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(54) Title: METHOD FOR INJECTION MOULDING OF THERMOPLASTIC POLE PARTS, AND MOULD FOR PROCEEDING THE SAME

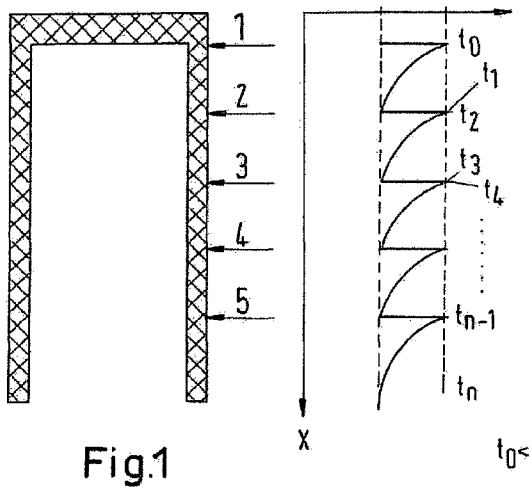

Fig.1

(57) Abstract: The invention relates to a method for injection moulding of thermoplastic pole parts, with the use of a mould in which at least one vacuum interrupter and contact terminals are fixed during the moulding procees, and with at least one injection opening or gate for injection of thermoplastic material into the mould, and mould for proceeding the same, according to the preamble of claims 1 and 9. In order to solve the problem with a pressure gradient along the long axis of the moulded pole part, and to result in shorte process times as well as in a homogenous dissipation of material during the moulding process, the mould is applied with multiple injection openings at least along its long axis, for injection of hot thermoplastic material, and that the injection openings or gates can be steared in such a way, that they inject thermoplastic material simultaneously or with a defined time dependend injection pattern.

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Method for injection moulding of thermoplastic pole parts, and mould for proceeding the same

The invention relates to a method for injection moulding of thermoplastic pole parts, with the use of a mould in which at least one vacuum interrupter and contact terminals are fixed during the moulding process, and with at least one injection opening/gate for injection of thermoplastic material into the mould, and mould for proceeding the same, according to the preamble of claims 1 and 9.

Injection moulding of medium voltage pole parts, for example to cover them with a thermoplastic housing is well known. In difference to the use of duroplastic material for a resin, the proceding pressure for thermoplastic material during the moulding is higher. One of the greatest advantages of thermoplastic housing is, that the manufacture times are shorter than the manufacture times for epoxy resin. Reason for that is, that epoxy resin needs longterm curing periodes and slow temperature curves. Thermoplastic material only has to become solid by cooling down.

Injection moulding technology for thermoplastic pole parts is used only with single injection gate or opening.

Furthermore due to inlays which are sensitive to pressure like for example the vacuum-interrupters, injection moulding is possible only to upper pressure limits.

The filling of a cavity depends on the behaviour and the properties of thermoplastic materials, in scope of their resulting viscosity.

So the disadvantages of the processes in the state of the art are the following:

The filling pressure decreases along flow path to low pressure at the end, caused by the viscosity of the thermoplastic material. This finally results in filling problems.

The maximum filling pressure inside the mould increases with height of the pole part or the pole part arrangement along the flow path.

Geometric constraints require inhomogeneous wall thickness along flow path, and therefore voids occur, and incomplete filling at dedicated pressures is the possible result.

The introduction of geometric reinforcement elements like fins etc. for strength and stiffness of pole part is almost impossible due to ineligible increase of cavity pressure.

Injection moulding of material with increased viscosity is with that known technology not possible.

So according to the fact, that the manufacture time cycles for thermoplastic covered pole parts are quite short, so dynamic effects like viscosity of the liquid hot thermoplastic material occur during the process.

Therefore it is an object of the invention, to solve the problem with a controlled pressure gradient along the long axis of the moulded pole part, and to result in shorter process times as well as in a homogenous dissipation of material during the moulding process.

