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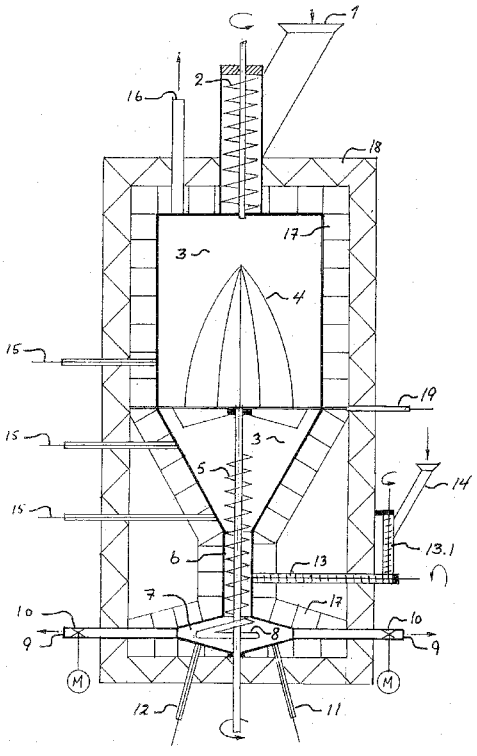
(54) Title: METHOD AND DEVICE FOR PRODUCING FOAMED GLASS UNDER PRESSURE



(57) Abstract: A method and a device for producing foamed glass are described, where glass/cullet is introduced into a melting chamber (3) using a feed screw (2) and molten glass is passed into the extrusion chamber (7) by the feed screw (5) through the feed housing / tube (6) for subsequent extrusion, where foaming agent or an expansion additive is supplied under positive pressure by feed screw (13) and (13.1) and mixed with molten glass in the introduction phase of the extrusion chamber (7) by the feed screw (5) and finally mixed by mixer (8) prior to expansion of foamed glass through adjustable nozzles (10) for cooling.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

METHOD AND DEVICE FOR PRODUCING FOAMED GLASS UNDER PRESSURE

The invention relates to the production of foamed glass based on the extrusion principle, and, more specifically, it relates to a method as disclosed in the preamble of independent claim 1, and a device as disclosed in independent claim 3.

Production methods for foamed glass using extrusion techniques are previously known. See, for example, US Patents 2 322 581 and 2 255 238.

The production of foamed glass by extrusion has major advantages, which separate tests have shown, and is described in the Applicant's NO Patent Application Nos. 97 4760 and 2002 21350.

The inventor has also established through tests that major problems relate to varying product quality and high costs.
To the best of the inventor's knowledge, none of these problems have been solved in an adequate or satisfactory manner, and it is assumed that this has been a contributing factor to the failure of known extrusion processes for producing foamed glass to achieve satisfactory success.

The object of the invention is to remedy the defects of the known techniques, and this is achieved by means a method and a device of the type mentioned above, which are characterised by the features disclosed in the characterising clause of the respective independent claims.

Advantageous embodiments of the invention are disclosed in the dependent claims.

In an extrusion process of the type in question, expansion or foaming agent is added to molten glass under pressure in a heat range that is optimal for the process.

The invention provides the option of a device for feed-in of expansion or foaming agent into an extrusion chamber with molten glass under pressure in the extrusion process.

Glass is fed into the melting chamber by a feed screw or similar device and is melted in the melting furnace to an optimal temperature for the process.

According to the invention, a device is also provided that is of importance for supplying thermal energy in the centre of the melting furnace.

The invention makes it possible to provide an arrangement of a feed screw or similar device which is located in a chamber in the extension of the melting chamber and constitutes a container in which molten glass is mixed with expansion or foaming agent and passed into the extrusion chamber, which has an optimal form for the final mixing step in the mixing process.

The invention relates to a device where feed-in of expansion or foaming agent is handled by a feed screw or similar device which will displace the back pressure from the molten glass and permit mixing under pressure through to the extrusion chamber outlet.

According to the invention, there are nozzles provided in the outlet of the extrusion chamber, which are essential to the control of the production process. In an especially advantageous manner, process-controlled valves are used to adjust the nozzle orifice and thus the quality of the foamed glass product and the magnitude of the volume flow which expands through the nozzle. Tests have shown that by increasing or decreasing the pressure in the extrusion chamber, the size of the air voids in the end product, the foamed glass, will also vary correspondingly, giving corresponding variation in the density of the product. The pressure in the mixing chamber, in one of several variants, can be provided by calculation of height of the glass column containing liquid glass.

The invention will now be described with reference to the drawing, which shows the whole extrusion unit without external connections.

