space portion defined in the closed die by at least said pots, said cavities and resin passages communicating said pots with said cavities, is cut off from the exterior;

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a first relatively longer evacuation step of forcibly sucking/discharging air, gas and/or moisture in said internal die space portion;

a second, relatively shorter evacuation step of forcibly sucking/discharging said air, gas and/or moisture in said internal die space portion;

a resin molding step in which said resin tablets are heated and melted in said pots to flow into said cavities arranged to the sides of said pots through said resin passages, thereby sealing said electronic parts with resin; wherein said die closing step comprises:-

an intermediate closing step of defining a prescribed clearance between die surfaces of said upper and lower mold sections, and

a complete closing step of joining said die surfaces of said upper and lower mold sections to each other; and wherein

both of said first evacuation step and said second evacuation step are carried out in both said intermediate closing step and said complete closing step.

According to this method, it is possible to improve the degree of vacuum in the internal die space portion in a short time, by discharging the air, moisture and gas from the internal die space portion through evacuation and instantaneous evacuation while cutting off the internal die space portion which is defined upon closing of the die from the exterior.

Further it is possible to improve the degree of vacuum in the internal die space portion by a synergistic effect of evacuation and instantaneous evacuation. Therefore, it is possible to prevent the air, moisture and gas which are contained in the internal die space portion from infiltrating into or being entrained in the

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melted resin materials. Consequently¹⁴, it is possible to reliably prevent formation of voids and defects, resulting from presence of the air, moisture and gas, in the interior and exterior of resin molded members.

the lead frames and the resin molded members so strongly adhere to each other that no voids and clearances are defined between the lead frames and the resin, and the products are improved in moisture resistance to attain high quality and high reliability.

Further, the air and/or moisture remaining in the internal die space portion, the air and/or moisture contained in the resin tablets and the gas generated upon heating of the resin tablets, which are main causes forming voids in the interior and the exterior of the resin molded members, can be efficiently and reliably discharged to the exterior of the internal die space portion in a short time, whereby it is not necessary to carry out the conventional high-pressure compression molding, which is employed as a countermeasure for preventing occurrence of voids. Therefore, it is possible to make effective use of the aforementioned multistage injection as a countermeasure for protecting bonding wires in resin molding.

In the inventive method of molding resin to seal electronic parts, evacuation and instantaneous evacuation steps can be continuously carried out in this order or vice versa, while it is also possible to simultaneously carry out these steps.

In a preferred method of molding resin to seal electronic parts, the resin tablets are thermally expanded through a step of heating the resin tablets so that the interior and the exterior of the resin tablets are communicative and ventilative, so that the instantaneous evacuation step is thereafter carried out.

According to another aspect of the invention, there is provided apparatus for molding resin to seal electronic parts, comprising:

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a die for resin molding including an upper mold section and a lower mold section arranged oppositely to each other and containing a plurality of pots, a plurality of cavities and a plurality of resin passages for communicating said pots and said cavities;

means for supplying resin tablets into respective pots;

means for supplying and setting electronic parts mounted on lead frames in prescribed positions in said cavities of said die;

means for closing said die with said resin tablets in said pots and said electronic parts in said cavities, and for heating said resin tablets for melting the same; and

means for injecting melted resin material into said cavities through said resin passages, thereby sealing said electronic parts with resin, said apparatus further comprising:

means for cutting off an internal die space portion defined upon closing of said die by at least said pots, said resin passages and said cavities;

first evacuation means for forcibly sucking and discharging air, moisture and gas contained in said internal die space portion to the exterior, thereby improving the degree of vacuum in said internal die space portion in a relatively longer time;

second evacuation means for forcibly sucking and discharging said air, said moisture and said gas contained in said internal die space portion to the exterior in a relatively shorter time, thereby again improving the degree of vacuum in said internal die space portion: and

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means ~~whereby~~ said die closing means operates with intermediate and complete closing stages. and said first and second evacuation means are operative at both said die closing stages.

The means for sealing/molding the electronic parts with resin preferably includes multistage injection means capable of changing the speed for injecting said melted resin material into said cavities.

In a preferred embodiment of the inventive apparatus for molding resin to seal electronic parts, the evacuation means includes a vacuum source and the instantaneous evacuation means includes a vacuum tank, while three end portions of a vacuum path having three branch portions are connected to the vacuum source, the vacuum tank and the

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internal die space portion to communicate with the same, while switching valves are provided between the branch portions and the vacuum tank as well as the internal space portion.

Due to the aforementioned structure, it is possible to bring the vacuum tank into a prescribed vacuum state by driving the vacuum source while closing the switching valve provided between the branch portion and the internal die space portion and opening that provided between the branch portion and the vacuum tank, and to instantaneously suck air etc. contained in the internal die space portion into the vacuum tank by opening both switching valves when it is necessary to carry out instantaneous evacuation. Therefore, it is possible to carry out evacuation and instantaneous evacuation through a single vacuum source. Consequently, it is possible to implement the inventive method of molding resin to seal electronic parts by an apparatus having a relatively simple structure.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partially fragmented sectional view

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showing a principal part of a die, provided in an apparatus for molding resin to seal electronic parts, which is in an opened state;

Fig. 2 is a partially fragmented sectional view of the die, shown in Fig. 1, which is in an intermediately closed state;

Fig. 3 is a partially fragmented sectional view of the die, shown in Fig. 1, which is in a completely closed state for molding resin to seal electronic parts;

Fig. 4 is a partially fragmented bottom plan view showing a principal part of a die surface of an upper mold section which is provided in the die shown in Fig. 1;

Fig. 5 is a partially fragmented sectional view showing a portion of a die around cavities, for illustrating a state of injecting a melted resin material into the cavities from a pot through a resin passage; and

Fig. 6 is a graph showing exemplary evacuation efficiency levels in ordinary evacuation and instantaneous evacuation carried out in an internal die space portion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention is now described in detail with reference to Figs. 1 to 4.

Fig. 1 is a partially fragmented sectional view showing a principal part of a die, provided in an apparatus for molding resin to seal electronic parts

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according to the present invention, which is in an opened state.

Fig. 2 is a partially fragmented sectional view corresponding to Fig. 1, showing the principal part of the die which is in an intermediately closed state in advance of complete closing.

Fig. 3 is a partially fragmented sectional view corresponding to Fig. 1, showing the principal part of the die which is in a completely closed state.

Fig. 4 shows a die surface of an upper mold section provided in the die shown in Fig. 1.

This resin sealing/molding apparatus is oppositely provided with an upper mold section 1 (fixed type) which is mounted on an upper fixed plate and a lower mold section 2 (movable type) which is mounted on a lower movable plate.

Further, die bases 3 and 4 of the upper mold section 1 and the lower mold section 2 are provided with heating means 5 and 6 such as heaters respectively.

