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DECLARATION FOR PATENT APPLICATION AND ASSIGNMENT

Title of the Invention: DEVICE AND METHOD FOR THE HOMOGENISATION OF PLASTICS MATERIAL MELTS

As a below named inventor, I hereby declare that:

This declaration is directed to:

☒ The attached application, or

☐ United States application or PCT international application number _____

             filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

WHEREAS, Coperion GmbH _____

(hereinafter referred to as Assignee) having a place of business at: Theodorstrasse 10, 70469 Sttutgart, GERMANY

is desirous of acquiring the entire right, title and interest to said invention and in the Letters Patent to be obtained therefor from the United States;

NOW THEREFORE, be it known by all whom it may concern, that for and in consideration of the sum of One Dollar ($1.00) (or the equivalent thereof in foreign currency) and other valuable consideration, the receipt of which is hereby acknowledged, I have assigned, sold and set over and by these presents do assign, sell and set over unto the said Assignee for the territory of the United States of America and not elsewhere, the full and exclusive right, title and interest in and to the said invention, said invention, application and Letters Patent to be held and enjoyed by the said Assignee for its own use and behoof and for the use and behoof of its successors and assigns to the full end of the term for which said Letters Patent is granted, as fully and entirely as the same would have been held by me had this Assignment and sale not been made.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than (5) years, or both.

LEGAL NAME OF INVENTOR

INVENTOR: Micheal AHLGRIMM _____

→Inventor's signature _Michael Ahlgrimm_   →Date 11.03. 2015

DEVICE AND METHOD FOR THE HOMOGENISATION OF
PLASTICS MATERIAL MELTS

CROSS-REFERENCES TO RELATED APPLICATIONS

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This application claims the priority of European Patent Application, Serial
No. 14 160 921.4, filed March 20, 2014, pursuant to 35 U.S.C. 119(a)-(d),
the content of which is incorporated herein by reference in its entirety as if
fully set forth herein.

10

FIELD OF THE INVENTION

The invention relates to a device for the homogenisation of plastics
material melts. Furthermore, the invention relates to a method for the
15   homogenisation of plastics material melts.

BACKGROUND OF THE INVENTION

A multi-shaft screw machine for preparing polymer melts is known from
20   EP 2 374 601 A1. Strainer plates having a large number of through-
openings for the polymer melt are arranged in the housing bores of the
screw machine. The polymer melt is conveyed through the through-
openings. The polymer melt is divided here into a large number of part
streams, so that the surface of the polymer melt is enlarged and the
25   polymer melt is thereby degassed and homogenised.

SUMMARY OF THE INVENTION

The invention is based on an object of providing a device, which, in a simple, effective and efficient manner, allows a homogenisation of plastic material melts.

5

This object is achieved by a device for the homogenisation of plastics material melts, comprising
- a housing,
- at least one housing channel for a plastics material melt to be
10 homogenised,
  -- which is formed in the housing and
  -- which extends from a feed opening to a discharge opening,
- at least one homogenising element comprising a plurality of flow channels for the plastic material melt to be homogenised,
15 -- wherein each of the flow channels has a length defined in a channel longitudinal direction and a cross sectional area defined transverse to the channel longitudinal direction and a cross sectional shape,
  -- wherein at least some of the flow channels differ with respect to at
20 least one feature from the group length, cross sectional area and cross sectional shape,
  -- wherein the at least one homogenising element is arranged between the feed opening and the discharge opening.

25 Since the flow channels of the at least one homogenising element differ with respect to their length, cross sectional area and/or cross sectional shape, different differential pressures are produced along the flow channels, so the part streams of the plastics material melt have different flow speeds and/or flow profiles when leaving the respective flow channel.

During the subsequent transition to a common drag flow profile, starting from the different flow speeds of the part streams, an expansion and shearing occurs, and therefore a mixing and homogenisation of the plastic material melt. In particular the expansion leads to an effective mixing and

5   homogenisation of the plastics material melt. This applies, in particular, to bimodal polymer melts. The cross sectional area and/or the cross sectional shape of the respective flow channel remain constant along its length. Since the free cross sectional areas of the flow channels may be comparatively large, as the homogenising effect substantially depends on

10   the difference in the flow speeds of the part streams, the pressure loss of the plastics material melt along the homogenising element is comparatively small. In addition, the structure of the at least one homogenising element is simple and robust. Overall, the device therefore allows a homogenisation of plastics material melts in a simple, effective and efficient manner.

15

The device is used, in particular, for homogenising plastics material melts, in particular polymer melts, which have constituents with different viscosities. This is, for example, the case in bimodal polymer melts. By means of the device, in particular gels in bimodal polymer melts can be

20   significantly reduced, so a homogenisation of the bimodal polymer melt takes place.