Reference numeral 1 indicates a device for introducing glass into the melting chamber;

2 indicates a feed screw for feeding glass to the melting chamber;

3 indicates a melting chamber for glass;

4 indicates an internal heat source with a profile or shape which provides efficient heat transfer and optional stirring of molten glass;

5 indicates a feed screw / mixer for molten glass and expansion or foaming agent;

6 indicates a feed housing / tube for the feed screw;

7 indicates a mixing chamber / extrusion chamber;

8 indicates a beater / mixer in the extrusion chamber;

9 indicates outlet pipes from the extrusion chamber;

10 indicates adjustable nozzles / nozzle orifices, which are handled by automatic control;

11 indicates a sensor for recording zone temperature in the molten mass and / or the extruder;

12 indicates a pressure sensor for the extrusion chamber;

13 indicates a feed screw for expansion or foaming agent;

13.1 indicates a feed screw that is angled up towards an adjacent feed screw;

14 indicates a device for introducing expansion or foaming agent into the feed screw;

15 indicates sensors for recording zone temperatures in the molten mass and / or the melting chamber;

16 indicates an outlet pipe / safety valve for any gases that may be produced in the chamber;

17 indicates heating elements which supply heat to the melting chamber / mixing chamber / extrusion chamber;

18 indicates external insulation of the extruder unit;

19 indicates a pressure sensor for the melting chamber;

The drawing shows a device 1 for introducing glass into the feed screw 2 which then passes the glass into the melting chamber 3. Here, the glass is supplied with heat energy from the heat sources / heating elements 17 and the internal heat source 4 that melts the glass which is passed by the feed screw 5 into the feed housing / tube 6 that is surrounded by heating elements 17.

In the area within the feed housing / tube 6, the feed screw 13 has its outlet and here expansion or foaming agent is introduced through the feed screws or the like 13 and 13.1, which must have a favourable geometric location that allows them to provide a pre-determined pressure in relation te the pressure in the extrusion chamber 7 with access to expansion or foaming agent through the introduction device 14.

When the feed screw 5 is rotated, it draws with it molten glass which passes the outlet from the feed screw 13, where molten glass and expansion or foaming agent flow together and start a mixing process under pre-determined pressure through to the extrusion chamber 7, where the mixture is given a final stirring by the mixer 8 as it moves towards the outlets 9 through an adjustable outlet nozzle 10, where the expansion takes place and the mixture in the extrusion chamber 7 becomes foam that is cooled from a liquid state into a solid form as the product, foamed glass, is formed.

Sensors 11 and 12 record the temperature and the pressure in the extrusion chamber 7, which are of major importance for process control.

The melting chamber 3 has sensors 15, which sense and record the zone temperature, and sensor 19, which senses and records the zone pressure. All information about the process is of crucial importance for process control and the end product.

The purpose of the outlet pipe 16 is to release gases which may be produced during the melting process in the melting chamber 3 and also to be able to evacuate undesired pressure.

The extrusion chamber 7 outlet pipe 9, feed housing / tube 6 and heating chamber 3 with internal heating profile / stirrer 4 are produced of heat resistant material and are surrounded by heating elements 17 which, together with the internal heating profile 4, are controlled by the sensors / thermostats 15 and 11 to a pre-determined temperature in the melting chamber 3 and in the extrusion chamber 7 with separate pressure sensor 12

To prevent energy loss from the melting chamber 3, the feed housing 6, the outlet pipe 9, feed screw 13 and the extrusion chamber 7, where the temperature lies within the melting temperature for glass, there is provided suitable external insulation 18 in the form of a "frame" for the production unit.

A detailed description of an embodiment of the invention has been given above, and many modifications will be possible. For example, the production unit according to the invention could easily be provided as a production battery consisting of a row of cells arranged in parallel. The invention is thus not limited to the illustrated embodiment, but includes all modifications and equivalents which fall within the scope defined by the following patent claims.

PATENT CLAIMS

1. A method for producing foamed glass, comprising introducing glass into a heating chamber (3) where it is heated until the glass melts and then passing the molten glass via a feed tube or feed housing (6) into an extrusion chamber (7) for subsequent extrusion through an outlet (9),
characterised in that a foaming agent or expansion agent is added under positive pressure to the molten glass in the feed tube or feed housing (6), that the molten glass in the extrusion chamber (7) is under positive pressure, and that the molten glass is extruded through outlets (9) to an area having atmospheric pressure so that expansion is started in the glass which results in the formation of foamed glass containing voids.

2. A method according to claim 1,
characterised in that the glass is introduced into the heating chamber (3) with the aid of a feed screw (2).

3. A method according to claims 1 or 2,
characterised in that the foaming agent or an expansion additive is introduced into feed tube or feed housing (6) with the aid of a feed screw (13 / 13.1).

4. A method according to one of claims 1 - 3,
characterised in that the positive pressure in the extrusion chamber (7) is obtained in that the heating chamber (3), feed tube or feed housing (6) and the extrusion chamber (7) are arranged vertically, such that a glass column of liquid glass is formed, and that the height of the glass column forms the pressure in the extrusion chamber (7).