A fixed chase block 7 is detachably mounted on the fixed die base 3 by proper engaging means such as a dovetail groove and a dovetail portion.

On the other hand, a movable chase block 8 is detachably mounted on the movable die base 4 by engaging means which are similar to those provided on the fixed

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side.

The chase blocks 7 and 8 which are engaged in the die bases 3 and 4 are set in prescribed positions by proper fixing blocks (not shown) for fixing the same on horizontal end portions thereof.

Proper seal members (not shown) are preferably inserted between the chase blocks 7 and 8 and the fixing blocks.

The movable chase block 8 is provided with a plurality of pots 9, while a required number of resin molding cavities 10 are arranged on side positions of the respective pots 9.

The movable chase block 8 is also provided with dedicated heating means 11 such as heaters.

The movable chase block 8 is further provided on its lower position with a lower ejector plate 12 comprising ejector pins 12a for ejecting and releasing resin molded members which are molded in the cavities 10, and a plunger holder 13 (see Fig. 3) comprising plungers 13a (resin pressurizing means) for pressurizing resin tablets R which are supplied in the pots 9 respectively.

Upper end portions of the ejector pins 13a are engaged in pin holes 14 communicating with the cavities 10.

Further, upper portions of the plungers 13a are

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engaged in the respective pots 9 through insertion holes 15 and 16 which are provided in the movable die base 4 and the ejector plate 12.

Proper seal members (not shown) are preferably inserted between an engaging space for the lower ejector plate 12 which is provided in the movable die base 4 and the exterior of this space as well as between the plungers 13a and the engaging space.

On the other hand, the fixed chase block 7 is provided with cavities 20 in correspondence to the positions and the number of the cavities 10 provided in the movable chase block 8.

The fixed chase block 7 is further provided with cull portions 25, oppositely to the pots 9 of the movable chase block 8.

The cull portions 25 and the cavities 20 communicate with each other through resin passages 26, whereby the pots 9 and the cavities 10 and 20 communicate with each other through the short resin passages 26 including the cul portions 25 when the upper mold section 1 and the lower mold section 2 are closed. Further, the plungers 13a which are engaged in the pots 9 are vertically driven by a proper driving mechanism (not shown) such as a hydraulic or pneumatic motor or an electric motor.

When the plungers 13a pressurize the resin tablets R

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which are received in the pots 9, resin materials heated and melted in the pots 9 are injected into the cavities 10 and 20 through the resin passages 26 including the cull portions 25.

The upper cavities 20 are provided with air vents 43 (see Fig. 4) for making the cavities 10 and 20 communicate with the exterior upon closing thereof.

The fixed chase block 7 is further provided with dedicated heating means 21 such as heaters.

The fixed chase block 7 is further provided on its upper position with a support pin 22b for an upper ejector plate 22 comprising ejector pins 22a for ejecting and releasing resin molded members which are molded in the cavities 20, and an elastic member 23 such as a spring for downwardly pressing the upper ejector plate 22 through the support pin 22b.

Lower end portions of the ejector pins 22a are engaged with pin holes 24 communicating with the cavities 20 and pin holes 24a communicating with the cull portions 25 respectively.

The upper ejector plate 22 is downwardly pressed by elasticity of the elastic member 23 when the upper mold section 1 and the lower mold section 2 are opened as shown in Fig. 1, so that hardened resin members in the resin passages 26 which are provided between the cull portions

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25 and the cavities 20 and the resin molded members hardened in the cavities 20 can be downwardly ejected and released.

When the upper mold section 1 and the lower mold section 2 are opened, further, the lower ejector plate 12 is upwardly pressed by an ejector bar 12b, so that the ejector pins 12a upwardly eject and release the resin molded members from the cavities 10.

When the upper mold section 1 and the lower mold section 2 are completely closed as shown in Fig. 3, the ejector plates 22 and 12 are upwardly and downwardly retracted respectively through upper and lower return pins (not shown) which are oppositely provided on the ejector plates 22 and 12.

An outside air blocking member 30 which is in the form of a circular or rectangular cylinder is engaged with the movable die base 4 for covering at least outer peripheries of the pots 9 and the cavities 10 in a die surface of the lower mold section 2. This outside air blocking member 30 is slidable along the direction for opening/closing the upper mold section 1 and the lower mold section 2 through a required driving mechanism 31.

Further, a proper seal member 32 is interposed between the engaging surfaces of the movable die base 4 and the outside air blocking member 30.

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Another outside air blocking member 33 which is in the form of a circular or rectangular cylinder is engaged with the fixed base 3 for covering outer peripheries of the resin passages 25 and 26 and the cavities 20 in a die surface of the upper mold section 1. This outside air blocking member 33 is slidable along the direction for opening/closing the upper mold section 1 and the lower mold section 2 through a proper driving mechanism 34.

Further, a proper seal member 35 is interposed between the engaging surfaces of the fixed die base 3 and the outside air blocking member 33.

When the outside air blocking members 30 and 33 are moved to close the upper mold section 1 and the lower mold section 2 through the driving mechanisms 31 and 34 respectively, forward ends of these outside air blocking members 30 and 33 are engaged with each other (see Figs. 2 and 3).

Referring to Fig. 3, an upper end of the outside air blocking member 30 which is engaged with the movable die base 4 is upwardly moved to a portion close to the die surface of the lower mold section 2, while the outside air blocking member 33 which is engaged with the fixed die base 3 is engaged an outer peripheral surface of the outside air blocking member 30 engaged with the movable die base 4.

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While the engaging surfaces of the outside air blocking members 30 and 33 are vertically perpendicular in the figures, other proper engaging surfaces may be employed in place of such a structure.

Further, a proper seal member 36 is interposed between the engaging surfaces of the outside air blocking members 30 and 33.

In addition, proper seal members 37 are also interposed between the die bases 3 and 4 and the chase blocks 7 and 8, between the chase blocks 7 and 8 and the ejector pins 22a and 12a, and between the movable chase block 8 and the pots 9 and the plungers 13a.

When the upper mold section 1 and the lower mold section 2 are closed, therefore, the forward ends of the outside air blocking members 30 and 33 are so engaged as to define an outside air blocking space portion 38 (see Figs. 2 and 3), which is cut off from the outside air by the outside air blocking members 30 and 33 and the seal members 32, 35, 36 and 37.

The seal members 32, 35, 36 and 37 may simply define the space portion 38 which requires a proper vacuum state between the upper mold section 1 and the lower mold section 2.

The outside air blocking members 30 and 33 can be retracted through the driving mechanisms 31 and 34 to

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positions not inhibiting operations for detaching the chase blocks 7 and 8 from the die bases 3 and 4 and exchanging the same.

Thus, it is possible to open and close the upper mold section 1 and the lower mold section 2 while locating the outside air blocking members 30 and 33 in the positions shown in Figs. 2 and 3, for example, whereby the outside air blocking members 30 and 33 may not be retracted every molding cycle time in ordinary resin molding.