In a first embodiment, the device is configured as a screw machine, in particular as a multi-shaft screw machine. The screw machine has a

25   housing, in which at least one housing channel or at least one housing bore is formed. At least one treatment elementtreatment element shaft, which can be rotatably driven about an associated rotational axis, is arranged in the at least one housing channel or the at least one housing bore. The at least one treatment elementtreatment element shaft comprises at least one

shaft, on which treatment elementtreatment elements are non-rotatably arranged consecutively. The at least one homogenising element is arranged between a feed opening and a discharge opening of the screw machine. The at least one homogenising element extends into the at least one housing

5   channel or the at least one housing bore and, in particular, has the at least one treatment element shaft passing through it. The at least one homogenising element is, in particular, rigidly connected to the housing. In a multi-shaft screw machine, the treatment element shafts are preferably configured to tightly mesh and can be rotatably driven in the same

10   direction. Downstream of the respective homogenising element, a mixing zone is preferably formed, in which no treatment elements are arranged on the at least one shaft. At least one sleeve is preferably arranged on the at least one shaft in the mixing zone so a free space or mixing space for homogenising and mixing the part streams is formed in the mixing zone.

15   The screw machine is therefore a device for the homogenisation of plastics material melts.

In a second embodiment the device is static. The static homogenising device is, for example, arranged between a screw machine and a

20   granulating device.

The at least one homogenising device is part of a preparation system for preparing plastics materials, in particular polymers. The preparation system comprises, in particular, a homogenising device configured as a screw

25   machine and/or a static homogenising device.

A device, in which the flow channels have at least two different lengths, in particular at least three different lengths, and, in particular, at least four different lengths, ensures an effective homogenisation. Owing to the

different lengths, the part streams at the downstream outlet of the flow channels have different flow speeds and/or flow profiles, so an expansion, shearing and mixing of the plastics material melt takes place. The homogenising effect for the respective plastics material melt can be

5   optimised by the number of flow channels of different lengths. The cross sectional area and/or the cross sectional shape of the flow channels is/are the same and/or different.

A device, in which there applies to the ratio of a maximum length L_{max} to a

10   minimum length L_{min} of the flow channels: $L_{max}/L_{min} \geq 1.2$, in particular $L_{max}/L_{min} \geq 1.6$, and, in particular, $L_{max}/L_{min} \geq 2$, ensures an effective homogenisation. The difference in the flow resistances in the individual flow channels and therefore the difference in the flow speeds of the part streams at the downstream outlet of the flow channels is influenced by the

15   ratio of the maximum length L_{max} to the minimum length L_{min}. The homogenising effect can be accordingly optimised by the ratio L_{max}/L_{min}.

A device, in which there applies to a minimum length L_{min} of the flow channels: $L_{min} \geq 10$ mm, in particular $L_{min} \geq 30$ mm, and, in particular, L_{min}

20   ≥ 50 mm, and/or in which there applies to a maximum length L_{max} of the flow channels: $L_{max} \leq 500$ mm, in particular, $L_{max} \leq 300$ mm, and, in particular, $L_{max} \leq 100$ mm, ensures an effective and efficient homogenisation. Owing to the minimum length L_{min}, a minimum homogenising effect is ensured, on the one hand, whereas an undesirably

25   high pressure loss is avoided by limiting the maximum length L_{max}.

A device, in which the flow channels end flush at an open side, in particular at a side that is downstream in relation to a conveying direction of the plastics material melt, ensures an effective homogenisation. Since

the flow channels end flush, the part streams of the plastics material melt meet one another simultaneously at the downstream outlet of the flow channels at, as far as possible, different flow speeds. As a result, an optimal expansion and shearing and, accordingly, an optimal homogenising effect

5 is achieved.

A device, in which the flow channels end offset at an open side, in particular at a side that is upstream in relation to a conveying direction of the plastic material melt, easily ensures an effective homogenisation. The

10 flow channels preferably end offset from one another at the upstream inlet and flush with one another at the downstream outlet. As a result, on the one hand, an effective homogenisation is ensured, while, on the other hand, the structure of the at least one homogenising element is simple. In a first embodiment, the at least one homogenising element has a base plate,

15 which, in particular in the conveying direction of the plastics material melt, has a constant thickness or length, and on which tubes having a different length and optionally additionally a different cross sectional area and/or cross sectional shape, are arranged. The tubes may, for example, be screwed and/or soldered and/or welded to the base plate. The at least one

20 homogenising element can be easily produced and adjusted with respect to the desired homogenising effect by means of screwed tubes. In a second embodiment, the at least one homogenising element is formed from a base body or a base plate, which, owing to material removal in the conveying direction of the plastics material melt, has regions with a different

25 thickness or length. The flow channels are formed in these regions. The base body is machined, for example, by milling or erosion. The flow channels are, for example, formed by bores introduced into the base body.