The inventive solution of that problem is, that the mould is applied with multiple injection openings or gates or fim-injection gates at least along its long axis, for injection of hot thermoplastic material, and that the injection gates can be steared in such a way, that they inject thermoplastic material simultaneously or with a defined time dependend injection pattern.

An advantageous embodiment is, that further injection gates are located at that points in the mould where are located nonflat topography. This enhances a complete filling without time loss also at region with complicated topography. This furthermore results in a better mechanical as well as a better reduction of voids.

A further embodiment of the invention is, that the injection openings are applied with shutters, by which the flux of injected hot thermoplastic material can independently be steared for each injection opening. By these shutters each injection opening or gate can be steared in the optimal way, and with consideration of pressure gradient along the flow path of thermoplastic material.

It is an advantageous embodiment, that the pressure in the injection openings or near to them are measured via pressure sensors in order to stear the injection of each injection opening e.g. each shutter according to a predetermined pressure gradient.

In order to enhance the mechanical and the dielectric behavier and to cause reduction of voids of the pole part housing, the injected hot thermoplastic material is filled with particles or fibres, and that at least dedicated injection openings are applied with that, in order, to strengthen at least several regions of the pole part.

So in consequence of that, the injection gates are steared or driven via the shutter and the applied pressure in such a way, that the direction of the resulting material flow in the mould during the moulding process can be steared or optimized.

In order to use several material compounds it is advantageous, that at least two gates are applied with different hot thermoplastic material, in order to implement a two or more compound moulding during one moulding process.

According to a mould for the use of the method, the invention is, that the mould is applied with multiple injection gates at least along its long axis, for injection of hot thermoplastic material, and that at least one of the injection gates is applied with a steerable shutter.

A further advantageous embodiment to that is, that the shutter or the injection means are steared by stearing means, in which a pressure and or flux pattern is predetermined.

A further advantageous embodiment is, that in the injection gates or corresponding with them pressure sensors are located, and that the pressure sensor values are feed into the stearing means, in order to stear the shutter of injectors via a predetermined time/pressure pattern.

For all embodiments also film injection gates can be used.

One of the great advantages are, that thermoplastic pole parts for indoor application are using multiple injection gates, in order to reduce viscosity-dependant pressure gradient along the long axis of the mould, so that it results in more homogenous housing of the pole parts and improve filling of the mould.

By the fact, that the position of the injection openings or gates are choosen, it supports the alignment of inlays in the mould.

An embodiment of the invention is shown in the figures.

Figure 1: mould with several injection gates

Figure 2: state of the art

Figure 3: mould with additional use of inlays

Figure 4: mould with use of film injection gates

Figure 1 shows in principle a mould , with several injections openings or gates along the logaxis, of the mould, which is as well the flow path of the injected thermoplastic material. In the mould is not shown the inserted positioned vacuum interrupter, because it is not need to display it.

The injection gates 1, 2, 3, 4, 5 are applied in this case nearly equidistandly. But this is only an example, and it is not need in all cases to alligne them in that way in all cases. For example if regions of dense topography occur by given vacuum-interrupter- or inlay-construction the gates can be arranged nonequidistandly closes, that in other regions of the mould.

The effect of such an arrangement of injection gates is shown on the right side of figure 1. The diagram shows the pressure gradient along the long axis or the flow path of the injected thermoplastic material.
It is clear that the decrease of pressure caused by the viscosity of the thermoplastic material can be limited by the distance to the next injection gate.

Figure 2 shows according to figure 1 the comparison to the state of the art. Figure 2 shows a mould with only one injection gate 1. It is clear, that the pressure decreases along the flow path of the thermoplastic material.
So the difference becomes clear out the comparison of figure 1 with figure 2.

Figure 3 shows an embodiment in case of the use of additional inlays in the mould. This additional inlays can be the electric terminals of the pole part. So the injection gates are located in such, that they are positioned near to that inlays.
But a further detail in figure 3 is important. The injection gates 1, 2 are furthermore positioned in that way, that a force F_i is caused by injected material in that way and in that direction, that the inlay will be pushed into its predetermined end position. This gives a high performance in sense final measures and positioning of the manufacture of a pole part.