The driving mechanisms 31 and 34 for the outside air blocking members 30 and 33 may be prepared from mechanical driving mechanisms such as proper rack and pinion mechanisms, electric driving mechanisms such as electric motors, or hydraulic or pneumatic fluid driving mechanisms, while the aforementioned electric driving mechanisms or pneumatic driving mechanisms are preferable in consideration of the operation for molding resin to seal electronic parts.

Concave portions 29 for setting lead frames 27 provided with electronic parts 27a are provided in the die surface of the movable chase block 8.

Referring to Fig. 1, numeral 28 denotes lead frame supply/discharge mechanisms for supplying/setting the lead frames 27 in the concave portions 29.

The space portion 38 which is defined upon engagement

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of the outside air blocking members 30 and 33 is connected with an end of a vacuum path 39 such as a vacuum pipe to communicate with the same, while the other end of the vacuum path 39 is connected with a vacuum source 40 consisting of a vacuum pump or the like, and an instantaneous evacuation mechanism 45 consisting of a vacuum tank or the like, to communicate with the same.

Namely, the space portion 38 is connected with the vacuum source 40 through a switching valve 47 such as an electromagnetic valve which is provided in the vacuum path 39, to communicate with the same.

Further, the space portion 38 is connected with the instantaneous evacuation mechanism 45 through the switching valve 47 provided in the vacuum path 39 and another switching valve 48 such as an electromagnetic valve, to communicate with the same.

The vacuum source 40 is connected between the switching valves 47 and 48 in a communicative manner. Therefore, when the vacuum source 40 is driven while opening the switching valve 47 by an opening signal D and closing the other switching valve 48 by a closing signal e, for example, it is possible to evacuate the space portion 38 through the switching valve 47 and the vacuum path 39.

When the vacuum source 40 is driven while closing the

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switching valve 47 by a closing signal d and opening the other switching signal 48 by an opening signal E, on the other hand, it is possible to bring the instantaneous evacuation mechanism (vacuum tank) 45 into a prescribed vacuum state by evacuation through the switching valve 48 and the vacuum path 39.

Description is now made on evacuation of the space portion 38 which is defined when the upper mold section 1 and the lower mold section 2 are closed as shown in Fig. 2 or 3 and an internal die space portion defined by at least the pots 9, the resin passages 25 and 26 and the cavities 10 and 20 is cut off from the exterior, and instantaneous evacuation for quickly improving the degree of vacuum in the space portion 38.

First, the vacuum source 40 is driven while closing the switching valve 47 by the closing signal d and opening the switching valve 48 by the opening signal E, thereby bringing the instantaneous evacuation mechanism 45 into a prescribed vacuum state. At this time, the degree of vacuum in the instantaneous evacuation mechanism (vacuum tank) 45 can be arbitrarily set at a proper level.

Then, the switching valve 47 is opened by the opening signal D so that the space portion 38 communicates with the instantaneous evacuation mechanism 45 through the switching valves 47 and 48 and the vacuum path 39, whereby

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air remaining in the space portion 38 is instantaneously and forcibly sucked/discharged to the exterior in a short time by the instantaneous evacuation mechanism 45 which is maintained in the prescribed degree of vacuum. Thus, it is possible to carry out instantaneous evacuation for quickly increasing the degree of vacuum in the space portion 38. At this time, a high degree of vacuum can be attained in the space portion 38 in several seconds.

The space portion 38 communicates with the vacuum source 40 through the switching valve 47 and the vacuum path 39. Therefore, it is possible to carry out evacuation for forcibly sucking/discharging the air remaining in the space portion 38 to the exterior in continuation to the aforementioned instantaneous evacuation, driving the vacuum source 40 while closing the switching valve 48 by the closing signal e.

Due to the evacuation through the vacuum source 40, it is possible to maintain or further increase the degree of vacuum in the space portion 38 which is attained by the instantaneous evacuation. Thus, it is possible to instantaneously set the space portion 38 in a high vacuum state in a short time, by carrying out the instantaneous evacuation through the instantaneous evacuation mechanism 45 and the evacuation through the vacuum source 40.

The evacuation is carried out while closing the

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switching valve 48, so that only the vacuum source 40 and the space portion 38 communicate with each other for efficiently carrying out the evacuation without reducing the function of the vacuum source 40.

In the instantaneous evacuation and the evacuation of the space portion 38, it is possible to forcibly suck/discharge air and/or moisture remaining in the space portion 38, air and/moisture flowing out from the resin tablets R heated and expanded in the pots 9 into the space portion 38, and gas generated by heating to the exterior of the space portion 38.

Description is now made on operation for molding resin to seal the electronic parts 27a which are mounted on the lead frames 27 with resin through the apparatus having the aforementioned structure.

First, the vacuum source 40 is driven while previously closing the switching valve 47 by the closing signal d and opening the switching valve 48 by the opening signal E, thereby bringing the instantaneous evacuation mechanism (vacuum tank) 45 into a prescribed vacuum state through the switching valve 48 and the vacuum path 39.

Then, the lower mold section 2 is downwardly moved to open the upper mold section 1 and the lower mold section 2, as shown in Fig. 1. Then, the resin tablets R are supplied into the pots 9 which are provided in the lower

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mold section 2, while the lead frames 27 are supplied/set in the concave portions 29 which are provided in the die surface of the movable chase block 8 through the lead frame supply/discharge mechanisms 28.

The resin tablets R which are supplied in the pots 9 are heated and expanded/softened by the heating means 5, 6, 11 and 21 provided in the upper mold section 1 and the lower mold section 2, to be gradually melted.

Then, the lower mold section 2 is upwardly moved so that the upper mold section 1 and the lower mold section 2 are closed while the outside air blocking members 30 and 33 are slid to be engaged with each other, thereby defining the outside air blocking space portion 38 covering a space portion between the die surfaces of the upper mold section 1 and the lower mold section 2 and at least the outer peripheries of the pots 9, the resin passages 25 and 26 and the cavities 10 and 20, as shown in Figs. 2 and 3.

The upper mold section 1 and the lower mold section 2 are intermediately closed to define a required space S between the die surfaces thereof as shown in Fig. 2, and then completely closed to join the die surfaces with each other as shown in Fig. 3. Such intermediate closing and complete closing are carried out in continuation.

In the aforementioned closing, particularly in the

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intermediate closing of the upper mold section 1 and the lower mold section 2, an instantaneous evacuation step is carried out by the instantaneous evacuation mechanism 45.

Namely, the switching valve 47 is opened by the opening signal D so that the space portion 38 communicates with the instantaneous evacuation mechanism 45 through the switching valves 47 and 48 and the vacuum path 39, thereby instantaneously and forcibly sucking/discharging the air remaining in the space portion 38 and the like to the exterior in a short time.