A device, in which the flow channels have at least two different cross sectional areas, in particular at least three different cross sectional areas, and in particular at least four different cross sectional areas, ensures an effective homogenisation. Different flow distances are produced by the

5   different cross sectional areas, so the part streams at the downstream outlets of the flow channels have different flow speeds and/or flow profiles. A uniform flow is established again downstream of the at least one homogenising element, whereby an expansion and shearing of the part streams and, accordingly, a homogenisation of the plastics material melt,

10   takes place. The length and/or cross sectional shape of the flow channels is/are the same and/or different. The homogenising effect can be adjusted or optimised by the number of different cross sectional areas.

A device, in which there applies to the ratio of a maximum cross sectional

15   area A_{max} to a minimum cross sectional area A_{min} of the flow channels: $A_{max}/A_{min} \geq 1.2$, in particular, $A_{max}/A_{min} \geq 1.6$, and, in particular, $A_{max}/A_{min} \geq 2$, ensures an efficient and effective homogenisation. The homogenising effect can be adjusted by the ratio of the maximum cross sectional area A_{max} to the minimum cross sectional area A_{min}, as the

20   difference of the flow speeds changes depending on this ratio. At the same time, it is possible to adjust the free cross sectional area in such a way that the flow resistance and therefore the pressure loss of the plastics material melt are comparatively small.

25   A device, in which there applies to a minimum cross sectional area A_{min} of the flow channels: $A_{min} \geq 5$ mm^2, in particular, $A_{min} \geq 10$ mm^2, and, in particular, $A_{min} \geq 15$ mm^2, and/or in which there applies to a maximum cross sectional area A_{max} of the flow channels: $A_{max} \leq 1600$ mm^2, in particular, $A_{max} \leq 800$ mm^2, and, in particular, $A_{max} \leq 600$ mm^2, ensures an

efficient and effective homogenisation. Owing to the minimum cross sectional area A_{min} and the maximum cross sectional area A_{max}, on the one hand a desired homogenising effect is ensured and, on the other hand, an undesirably high pressure loss is avoided.

5

A device, in which the flow channels have at least two different cross sectional shapes, in particular at least three different cross sectional shapes, and, in particular, at least four different cross sectional shapes, ensures an effective homogenisation. Owing to the different cross sectional shapes,

10 different flow resistances are achieved, so the part streams at a downstream outlet have different flow speeds and/or flow profiles. A uniform flow is established downstream of the at least one homogenising element, so an expansion and shearing and therefore a homogenisation of the plastics material melt takes place. The length and/or cross sectional area of the flow

15 channels is/are the same and/or different. Owing to the number of different cross sectional shapes, the homogenising effect can be adjusted or optimised. Moreover, the different cross sectional shapes allow an optimal utilisation of the cross sectional area available overall and therefore an optimisation of the free cross sectional area of the flow channels. The

20 pressure loss caused by the at least one homogenising element can be accordingly minimised.

A device, in which the at least one cross sectional shape of the flow channels is selected from the group round, oval, drop-shaped and

25 polygonal, easily ensures an effective homogenisation. A round cross sectional shape is comparatively easy to produce. A comparatively large free cross sectional area of the at least one homogenising element is achieved by a polygonal cross sectional shape, for example a triangular,

quadrangular or hexagonal cross sectional shape, so the pressure loss is
small.

A device, in which the flow channels run linearly in a channel longitudinal

5   direction, ensures an efficient homogenisation. Owing to the linear course
of the flow channels, in particular in the conveying direction of the plastics
material melt, a low flow resistance and therefore a low pressure loss are
achieved.

10   A device, in which the flow channels run parallel to one another and, in
particular, parallel to a conveying direction of the plastics material melt,
ensures an efficient homogenisation. Since the flow channels run parallel to
one another and, in particular, in the conveying direction, a comparatively
large free cross sectional area is achieved, so the flow resistance and

15   therefore the pressure loss at the at least one homogenising element is
small.

A device being configured as a screw machine, in particular as a multi-
shaft screw machine, wherein at least one treatment element shaft is

20   arranged in the at least one housing channel, the treatment element shaft
being rotatably drivable about an associated rotational axis, wherein the at
least one treatment element shaft comprises at least one shaft on which
treatment elements are non-rotatably arranged consecutively, wherein the
at least one homogenising element extends in the at least one housing

25   channel and is passed through by the at least one treatment element shaft,
ensures a simple, effective and efficient homogenisation in a screw
machine. Preferably, the housing has a degassing opening downstream of
the at least one homogenising element.

A device, in which the at least one homogenising element is rigidly connected to the housing, wherein the at least one homogenising element comprises, in particular, a base plate which is fastened between housing portions of the housing, ensures a simple homogenisation in a screw

5   machine.