5. A method according to one of claims 1 - 4,
characterised in that a rotating feed screw (5) is arranged in the feed tube or feed housing (6), which feed screw (5) ensures the mixing of the liquid glass and foaming agent or expansion additive in the feed tube or feed housing (6) and the feeding of the liquid glass / foaming agent mixture through the feed housing / tube (6) to extrusion chamber (7).

6. A method according to claim 5,
characterised in that a beater or mixer (8) is arranged in the extrusion chamber (7) and in connection with the rotating feed screw (5).

7. A method according to one of claims 1 - 6,
characterised in that nozzles (10) are provided at the outlet (9) which are adjustable and connected to programmed process control with sensitive automatic control in order to control desired quality of the foamed glass that is formed at the outlet (9).

8. A method according to one of claims 1 - 7,
characterised in that a substance is added during the melting process which alters viscosity so as to provide a favourable mixing process for liquid glass and foaming agent or expansion additive under positive pressure.

9. A method according to one of claims 1 - 8,
characterised in that the glass is heated in the heating chamber (3) with the aid of a rotatable heating element (4).

10. A method according to claim 9,
characterised in that the glass, in addition, is heated in the heating chamber (3), feed tube or feed housing (6) and the extrusion chamber (7) with the aid of surrounding heating elements (17).

11. A method according to claim 10,
characterised in that the rotational speed and temperatures of heating element (4) are controlled by programmed process control so as to obtain the optimal flow rate of molten glass required in order to maintain a continuous production process.

12. A method according to one of claims 2 - 11,
characterised in that the pressure is provided in that feed screw (2) or a similar device displaces the back pressure from the molten glass and allows mixing under pressure through to the extrusion chamber outlet.

13. A method according to claims 4 - 12,
characterised in that the pressure is adjusted by height adjustment of the glass column.

14. A method according to one of claims 1 - 13,
characterised in that the size of the voids in the foamed glass are adjusted by increasing or decreasing the pressure in the extrusion chamber.

15. A device for producing foamed glass, comprising a heating chamber (3) arranged to receive and melt glass, an extrusion chamber (7) which receives molten glass from the heating chamber (3), means for adding a foaming agent or an expansion additive to the molten glass, and an outlet (9) for discharging the molten glass mixture such that foamed glass is formed,
characterised in that the device comprises means for adding a positive pressure to the molten glass in the extrusion chamber (7), a feed tube or feed housing (6) arranged between the heating chamber (3) and the extrusion chamber (7), and means for adding

the foaming agent or an expansion additive under pressure to the molten glass in the feed tube or feed housing (6).

16. A device according to claim 15,
characterised in that the heating chamber (3), feed tube or feed housing (6) and the extrusion chamber (7) are arranged vertically, thereby forming a glass column of liquid glass, and that the height of the glass column forms the pressure in the extrusion chamber (7).

17. A device according to one of claims 15 - 16,
characterised in that a feed screw (2) is provided to introduce the glass into the heating chamber (3).

18. A device according to one of claims 15 - 17,
characterised in that a feed screw (137 13.1) is provided to introduce the foaming agent or expansion additive into the feed tube or feed housing (6).

19. A device according to one of claims 15 - 18,
characterised in that a rotating feed screw (5) is arranged in the feed tube or feed housing (6), which feed screw (5) ensures the mixing of the liquid glass and foaming agent or expansion additive in the feed tube or feed housing (6) and the feeding of the liquid glass / foaming agent mixture through the feed housing / tube (6) to the extrusion chamber (7).