At this time, therefore, the degree of vacuum in the space portion 38 is quickly improved to attain a high degree of vacuum in several seconds.

Then, the switching valve 48 is closed by the closing signal e and the vacuum source 40 is driven to carry out an evacuation step of forcibly sucking/discharging the air remaining in the space portion 38 and the like to the exterior in continuation to the instantaneous evacuation step by the instantaneous evacuation mechanism 45.

At this time, therefore, it is possible to maintain the degree of vacuum in the space portion 38 which is attained by the instantaneous evacuation, or further improve the degree of vacuum.

The resin tablets R which are supplied in the pots 9 are heated and expanded/softened by the heating means 5,

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6, 11 and 21 provided in the upper mold section 1 and the lower mold section 2, while the interior and the exterior of the resin tablets R are brought into ventilative states so that air and/or moisture contained therein flow out into the pots 9. Namely, the resin tablets R supplied into the pots 9 which are in heated states are efficiently and quickly expanded by thermal expansion through heating by radiation heat and conduction heat received from the pots 9, expansion through the evacuation in the pots 9 and synergistic action/effect of these actions. Even if the resin tablets R which are supplied in the pots 9 contain a number of fine independent bubbles, therefore, such independent bubbles are reliably broken by the aforementioned expansion of the resin tablets 9. Therefore, the interior and the exterior of the resin tablets R communicate with each other to be in ventilative states, whereby air and moisture contained in the number of independent bubbles reliably flow out into the pots 9 (space portion 38).

Further, the resin tablets R supplied in the pots 9 generate gas upon heating. Therefore, it is possible to instantaneously set the space portion 38 in a high vacuum state in a short time by carrying out the instantaneous evacuation through the instantaneous evacuation mechanism 45 and the evacuation through the vacuum source 40.

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Consequently, all of the air and/or moisture remaining in the space portion 38, the air and/or moisture flowing out from the resin tablets R into the space portion 38 (pots 9) and the gas generated by heating of the resin tablets R can be forcibly sucked/discharged to the exterior of the space portion 38.

The resin tablets R which are supplied in the pots 9 contain moist air in states of a number of independent bubbles, which cannot communicate with each other and with the surfaces of the resin tablets R. When the resin tablets R are heated to a resin molding temperature in the pots 9, therefore, the resin tablets R are expanded/softened to be finally melted as follows:

In the resin tablets R which are received in the pots 9, bottom surfaces are placed on upper end surfaces of the plungers 13a and clearances are defined between the side surfaces and inner wall surfaces of the pots 9, while open space portions are defined between the upper surfaces and the cull portions 25.

In this state, therefore, conduction heat and radiation heat are applied to the bottom surface portions and the side surface portions of the resin tablets R respectively. Therefore, heating values on the bottom portions of the resin tablets R which are in contact with the upper end surfaces of the plungers 13a are first

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increased, so that the bottom portions are softened successively from central portions. Consequently, upper central portions of the resin tablets R are upwardly pressed from the interior to be expanded toward upper portions in the pots 9 (ie, toward the cull portions 25) in advance of the other portions.

At this time, the interior and the exterior of the resin tablets R communicate with each other to enter ventilative stages, whereby the air and/or moisture which is trapped in the independent bubbles easily flow out into the space portion 38 (pots 9). Thus, the instantaneous evacuation step is carried out after resin tablets R in said pots are heated and expanded during said resin tablet heating step so that the interior and the exterior of said resin tablets are brought into ventilative states.

Since the space portion 38 is set under a high vacuum state at this time, the air and/or moisture contained in the resin tablets R is forcibly sucked to flow into the space portion 38 (pots 9), and is efficiently and reliably discharged to the exterior by evacuation.

Then, the upper mold section 1 and the lower mold section 2 are completely closed, to thereafter carry out a resin molding step of sealing the electronic parts 27a which are provided on the lead frames 27 in resin molded members.

When the upper mold section 1 and the lower mold section 2 are completely closed, the resin tablets R received in the pots 9 are pressurised by the plungers 13a so that the melted resin materials which are heated and melted

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in the pots 9 are injected/charged into required numbers of the cavities 10 and 20 which are arranged on side positions of the pots 9. Thus, the electronic parts 27a provided on the lead frames 27 which are engaged/set in the respective cavities 10 and 20 can be sealed in the resin molded members.

As hereinabove described, the evacuation step of forcibly sucking/discharging the air remaining in the space portion 38 etc. to the exterior is continuously carried out also when the upper mold section 1 and the lower mold section 2 are intermediately and completely closed.

The residual air and/or moisture can be relatively easily discharged from the space portion 38 to the exterior due to the required space S defined in the space portion 38 particularly between the die surfaces of the upper mold section 1 and the lower mold section 2 when the same are intermediately closed, while it is relatively difficult to discharge the residual air and/or moisture from the space portion 38 when the upper mold section 1 and the lower mold section 2 are completely closed since no space S is defined between the die surfaces at this time.

Also when the upper mold section 1 and the lower mold section 2 are completely closed, however, the vacuum

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source 40 or the instantaneous evacuation mechanism 45 communicates with the pots 9, the resin passages 25 and 26 and the cavities 10 and 20 through the air vents 43 and the vacuum path 39, whereby the function for discharging the residual air etc. from the space portion 38 to the exterior is not deteriorated. Thus, it is possible to discharge the residual air etc. from the space portion 38 whether the upper mold section 1 and the lower mold section 2 are intermediately or completely closed.

Then, the upper mold section 1 and the lower mold section 2 may be again opened after a required curing time, so that the resin molded members and hardened resin are released from the cavities 10 and 20 and the resin passages 25 and 26 respectively by the ejector plates 22 and 12 and the ejector pins 22a and 12a.

According to a graph of evacuation efficiency in the internal die space portion shown in Fig. 6, it is possible to attain a high vacuum state in several seconds (about 2 to 3 seconds) when only instantaneous evacuation is carried out (see the solid line 1). Further, it is understood that about six to seven seconds are required for attaining a high vacuum state only by ordinary evacuation (see the broken line 2). Therefore, it is possible to set a long evacuation time in the internal die space portion by carrying out instantaneous evacuation for

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bringing the internal die space portion into a high vacuum state in a short time. Thus, it is possible to efficiently and reliably discharge air remaining in the internal die space portion, air flowing out from the aforementioned resin tablets and gas generated upon heating and melting of the resin tablets to the exterior before the resin tablets are completely heated and melted in the pots.

The present invention is not restricted to the aforementioned embodiment, but modifications can be arbitrarily and properly selected and employed at need within the scope of the present invention.

For example, the lower mold section 2 may not be completely stopped in intermediate closing, but the closing speed (speed for upwardly moving the lower mold section 2) may be reduced between the intermediate closing state shown in Fig. 2 and the complete closing state shown in Fig. 3, to continuously carry out the intermediate closing and the complete closing.