A device, in which downstream of the at least one homogenising element, a mixing zone is formed in which no treatment elements are arranged on the at least one shaft, wherein in particular at least one sleeve is arranged on

10   the at least one shaft in the mixing zone, ensures an effective and efficient homogenisation due to a free space formed in the mixing zone for homogenisation and mixing of the part streams of the plastics material melt.

15   A device, in which the device is static, wherein the housing forms a guide bore running transversely to the conveying direction and crossing the housing channel, a slide element being arranged in the guide bore that is displaceable in a direction transverse to the conveying direction by means of an actuating drive, ensures a simple homogenisation.

20

A device, in which two continuous receiving openings are formed in the slide element, with a homogenising element being mounted in each of said receiving openings, ensures an effective and efficient homogenisation. Depending on the type of the plastics material melt, a suitable

25   homogenising element can be selected by displacing the slide element by means of the actuating drive in a direction transverse to the conveying direction so that the desired homogenising element is arranged in the housing channel.

The invention is further based on the object of providing a method, which allows a simple, effective and efficient homogenisation of plastics material melts.

5   This object is achieved by a method for the homogenisation of plastics material melts, comprising the following steps:
- providing a device according to the invention and a plastics material melt,
- conveying the plastic material melt in a conveying direction to at least
10   one homogenising element,
- flowing through the at least one homogenising element, in that the plastics material melt is divided into a plurality of part streams and the part streams flow through a respective associated flow channel and on leaving the respective flow channel have different flow speeds,
15   - establishing a uniform flow of the plastics material melt downstream of the at least one homogenising element such that an expansion and shearing of the part streams takes place.

The advantages of the method according to the invention correspond to the
20   advantages already described of the homogenising element according to the invention and the homogenising device according to the invention. The plastics material melt, when flowing through the at least one homogenising element, is divided into a plurality of part streams, which flow through a respective associated flow channel. When leaving the flow channels, the
25   part streams have at least partially different flow speeds and/or flow profiles. A uniform flow is adjusted downstream of the at least one homogenising element, so an expansion and shearing of the part streams takes place. In particular, the expansion in the conveying direction leads to a mixing and homogenising of the plastic material melt.

Further features, advantages and details of the invention emerge from the following description of a plurality of embodiments.

5   BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1   shows a schematic view of a preparation system for preparing plastics materials with a homogenising device configured as a screw-machine and a downstream static

10   homogenising device,

Fig. 2   shows an enlarged view of the screw machine in Fig. 1 in the region of a homogenising element for the homogenisation of the plastics material melt located in the

15   screw machine according to first embodiment,

Fig. 3   shows a plan view of the homogenising element in Fig. 2,

Fig. 4   shows a section in the region of the homogenising element

20   along the section line IV-IV in Fig. 2, and

Fig. 5   shows a part section through the static homogenising device in the region of homogenising elements according to a second embodiment.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preparation system 1, for preparing plastics materials, has a multi-shaft screw machine 2, downstream of which is arranged in a conveying

direction 3, a static homogenising device 4, a melt pump 5 and a granulating device 6. The screw machine 2 has a housing 7 made of a plurality of housing portions 8 to 12 arranged one behind the other and called housing sections. The housing portions 8 to 12, at their ends, in each

5   case have flanges 13, by means of which adjacent housing portions 8 to 12 are connected to one another to form the housing 7.

Formed in the housing 7 are two housing bores 14, 15, which are parallel to one another and penetrate one another and which have the shape of a

10   horizontal eight in cross section. The housing bores 14, 15 form a housing channel. Concentrically arranged in the housing bores 14, 15 are two treatment element shafts 16, 17, which can be rotatably driven in the same direction about associated rotational axes 19, 20 by a drive motor 18. A coupling 21 and a branching gearing 22 are arranged between the drive

15   motor 18 and the treatment element shafts 16, 17, one behind the other in the conveying direction 3.

A material feed 23 in the form of a funnel, through which plastics material to be prepared or plastics material melt to be prepared can be introduced

20   via a feed opening 24 into the housing bores 14, 15, is arranged on the first housing portion 8. The plastics material melt K located in the screw machine 2 is discharged at a downstream end of the housing 2 through a discharge opening 25, which is formed in a nozzle plate 26 closing the housing 7.