So finally with the invention the following resulting important features and advantages can be summarized.

- An increased number of injection gates in the mould along the flow path.

- A location of injection gates will be selected in such a way, that a maximum filling pressure is reduced compared to single injection gate, and the flow of material is much

more homogenous in sense of high mechanical performance of the housing of the pole part. Furthermore a control of maximum filling pressures is possible, in order to consider each pressure sensitive inlay in such a pole part. The control of pressure profile along flow path is also possible, at least to consider several topography of the inlays, or of the outer surface of the pole part housing.

- An almost constant filling pressure is possible, which keeps filling pressure inside mould at a dedicated level.

- An alignment of glas fibre around vacuum-interrupter optimized concerning dielctric and mechanical strength is possible also in case of influence of viscosity by such additives in the hot thermoplastic material.

- Furthermore a control of positions of weld lines by selection of moments for opening further gates, th.m. injection before or after flow front arrives at injection gate, is given, and a support of positioning, th.m. alignment to mould, or sealing, of inlays due to dedicated changes of filling direction is given by location of the injection gate beneficially on the opposite side of the inlay in the mould.

- Furthermore the use of a defined injection angle, actually used 90° versus axial direction of pole part, can be applied by and/or each of the injection gates.

So the combination with complex structure elements, also possibly be caused by reinforcement elements, fine structures, far projected fins for mechanical reinforcement of pole part housing or increased creepage length, can be used in this moulding process as well.

Figure 4 shows schematically an embodiment in use of the invention in case of general or additional film injection method. Also in this case the invention is implemented. Film injection gates 1, 2, 3, 4, 5, 6 can be applied from the inner and/or the outer side of the mould.

They can be driven from the top or bottom side or as well from the sidewallposition or from the inner side of the so produced thermoplastic part. So all injection gates are steared in that way, described above.

Claims

1. Method for injection moulding of thermoplastic pole parts, with the use of a mould in which at least one vacuum interrupter and contact terminals are fixed during the moulding procees, and with at least one injection opening for injection of thermoplastic material into the mould,
characterized in
that the mould is applied with multiple injection openings or gates, or film-injection gates at least along its long axis, for injection of hot thermoplastic material, and that the injection gates can be steared or operated and are located in such a way, that they inject thermoplastic material simultaneously or with a defined time dependend injection pattern.

2. Method according to claim 1,
characterized in
that further injection openings are located at that points in the mould where are located nonflat topography.

3. Method according to claim 1,
characterized in
that the injection openings are applied with shutters, by which the flux of injected hot thermoplastic material can independently be steared for each injection opening.

4. Method according to claim 1,
characterized in
that the pressure in the injection openings or gates or near to them are measured via pressure sensors in order to stear the injection of each injection opening or gate e.g. each shutter according to a predetermined pressure gradient.

5. Method according to claim 1,
characterized in
that the injected hot thermoplastic material is filled with particles or fibres, and that at least dedicated injection openings or gates are applied with that, in order, to strengthen at least several regions of the pole part.

6. Method according to claim 1,
characterized in
that the injection openings are steared via the shutter and the applied pressure in such a way, that the direction of the resulting material flow in the mould during the moulding process can be steared.

7. Method according to claim 1,
characterized in
that at least two openings are applied with different hot thermoplastic material, in order to implement a two or more compound moulding during one moulding process.

8. Method according to claim 1,
characterized in
that the injection is operated by at least partly using film injection gates from the inner or outer side of the produced thermoplastic part.

9. Mould for the use of the method according to at least one of the aforesaid claims 1 to 8, for injection moulding of thermoplastic pole parts, in which at least one vacuum interrupter and contact terminals are fixed during the moulding procees, and with at least one injection opening or gates for injection of thermoplastic material into the mould,
characterized in
that the mould is applied with multiple injection openings or gates at least along its long axis, for injection of hot thermoplastic material, and that at least one of the injection opening or gate is applied with a steerable shutter.