The evacuation step and the instantaneous evacuation step for the outside air blocking space portion 38 may be arbitrarily and properly modified/selected on the basis of resin molding conditions and the like.

For example, the instantaneous evacuation step for the space portion 38 may be continuously carried out

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following the evacuation step therefor, and vice versa.

Further, the instantaneous evacuation step for the space portion 38 may be carried out simultaneously with the evacuation step.

Further, air holes communicating with the engaging space portions for the ejector plates 12 and 22 may be provided to communicate with the outside air blocking space portion 38 or with another vacuum path, to discharge residual air etc. from the engaging space portions to the exterior.

Further, air holes communicating with the outside air blocking space portion 38 may be provided in sliding portions of the pots 9 and the plungers 13a or such air holes may communicate with another vacuum path, to discharge the residual air etc. from the pots 9 to the exterior.

Further, a plurality of vacuum sources 40 such as vacuum pumps may be combined with a plurality of instantaneous evacuation mechanisms 45 such as vacuum tanks, while such members may be combined independently of each other.

While the chase blocks 7 and 8 are frequently detached in the aforementioned embodiment, the present invention is also applicable to an apparatus for molding resin to seal electronic parts having an ordinary die

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structure.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

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CLAIMS

1. A method of molding resin to seal electronic parts, comprising:

a resin tablet supplying step in which resin tablets (R) are supplied into respective pots (9) arranged in a resin molding die (1,2) consisting of an upper mold section (1) and a lower mold section 2;

a lead frame supplying step in which electronic parts (27a) mounted on lead frames (27) are set into prescribed positions in cavities (10,20) provided in said die (1,2);

a resin tablet heating step of heating said resin tablets (R);

a die closing step of closing said upper and lower mold sections (1, 2) to enclose said electronic parts (27a) on said lead frames (27) in said cavities (10,20);

an outside air blocking step in which an internal die space portion (25,26) defined in the closed die by at least said pots (9), said cavities (10,20) and resin passages communicating said pots (9) with said cavities (10,20), is cut off from the exterior;

a first relatively longer evacuation step of forcibly sucking/discharging air, gas and/or moisture in said internal die space portion (25,26);

a second, relatively shorter evacuation step of forcibly sucking/discharging said air, gas and/or moisture in said internal die space portion (25,26);

a resin molding step in which said resin tablets (R) are heated and melted



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in said pots (9) to flow into said cavities (10,20) arranged to the sides of said pots (9) through said resin passages (25,26), thereby sealing said electronic parts (27a) with resin: wherein said die closing step comprises:-

an intermediate closing step of defining a prescribed clearance between die surfaces of said upper and lower mold sections (1,2), and

a complete closing step of joining said die surfaces of said upper and lower mold sections (1,2) to each other; and wherein

both of said first evacuation step and said second evacuation step are carried out in both said intermediate closing step and said complete closing step.

2. A method of molding resin to seal electronic parts in accordance with claim 1, wherein said second evacuation step is carried out after said first evacuation step.
3. A method of molding resin to seal electronic parts in accordance with claim 1, wherein said first evacuation step is carried out after said second evacuation step.
4. A method of molding resin to seal electronic parts in accordance with claim 1, wherein said second evacuation step is carried out simultaneously with said first evacuation step.
5. A method of molding resin to seal electronic parts in accordance with a claim 1, wherein said second evacuation step is carried out after said resin tablets (R) in said pots (9) are heated and expanded during said resin tablet heating step so that the interior and the exterior of said resin tablets (R) are brought into ventilative states.

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6. A method of molding resin to seal electronic parts in accordance with claim 1, wherein said second evacuation step includes a step of releasing air, gas and/or moisture to a vacuum tank (45) being previously brought into a prescribed vacuum state when communication with said internal die space portion (25,26) is closed and said vacuum tank is communicated with a vacuum source (40).

7. Apparatus for molding resin to seal electronic parts, comprising:

a die (1,2) for resin molding including an upper mold section (1) and a lower mold section (2) arranged oppositely to each other and containing a plurality of pots (9), a plurality of cavities (10,20) and a plurality of resin passages (25,26) for communicating said pots (9) and said cavities (10,20);

means for supplying resin tablets (R) into respective pots (9);

means for supplying and setting electronic parts (27a) mounted on lead frames (27) in prescribed positions in said cavities (10,20) of said die (1,2);

means for closing said die (1,2) with said resin tablets (R) in said pots (9) and said electronic parts (27a) in said cavities (10,20), and for heating said resin tablets (R) for melting the same; and

means for injecting melted resin material into said cavities (10,20) through said resin passages (25,26), thereby sealing said electronic parts (27a) with resin, said apparatus further comprising:

means for cutting off an internal die space portion (25,26) defined upon closing of said die (1,2) by at least said pots (9), said resin passages (25,26) and said cavities (10,20);

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first evacuation means for forcibly sucking and discharging air, moisture and gas contained in said internal die space portion (25,26) to the exterior, thereby improving the degree of vacuum in said internal die space portion (25,26) in a relatively longer time;

second evacuation means for forcibly sucking and discharging said air, said moisture and said gas contained in said internal die space portion (25,26) to the exterior in a relatively shorter time, thereby again improving the degree of vacuum in said internal die space portion (25,26); and

means whereby said die closing means operates with intermediate and complete closing stages, and said first and second evacuation means are operative at both said die closing stages.

8. Apparatus for molding resin to seal electronic parts in accordance with claim 7, wherein:

said first evacuation means includes a vacuum source (40),

said second evacuation means (45) includes a vacuum tank, and

three end portions of a vacuum path having three branch portions are connected with said vacuum source (40), said vacuum tank and said internal die space portion (25,26) respectively to communicate with the same,

switching valves (47,48) being provided between said branch portions and said vacuum tank as well as said internal die space portion (25,26), respectively.

9. Apparatus for molding resin to seal electronic parts in accordance with claim



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8. further comprising means for controlling opening/closing of said switching valves (47,48) in linkage.

10. An apparatus for molding resin to seal electronic parts in accordance with any of claims 7 to 9, wherein said means for sealing/molding said electronic parts with resin includes multistage injection means capable of changing the speed for injecting said melted resin material into said cavities (10,20).

11. Apparatus for molding resin to seal electronic parts in accordance with any of claims 7 to 10, wherein said means (30,33) for cutting off said internal die space portion (25,26) from the exterior includes a pair of outside air blocking members (30,33) covering outer peripheries of said upper mold section (1) and said lower mold section (2) in positions adjacent said internal die space portion (25,26) and being slidable along said outer peripheries to be engageable with each other upon closing of said upper and lower mold sections (1,2).