25

The screw machine 2, in the conveying direction 3, one after the other, has a feed zone 27, a melting zone 28, a mixing zone 29 and a pressure build-up zone 30. The treatment element shafts 16, 17 in each case have associated shafts 31, 32, on which treatment elements associated with one

another pair-wise in each case are non-rotatably arranged one behind the other in the conveying direction 3. First screw elements 33, 34 are non-rotatably arranged on the shafts 31, 32 as treatment elements in the feed zone 27. The first screw elements 33, 34 extend into the melting zone 28,

5   in which disc-shaped kneading elements 35, 36 adjoin as treatment elements. Sleeves 37, 38 are arranged on the shafts 31, 32 in the mixing zone 29. Second screw elements 39, 40 as treatment elements extending to the end of the pressure build-up zone 30, adjoin the sleeves 37, 38. The treatment elements 33 to 36, 39, 40 are configured to mesh tightly pair-

10   wise.

For the homogenisation of the plastics material melt K, the multi-shaft screw machine 2 has a homogenising element 41. As a result, the screw machine 2 is used as a homogenising device. The homogenising element

15   41 is static. The homogenising element 41 comprises a base plate 42, which is fastened between the housing portions 10, 11. The base plate 42 extends, starting from the housing 7, into the housing bores 14, 15 and to guide the shafts 31, 32 through as well as the sleeves 37, 38 arranged thereon, has two shaft through-openings 43, 44. The homogenising element

20   41 forms a plurality of flow channels, which are individually designated S_1 to S_n, n designating the number of flow channels. The flow channels S_1 to S_n are formed by associated tubes R_1 to R_n, which are fastened in associated through-openings 45 in the base plate 42. The flow channels S_1 to S_n run linearly and parallel to one another in a channel longitudinal

25   direction 46. The channel longitudinal direction 46 runs parallel to the conveying direction 3.

The flow channels S_1 to S_n in each case have an associated length L_1 to L_n in the channel longitudinal direction 46 and an associated cross sectional

area A_1 to A_n and an associated cross sectional shape Q_1 to Q_n transverse to the channel direction 46. According to the invention, at least some of the flow channels S_1 to S_n differ with respect to at least one feature from the group length L_1 to L_n, cross sectional area A_1 to A_n and cross sectional

5   shape Q_1 to Q_n.

The flow channels S_1 to S_n have at least i different lengths L, wherein i designates the number of different lengths L. There applies to i: $2 \leq i \leq n$, in particular $3 \leq i \leq n$, and, in particular, $4 \leq i \leq n$. As shown in Fig. 2, the

10   lengths L_1, L_2 and L_n are, for example, different. The flow channels S_1 to S_n end flush at their downstream open side, in other words downstream in the conveying direction 3 or in the channel longitudinal direction 46. In contrast, the flow channels S_1 to S_n end offset from one another at their upstream open side, in other words upstream from the conveying direction

15   3 or the channel longitudinal direction 46, if the flow channels S_1 to S_n differ with respect to their lengths L_1 to L_n.

The flow channels S_1 to S_n, in the channel longitudinal direction 46, have a maximum length L_{max} and a minimum length L_{min}. In Fig. 2, the flow

20   channel S_1 by way of example has the maximum length $L_{max} = L_1$ and the flow channel S_2 has the minimum length $L_{min} = L_2$. There applies to the ratio of the maximum length L_{max} to the minimum length L_{min}: $L_{max} / L_{min} \geq$ 1.2, in particular $L_{max} / L_{min} \geq 1.6$, and, in particular, $L_{max} / L_{min} \geq 2$. Moreover, there applies to the minimum length L_{min} and/or the maximum

25   length L_{max}: $L_{min} \geq 10$ mm, in particular $L_{min} \geq 30$ mm, and, in particular, $L_{min} \geq 50$ mm, and/or $L_{max} \leq 500$ mm, in particular $L_{max} \leq 300$ mm, and, in particular, $L_{max} \leq 100$ mm.

The flow channels S_1 to S_n have j different cross sectional areas A, wherein j designates the number of different cross sectional areas A. There applies to j: $2 \leq j \leq n$, in particular $3 \leq j \leq n$, and, in particular $4 \leq j \leq n$. The cross sectional areas A_1 to A_n have a maximum cross sectional area A_{max} and a minimum cross sectional area A_{min}. In Fig. 4, the cross sectional area A_3 of the flow channel S_3 by way of example has the maximum cross sectional area A_{max} and the cross sectional area A_4 of the flow channel S_4 has the minimum cross sectional area A_{min}. There applies to the ratio of the maximum cross sectional area A_{max} to the minimum cross sectional area A_{min}: $A_{max} / A_{min} \geq 1.2$, in particular $A_{max} / A_{min} \geq 1.6$, and, in particular $A_{max} / A_{min} \geq 2$. Furthermore, there applies to the minimum cross sectional area A_{min} and/or the maximum cross sectional area A_{max}: $A_{min} \geq 5$ mm^2, in particular, $A_{min} \geq 10$ mm^2, and, in particular $A_{min} \geq 15$ mm^2 and/or $A_{max} \leq 1600$ mm^2, in particular $A_{max} \leq 800$ mm^2 and, in particular, $A_{max} \leq 600$ mm^2.