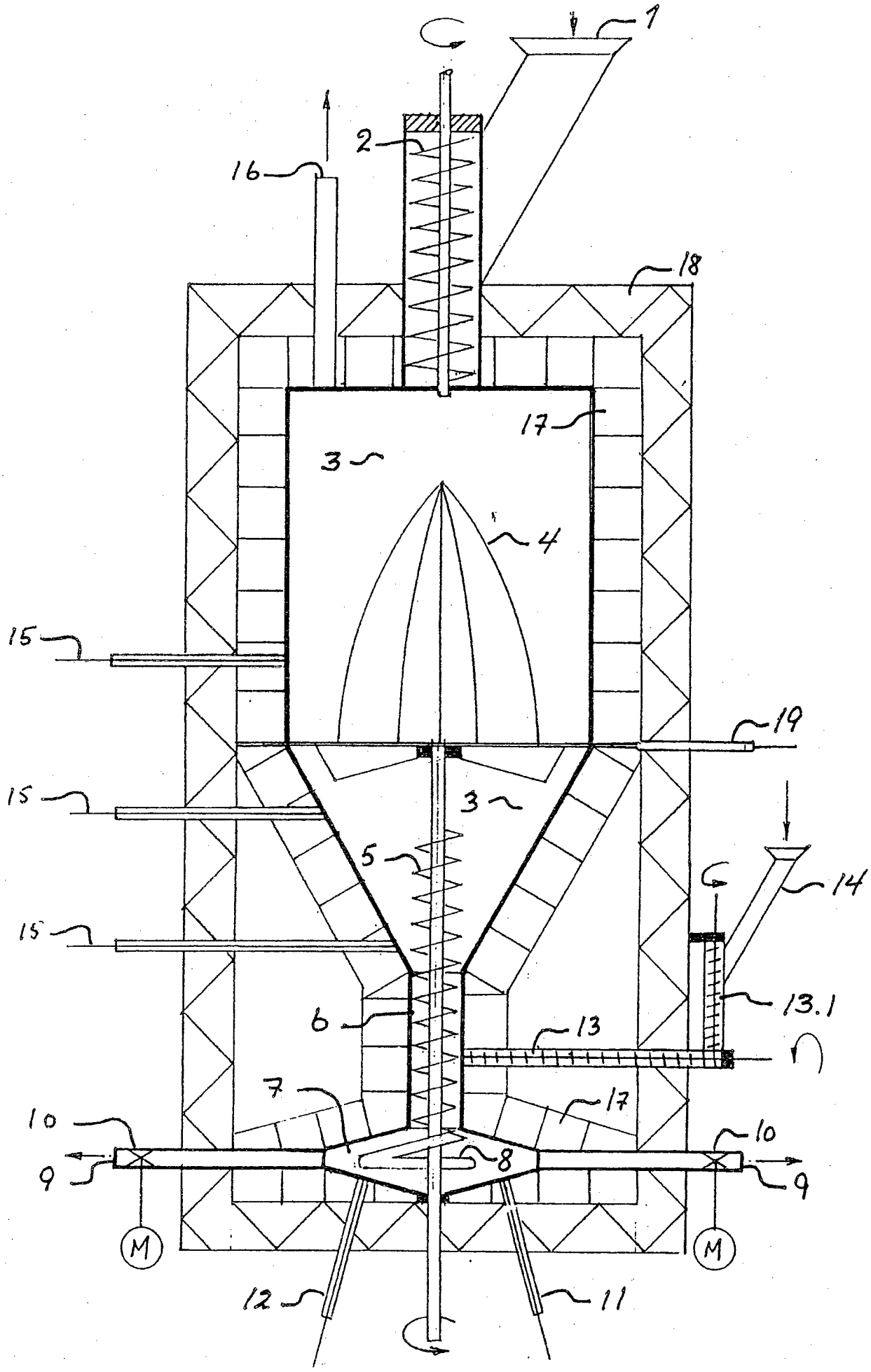
20. A device according to claim 19,
characterised in that a beater or mixer (8) is arranged in the extrusion chamber (7) and in connection with the rotating feed screw (5).

21. A device according to one of claims 15 - 20,
characterised in that at nozzles (10) are provided the outlet (9) which are adjustable and connected to programmed process control with sensitive automatic control in order to control desired quality of the foamed glass that is formed at the outlet (9).

22. A device according to one of claims 15 - 21,
characterised in that a heating element (4) is provided in the heating chamber (3).

23. A device according to one of claims 15 - 22,
characterised in that the heating chamber (3), extrusion chamber (7) and the feed tube or feed housing (6) are surrounded by heating elements (17).

24. A device according to one of claims 15 - 23, characterised in that the device is surrounded by an insulating outer wall (18).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INTERNATIONAL SEARCH REPORT

International application No
PCT/NO2011/000013

A. CLASSIFICATION OF SUBJECT MATTER
INV. C03B19/08
ADD.

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)
C03B C03C

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 practical, 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.
X	US 2 215 223 A (LYTLE WILLIAM O) 17 September 1940 (1940-09-17) page 1, left column, line 36 - page 2, left column, line 8claim 1; figure 1	1-24
A	US 3 628 937 A (SCHOTT LAWRENCE A) 21 December 1971 (1971-12-21) claim 1; figure 1	1,6, 15, 20
A	US 2 354 807 A (FOX JOHN H ET AL) 1 August 1944 (1944-08-01) page 1, left column, line 47 - page 1, right column, line 5figure 1	1, 15
A	US 3 574 583 A (GOLDSMITH AARON) 13 April 1971 (1971-04-13) column 2, line 43 - column 3, line 65; figure 1	1,4, 15, 16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 May 2011	31/05/2011

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NO2011/000013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2215223 A	17-09-1940	NONE	
US 3628937 A	21-12-1971	NONE	
us 2354807 A	01-08-1944	NONE	
us 3574583 A	13-04-1971	NONE	