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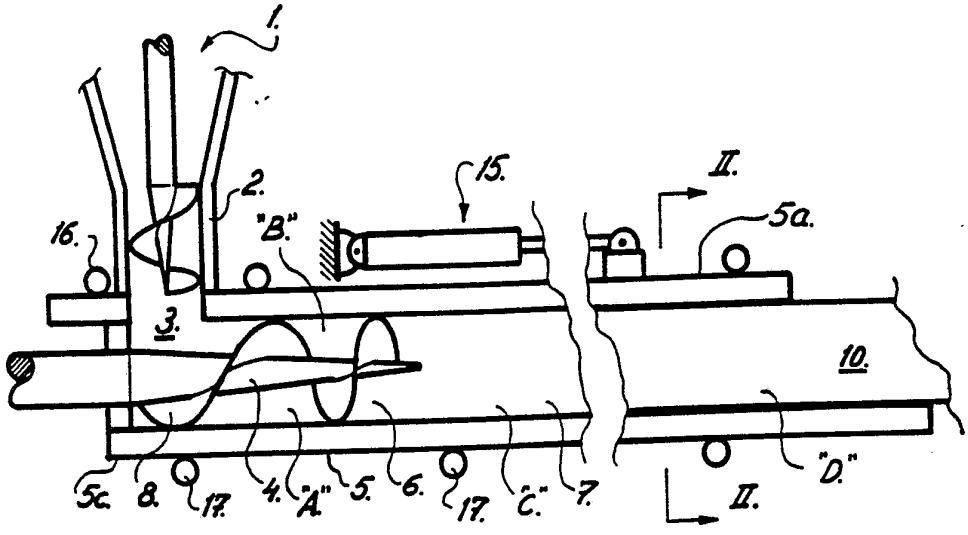
(54) Title: A METHOD FOR MANUFACTURING AN ELONGATED MEMBER AND APPARATUS FOR CARRYING OUT THE METHOD



(57) Abstract

The invention relates to a method and an apparatus for the continuous manufacture of an elongated member (10) from compressible material. A plastics material is delivered to a space (3) and there subjected to compression. The compressed material is pressed to a further space (7), defined by a matrix (5), where the material (10) is able to solidify. The matrix (5) has reciprocatingly movable walls. At least part of the thermal energy required to bring the plastics material to a tacky or molten state is generated by controlling the speed of a screw-feeder (4) forming part of the compression device.

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TITLE OF THE INVENTION: A method for manufacturing an elongated member and apparatus for carrying out the method

TECHNICAL FIELD

The present invention relates primarily to a method of manufacturing an elongated member, and in particular to a method in the continuous manufacture of an elongated member from a compressible and compressed starting material.

The invention also relates to apparatus for the continuous manufacture of an elongated member with the use of compressible starting material.

The invention also relates to the use of a plastics material, particularly a plastics-material mixture as the compressible material.

BACKGROUND PRIOR ART

Various methods and apparatus are known for the manufacture of elongated members or organs, these methods and apparatus being adapted to the material from which the elongated member is produced.

An example of the prior state of the art is found in International Patent Application No. PCT/SE84/00303, which teaches an apparatus for the manufacture of an elongated member in which a compression device located in a compression section is operative to displace and compact sequential, well-defined and binder-moistened

material batches, and in which the compacted, individual batches are passed sequentially through a high-frequency heating section.

A further example of the apparatus and methods known to the art is found in Swedish Patent Specification 415 547 (Swedish Patent Application 7809708-4), which teaches an apparatus in which the wall sections of the heating section are reciprocatingly movable in a horizontal direction and function, partially, as a means for transporting compacted material batches.

In each of the aforesaid cases, the elongated member is produced from separate, well-defined batches which are mutually separated by an interface or boundary region of mutually different degrees of compression and in which the fibre directions are also displaced relative to one another, to a certain extent, in the vertical plane. Hardening takes place in a heating section.

Swedish Patent Application 8804156-1 describes a method and apparatus for manufacturing an elongated member from a mixture of a plastics material and a filler, such as wood fibres, textile fibres and the like, by compacting the mixture when the plastics material is in a molten state.

SUMMARY OF THE INVENTION

TECHNICAL PROBLEMS

A study of the prior art within this technical field will reveal that a particularly challenging technical problem arises in the provision of a method and an apparatus by means of which an elongated member can be

manufactured continuously in a simple and inexpensive manner, without the need of compacting separate batches of material, and where the elongated-member material is hot and comprises a compressible material, such as a mixture of plastics material and filler, and which will enable the material to be cooled and therewith create conditions by means of which the temperature can be controlled readily in the compression section.

A particularly challenging technical problem also arises in realizing those advantages which are afforded when the temperature of the mixture can be controlled at the compression-section inlet, optionally with the aid of externally applied heat, and when the thermal energy generated by compression is utilized to soften and/or to melt the plastic content of the mixture, at least at the end of the compression section.

A particularly challenging technical problem also arises in realizing those advantages which are afforded when the heat generated in the compression section is controlled by controlling the speed of a screw-feeder located in the compression section, while taking into account prevailing production speeds.