Furthermore, the flow channels S_1 to S_n have k different cross sectional shapes Q, wherein k designates the number of different cross sectional shapes Q. To k there applies: $2 \leq k \leq n$, in particular $3 \leq k \leq n$, and, in particular $4 \leq k \leq n$. The cross sectional shapes Q of the flow channels S_1 to S_n are selected from the group round, oval, drop-shaped and polygonal. The polygonal cross sectional shapes Q are, in particular, selected from the group triangular, quadrangular, pentagonal and hexagonal. Fig. 4 by way of example shows round, drop-shaped and oval cross sectional shapes Q, wherein, for example, the cross sectional shape Q_1 is round and the cross sectional shape Q_3 is oval.

Downstream of the homogenising element 41, a free space or mixing space 47 is formed in the mixing zone 29 between the housing portion 11 and the

sleeves 37, 38. Moreover, the housing 7 has a degassing opening 48 downstream of the homogenising element 41.

The static homogenising device 4 is arranged downstream of the screw machine 2 in the conveying direction 3. The homogenising device 4 has a housing 49, in which is formed a housing channel 50 for the plastics material melt K, said channel running in the conveying direction 3. The housing channel 50 has a feed opening 60 and a discharge opening 61 for the plastics material melt K. Furthermore, formed in the housing 49 is a guide bore 51 crossing the housing channel 50 and running transversely to the conveying direction 3. Arranged in the guide bore 51 is a slide element 52, which can be displaced transverse to the conveying direction 3 by means of an actuating drive 53. The actuating drive 53 is, for example, hydraulic or electromechanical and is merely indicated in Fig. 5.

Two continuous receiving openings 54, 55, in which a static homogenising element 56, 57 is mounted in each case, are formed in the slide element 52. The receiving openings 54, 55 are spaced apart transversely to the conveying direction 3 in such a way that, in each case, one of the homogenising elements 56, 57 is located outside the housing 49 when the respective other homogenising element 56, 57 is located in the housing channel 50.

The homogenising elements 56, 57 in each case have a base plate 58, in which, corresponding to the homogenising element 41, a plurality of flow channels S_1 to S_n are formed. The flow channels S_1 to S_n, in a channel longitudinal direction 59, have associated lengths L_1 to L_n and, transverse to the channel longitudinal direction 59, have associated cross sectional areas A_1 to A_n and associated cross sectional shapes Q_1 to Q_n. According to

the invention, at least some of the flow channels S_1 to S_n differ with respect to at least one of the features from the group length L_1 to L_n, cross sectional area A_1 to A_n and cross sectional shape Q_1 to Q_n. The homogenising elements 56, 57 have, as shown by way of example in Fig. 5, in particular

5   polygonal cross sectional shapes Q. The different lengths L of the flow channels S_1 to S_n were produced, for example, by removing the base plate 58 in part regions. With regard to the further features, reference is made to the homogenising element 41. The homogenising elements 56, 57 may be identical or different with respect to their flow channels S_1 to S_n.

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The melt pump 5 is basically known with respect to the structure and, for example, configured as a gear pump. The melt pump 5 is used to increase the melt pressure for the downstream granulating device 6. The granulating device 6 is also known with respect to the structure and, for example,

15   configured as an underwater granulating device.

The mode of functioning of the preparation system 1 will be described below:

20   The preparation system 1 is used to prepare and homogenise plastics material melts K. The plastics material melts K have, in particular, constituents with different viscosities. For example, these plastics material melts K are bimodal polymer melts, which are difficult to mix and homogenise and contain undesired gels.

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To produce the plastics material melt K, plastics material is fed in a conventional manner through the feed opening 24 into the feed zone 27 of the screw machine 2. The plastics material is conveyed in the conveying

direction 3 to the melting zone 28 and melted there to form the plastics material melt K.

The plastics material K is then conveyed to the mixing zone 29 and fed to the homogenising element 41. Owing to the forced conveyance, the plastics material melt K flows through the homogenising element 41, the plastics material melt K being divided because of the flow channels S_1 to S_n into corresponding part streams T_1 to T_n. The part streams T_1 to T_n flow through the flow channels S_1 to S_n, wherein the flow ratios in the individual flow channels S_1 to S_n differ from one another because of the different lengths L and/or the different cross sectional areas A and/or the different cross sectional shapes Q. This leads to the fact that the part streams T_1 to T_n at the downstream outlet of the homogenising element 41 have different flow profiles and/or different flow speeds v_1 to v_n. This is illustrated by way of example in Fig. 2, in which flow profiles with flow speeds v_1 to v_n of the part streams T_1, T_2 and T_n are shown.