12. Apparatus for molding resin to seal electronic parts in accordance with any of claims 7 to 11, further comprising a pair of chase blocks (7,8), containing the principal parts for carrying out resin molding, said blocks being detachably engaged with said upper mold section (1) and said lower mold section (2), respectively.

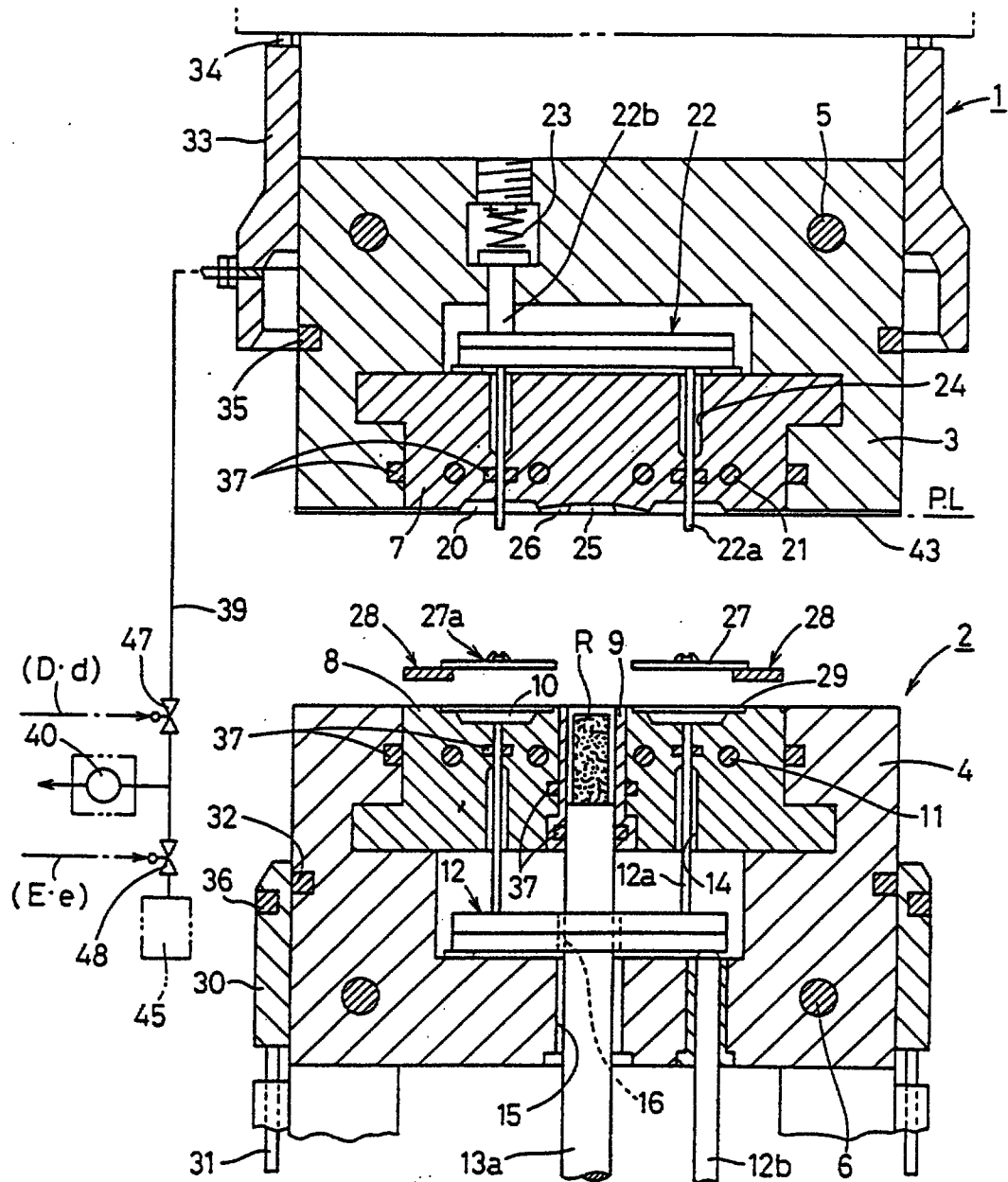


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FIG.1

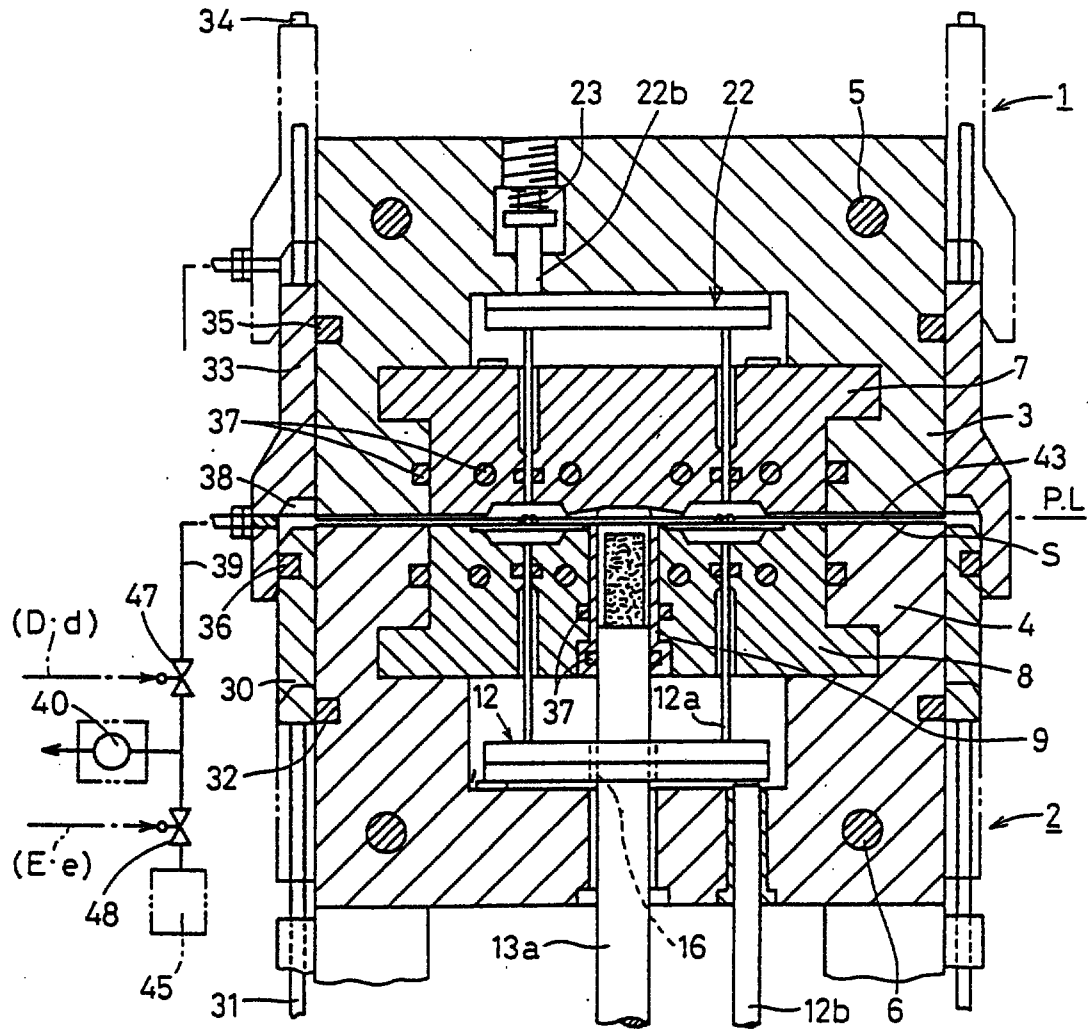
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FIG.2