10. Mould according to claim 9,
characterized in
that the shutter or the injection means are steared by stearing means, in which a pressure and or flux pattern is predetermined.

11. Mould according to claim 10,
characterized in
that in the injection openings or corresponding with them pressure sensors are located, and that the pressure sensor values are feed into the stearing means, in order to stear the shutter of injectors via a predetermined time/pressure pattern.

12. Mould according to one of the claims 9 to 11,
characterized in
that at least a part of the injection gates are applied as film injection gates.

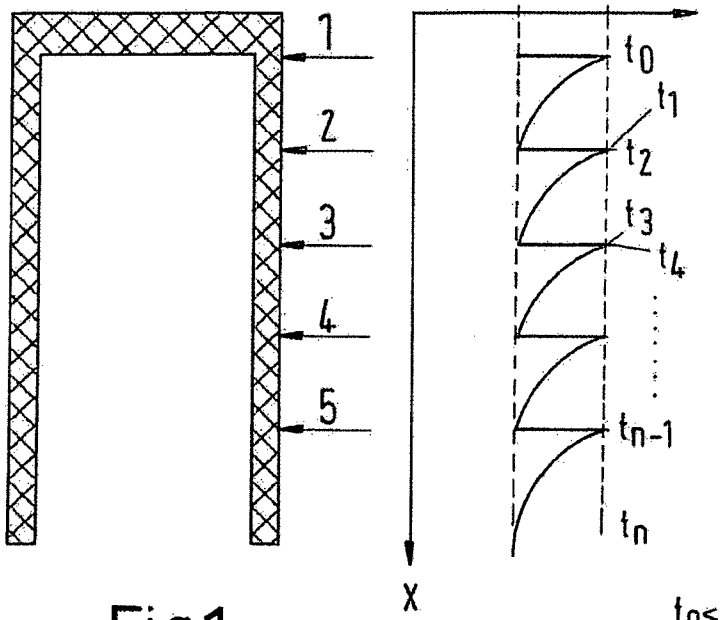

Fig.1

$t_0 < t_1 < t_2 < \ldots < t_n$

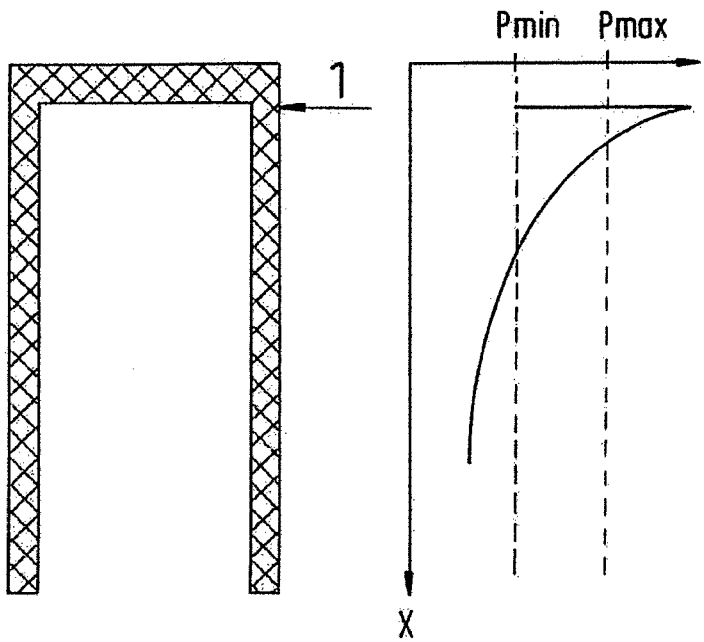

Fig.2

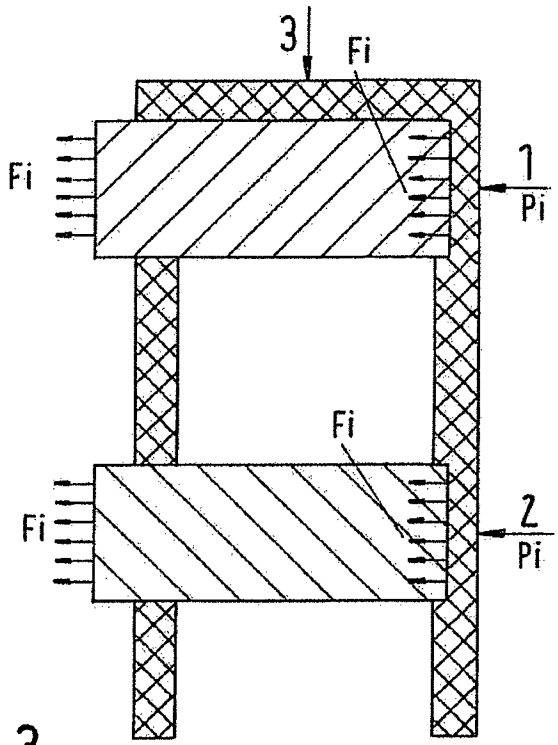

Fig.3

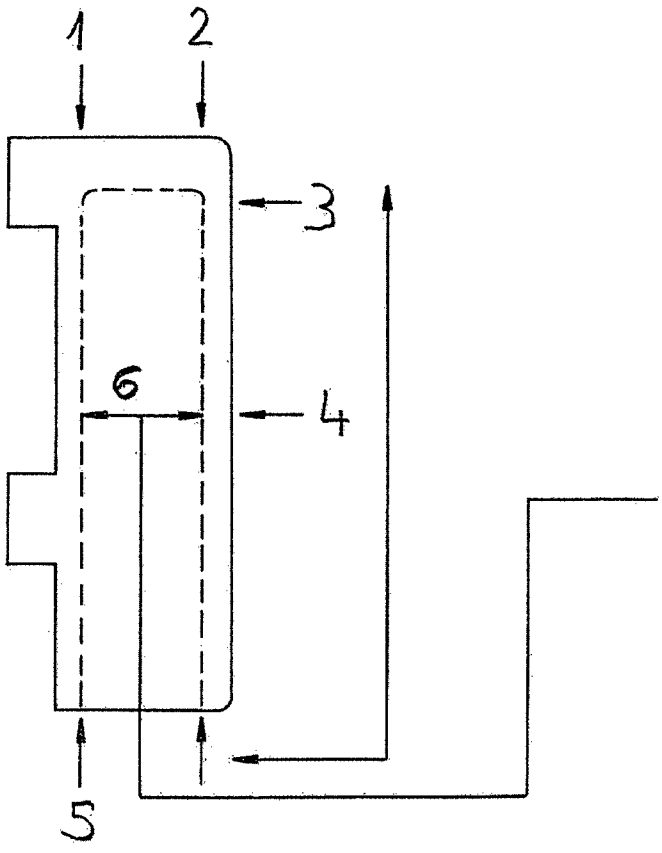

Fig.4

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C45/14 H01H33/662
ADD. B29K105/12 B29C45/16 B29C45/27

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B29C H01H B29K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/142485 A1 (GENTSCH DIETMAR [DE] ET AL) 19 June 2008 (2008-06-19) claims 1,2,10; figures	1-3,5-7, 9,10
Y	GB 1 506 851 A (JESMAN L) 12 April 1978 (1978-04-12) page 1, line 89 - page 2, line 92; figures	1-3,5-7, 9,10
A	JP 2001 179786 A (KANTO JIDOSHA KOGYO KK) 3 July 2001 (2001-07-03) abstract; figures	3,4,9-11
A	WO 98/39150 A2 (CASCADE ENG INC [US]; KELLER FREDERICK P [US]; MISNER JOHN E [US]; FIL) 11 September 1998 (1998-09-11) page 8, line 28 - page 9, line 29; claims 1,2; figure 4	3,4,9-11

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/001212

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03/057448 A1 (SYNVENTIVE MOLDING SOLUTIONS I [US]) 17 July 2003 (2003-07-17) paragraph [0072]; figure 13	3,4,9-11
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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