A uniform flow is adjusted again in the following free space 47 of the mixing zone 29, so that the plastics material melt K or its part streams T_1 to T_n, on transition to a uniform flow, is subjected to an expansion and shearing. Expansion and shearing forces, which lead to a homogenisation of the plastics material melt K, therefore act on the part streams T_1 to T_n. In the conveying direction 3, the free space 47 has a length L_F. There applies to the length L_F, in relation to a maximum dimension D of the flow channels S_1 to S_N, transverse or perpendicular to the conveying direction 3: $L_F \geq 0.5 \cdot D$, in particular, $L_F \geq 2 \cdot D$ and, in particular, $L_F \geq 4 \cdot D$.

Owing to the differently formed flow channels S_1 to S_n, an associated differential pressure p_1 to p_n of the part streams T_1 to T_n from the inlet to

the associated outlet of the respective flow channel S_1 to S_n is different.
These different differential pressures p_1 to p_n lead on the outlet side to the
different flow profiles and flow speeds v_1 to v_n, so, during the transition to
the common flow or the common flow profile, the expansion and shearing

5   and, correspondingly, homogenisation of the plastics material melt K take
place. The difference between the differential pressures p_1 to p_n is all the
greater, the greater the ratio L_{max}/L_{min} and/or A_{max}/A_{min}.

Viewed absolutely, the differential pressures p_1 to p_n are comparatively

10   small, however, because of the overall large free cross sectional area
$A_1 + ... + A_n$ so the homogenising element 41 overall leads to a small
pressure loss of the plastics material melt K. Owing to different cross
sectional shapes Q and because of the wall adhesion of the plastic material
melt K, different flow profiles and flow speeds v_1 to v_n can be produced.

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Volatile constituents can escape through the degassing opening 48 during
the homogenisation. The homogenised plastics material melt K is then
conveyed to the pressure build-up zone 30 and discharged there through the
discharge opening 25 from the screw machine 2 and fed to the static

20   homogenising device 4. A homogenisation of the plastic material melt K
takes place again there, in that the latter flows through one of the
homogenising elements 56, 57. With regard to the mode of functioning of
the homogenising elements 56, 57, reference is made to statements on the
homogenising element 41. In a different configuration of the homogenising

25   elements 56, 57, depending on the type of plastics material melt K, a
suitable homogenising element 56, 57 can be selected, in that by means of
the actuating drive 53, the slide element 52 is displaced transverse to the
conveying direction 3 and the desired homogenising element 56, 57 is
arranged in the housing channel 50.

The features of the homogenising elements 41, 56, 57 and the associated homogenising devices 2, 4 can be combined with one another as desired to achieve a desired homogenising effect.

5

WHAT IS CLAIMED IS

1. A device for the homogenisation of plastics material melts, comprising
   - a housing (7; 49),
   - at least one housing channel (14, 15; 50) for a plastics material
     melt (K) to be homogenised,
     -- which is formed in the housing (7; 49) and
     -- which extends from a feed opening (24; 60) to a discharge
        opening (25; 61),
   - at least one homogenising element (41; 56, 57) comprising a
     plurality of flow channels (S_1 to S_n) for the plastic material melt
     (K) to be homogenised,
     -- wherein each of the flow channels (S_1 to S_n) has a length (L_1 to
        L_n) defined in a channel longitudinal direction (46) and a cross
        sectional area (A_1 to A_n) defined transverse to the channel
        longitudinal direction (46) and a cross sectional shape (Q_1 to
        Q_n),
     -- wherein at least some of the flow channels (S_1 to S_n) differ
        with respect to at least one feature from the group length (L_1 to
        L_n), cross sectional area (A_1 to A_n) and cross sectional shape
        (Q_1 to Q_n),
     -- wherein the at least one homogenising element (41; 56, 57) is
        arranged between the feed opening (24; 60) and the discharge
        opening (25; 61).

2. A device according to claim 1,
   wherein the flow channels (S_1 to S_n) have at least two different lengths
   (L).

3. A device according to claim 1,

   wherein there applies to the ratio of a maximum length L_{max} to a

   minimum length L_{min} of the flow channels (S_1 to S_n): $L_{max}/ L_{min} \geq 1.2$.

5 4. A device according to claim 1,

   wherein there applies to at least one of a minimum length L_{min} of the

   flow channels (S_1 to S_n): $L_{min} \geq 10$ mm, and a maximum length L_{max} of

   the flow channels (S_1 to S_n): $L_{max} \leq 500$ mm.

10 5. A device according to claim 1,

   wherein the flow channels (S_1 to S_n) end flush at an open side.

6. A device according to claim 1,

   wherein the flow channels (S_1 to S_n) end flush at a side that is

15   downstream in relation to a conveying direction (3) of the plastics

   material melt (K).

7. A device according to claim 1,

   wherein the flow channels (S_1 to S_n) end offset at an open side.