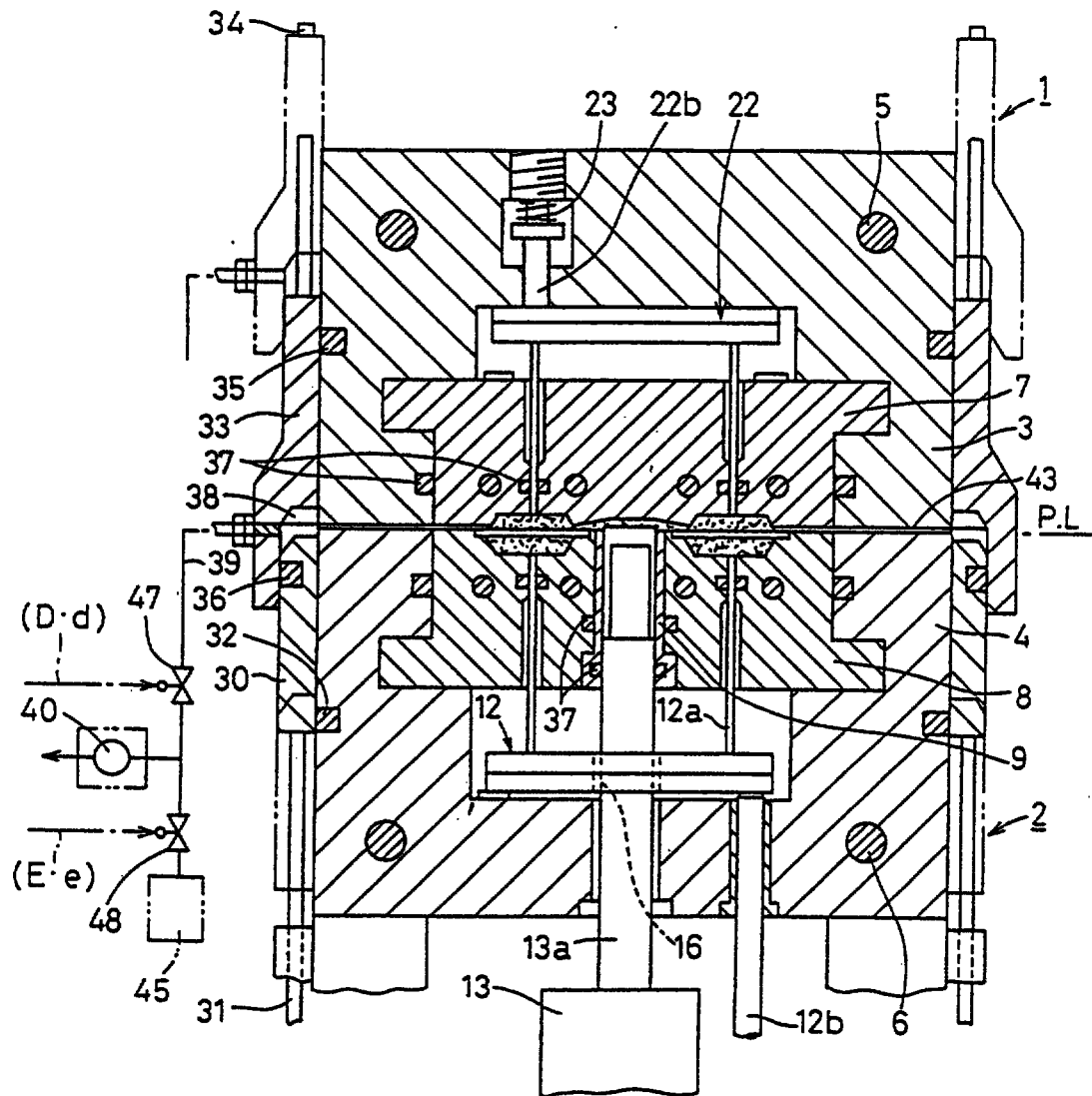


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FIG.3

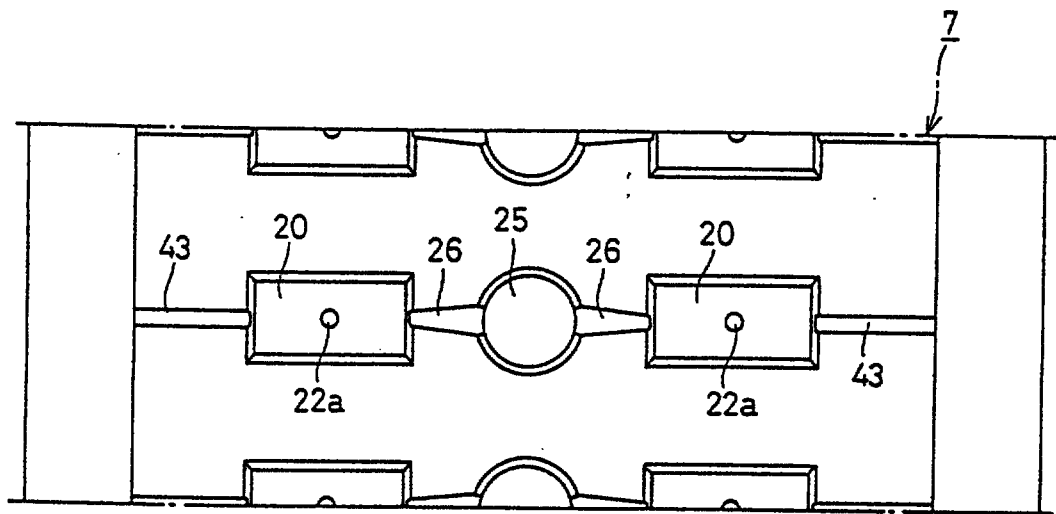
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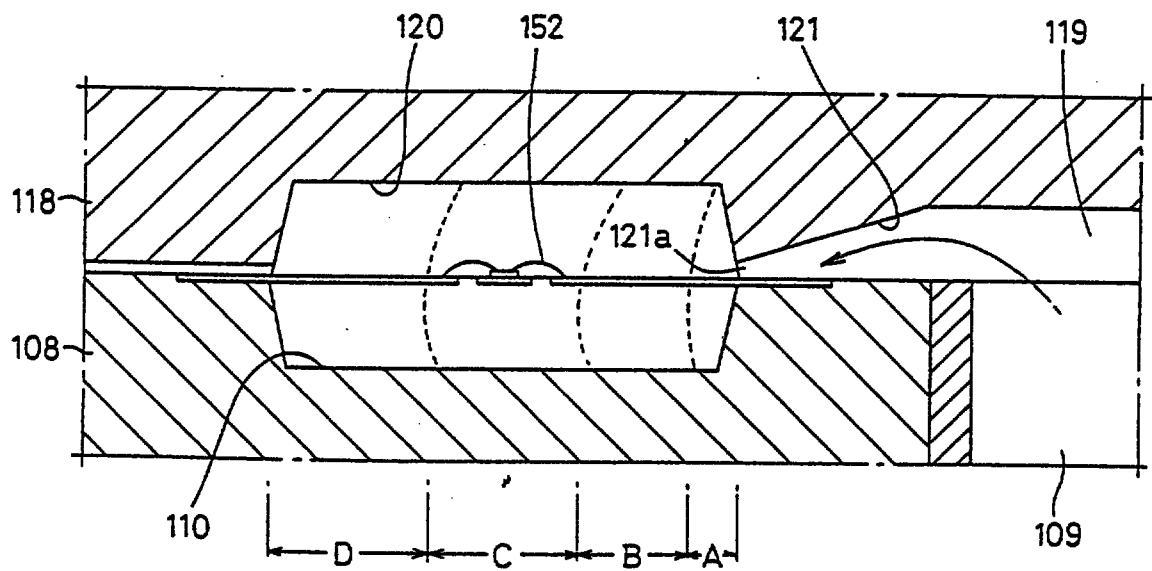
FIG.4



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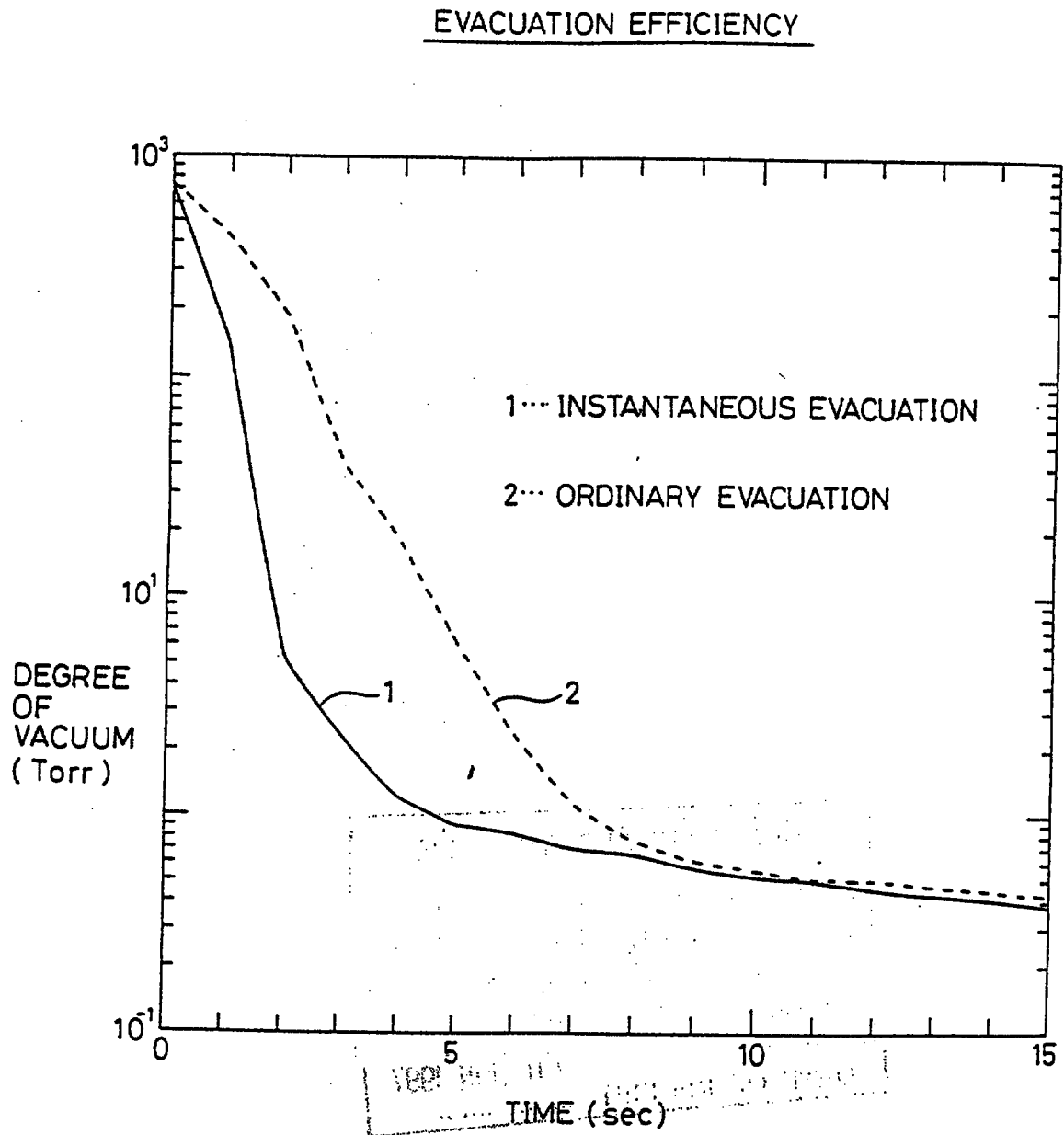
FIG.5



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FIG.6



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☐ Claim(s) : paged to paged
☐ Drawing(s) : paged to paged
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METHOD OF AND APPARATUS FOR MOLDING RESIN TO SEAL ELECTRONIC PARTS

ABSTRACT OF THE DISCLOSURE

In a method of molding resin to seal electronic parts, an internal die space portion (38) which is defined at least by pots (9), cull portions (25), resin passages (26) and cavities (10, 20) when an upper mold section (1) and a lower mold section (2) are closed is cut off from the exterior to carry out evacuation by a vacuum source (40) and instantaneous evacuation by an instantaneous evacuation mechanism (45). According to this method, it is possible to quickly improve the degree of vacuum in the internal die space portion (38) by efficiently and reliably discharging air, moisture and gas from the internal die space portion (38) to the exterior due to synergistic action of the evacuation and the instantaneous evacuation. Consequently, resin molded members are prevented from formation of voids.

Figure 3

This is the replacement sheet

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