20

8. A device according to claim 1,

   wherein the flow channels (S_1 to S_n) end offset at a side that is

   upstream in relation to a conveying direction (3) of the plastic material

   melt (K).

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9. A device according to claim 1,

   wherein the flow channels (S_1 to S_n) have at least two different cross

   sectional areas (A).

10. A device according to claim 1,

   wherein there applies to the ratio of a maximum cross sectional area A_{max} to a minimum cross sectional area A_{min} of the flow channels (S_1 to S_n): $A_{max}/A_{min} \geq 1.2$.

5

11. A device according to claim 1,

   wherein there applies to at least one of a minimum cross sectional area A_{min} of the flow channels (S_1 to S_n): $A_{min} \geq 5$ mm^2, and a maximum cross sectional area A_{max} of the flow channels (S_1 to S_n): $A_{max} \leq 1600$

10   mm^2.

12. A device according to claim 1,

   wherein the flow channels (S_1 to S_n) have at least two different cross sectional shapes (Q) .

15

13. A device according to claim 1,

   wherein the at least one cross sectional shape (Q) of the flow channels (S_1 to S_n) is selected from the group round, oval, drop-shaped and polygonal.

20

14. A device according to claim 1,

   wherein the flow channels (S_1 to S_n) run linearly in a channel longitudinal direction (46).

25 15. A device according to claim 1,

   wherein the flow channels (S_1 to S_n) run parallel to one another.

16. A device according to claim 1,

wherein the flow channels (S_1 to S_n) run parallel to a conveying direction (3) of the plastics material melt (K).

17. A device according to claim 1,

wherein the device is configured as a screw machine (2), wherein at least one treatment element shaft (16, 17) is arranged in the at least one housing channel (14, 15), the treatment element shaft (16, 17) being rotatably drivable about an associated rotational axis (19, 20), wherein the at least one treatment element shaft (16, 17) comprises at least one shaft (31, 32) on which treatment elements (33, 34, 35, 36, 39, 40) are non-rotatably arranged consecutively, wherein the at least one homogenising element (41) extends in the at least one housing channel (14, 15) and is passed through by the at least one treatment element shaft (16, 17).

18. A device according to claim 17,

wherein the device is configured as a multi-shaft screw machine (2).

19. A device according to claim 17,

wherein the at least one homogenising element (41) is rigidly connected to the housing (7), wherein the at least one homogenising element (41) comprises a base plate (42) which is fastened between housing portions (8, 9, 10, 11, 12) of the housing (7).

20. A device according to claim 17,

wherein downstream of the at least one homogenising element (41), a mixing zone (29) is formed in which no treatment elements are arranged on the at least one shaft (31, 32) .

21. A device according to claim 20,

   wherein at least one sleeve (37, 38) is arranged on the at least one shaft
   (31, 32) in the mixing zone (29).

5 22. Device according to claim 1,

   wherein the device is static, wherein the housing (49) forms a guide
   bore (51) running transversely to the conveying direction (3) and
   crossing the housing channel (50), a slide element (52) being arranged
   in the guide bore (51) that is displaceable in a direction transverse to
10   the conveying direction (3) by means of an actuating drive (53).

23. Device according to claim 22,

   wherein two continuous receiving openings (54, 55) are formed in the
   slide element (52), with a homogenising element (56, 57) being
15   mounted in each of said receiving openings (54, 55).

24. Method for the homogenisation of plastics material melts, comprising
   the following steps:
   - providing a device (2; 4) according to claim 1 and a plastics
20   material melt (K),
   - conveying the plastic material melt (K) in a conveying direction
      (3) to at least one homogenising element (41; 56, 57),
   - flowing through the at least one homogenising element (41; 56,
      57), in that the plastics material melt (K) is divided into a plurality
25   of part streams (T_1 to T_n) and the part streams (T_1 to T_n) flow
      through a respective associated flow channel (S_1 to S_n) and on
      leaving the respective flow channel (S_1 to S_n) have different flow
      speeds (v_1 to v_n),

- establishing a uniform flow of the plastics material melt (K) downstream of the at least one homogenising element (41; 56, 57) such that an expansion and shearing of the part streams (T_1 to T_n) takes place.

5

ABSTRACT OF THE DISCLOSURE

A device, to homogenise plastics material melts, has a homogenising element with a plurality of flow channels, which differ with respect to at

5   least one feature from the group length, cross sectional area and cross sectional shape. When flowing through the homogenising element, the plastics material melt is divided into a plurality of part streams, which, in each case, flow through an associated flow channel. When leaving the respective flow channel the part streams have different flow speeds so the

10   plastics material melt is expanded and sheared on transition to a uniform flow. As a result, a homogenisation of the plastics material melt takes place in a simple, efficient and effective manner.