A particularly challenging technical problem also arises in realizing that the aforesaid technical problems can be solved when the plastic content of the starting mixture is precompacted in a molten or heated state, and is then caused to solidify in a cooling section.

A particularly challenging technical problem also arises in the provision of means whereby the degree of compression necessary for this purpose can be achieved

with the aid of a simple screw-feeder provided with a helix of decreasing pitch, such that essentially the total necessary compression is effected in the screw-feeder itself.

A particularly challenging technical problem also arises in the provision of a simple matrix-mould which will embrace the elongated member during its manufacture, and with which only limited measures need be taken for the purpose of reducing the friction between the matrix mould and the elongated member during its manufacture, by moving one or more walls of the matrix backwards and forwards, and by providing a matrix which is so configured that the resultant elongated member will have a circular or rectangular cross-section, or some other suitable cross-section.

A particularly challenging technical problem also arises in the realization that the starting material may comprise waste material, where plastic material is of significance, and of realizing that the plastic material and filler should be mixed in appropriate proportions, particularly when the filler is a finely divided fibrous material, such as wood-fibre material, so as to obtain a mechanically strong elongated member.

A particularly challenging technical problem also arises in the ability to realize the possibility that when the filler comprises a wood-fibre material, such as wood chips (sawdust, cutter chips), and has been heat-dried in a preceding operation, the filler can be mixed with plastic material immediately after being dried, and the mixture further heated, when necessary, so as to convert the plastic content of the mixture to a

tacky or liquid state, prior to compacting the mixture and subsequent cooling thereof to form said elongated member.

A particularly challenging technical problem will also be seen to exist in the provision of a reciprocatingly movable matrix-mould which is contained in a heating section at one end thereof and in a cooling section at the other end thereof, and to realize that the infeed device must accompany the matrix in one direction of movement thereof.

Finally, a particularly challenging technical problem also arises in realizing those advantages that are afforded by the use of an extruder which comprises a speed-controlled screw-press.

SOLUTION

With the intention of solving one or more of the aforementioned technical problems, the present invention relates primarily to a method of manufacturing continuously an elongated member from compressible and compacted material.

The compressible material used comprises a mixture of plastics material and filler, and the mixture with its plastic content preferably in a molten state, is delivered to a first space and compacted therein. The compressed material is then pressed into another space, defined by a matrix mould, where the mixture is cooled so that the plastic content thereof will solidify.

In accordance with the present invention, the thermal energy generated during compression of the mixture is

adapted so that the temperature of the plastic material will be sufficiently high to soften, preferably melt said material.

In accordance with one advantageous embodiment of the invention, the mixture is compressed with the aid of a screw-feeder, by controlling the speed of the screw-feeder and/or providing the helix of the screw-feeder with a pitch which decreases towards the aforesaid second space, so as to achieve desired compression within the screw-feeder.

According to a further embodiment of the invention the mixture can be precompressed with the aid of a further screw-feeder, but preferably at different rotational speeds. In this case, the further screw-feeder will preferably rotate at a higher speed than the first mentioned screw-feeder.

It is also proposed that the precompression screw-feeder will be stationary in relation to one of the sections of said matrix, namely one end-part of the upper matrix-section.

For the purpose of obtaining a flexurily rigid elongated member, it is proposed that the plastic content of the plastic-material/filler mixture comprises between 20 and 60%, say between 30-50%, normally about 40% of the total material content.

The filler used is preferably a newly dried and heated fibrous material, whereas the plastics material used may be waste-plastic, domestic plastic waste or some like inexpensive material.

Means are preferably provided for cooling the part of the matrix located adjacent the extruder, preferably with the aid of water.

In accordance with one advantageous embodiment of the invention, the matrix is divided into sections, which are capable of being displaced synchronously or asynchronously in relation to one another, along the outer surfaces of the elongated member during the manufacture thereof.

The invention also relates to an apparatus for the continuous manufacture of an elongated member, this apparatus comprising a compression device having a rotatable shaft arranged concentrically with a matrix mould, and being operative to press the mixture through the matrix.

The apparatus also includes a precompressing device which delivers precompressed mixture to the compressing device.

The matrix sections embrace the elongated member during its manufacture, and one or more of the matrix sections are reciprocatingly movable. The precompressing device coacts with one section.

ADVANTAGES

Those advantages which may primarily be regarded as being characteristic of a method and apparatus according to the present invention are that possibilities are created in this way of enabling a mixture of filler and plastics material, with the plastics material prefer-

ably in a liquid state and constituting a smaller proportion of the mixture than the filler, and in which the plastic material is optionally admixed with a reinforcing material, such as a glass fibre material, to be pressed from a first heated space to an adjacent, colder second space located downstream of the first mentioned space, and to enable the elongated member to be manufactured with the aid of movable matrix sections from an inexpensive starting material and with low friction against the matrix walls, and therewith enabling the temperature of the plastics material to be controlled and maintained constant by the thermal energy generated by said compression.

This is achieved in the simplest manner by controlling the speed of a screw-feeder incorporated in the compression section in the form of an extruder.

The elongated member can be used as a nailing batten, in the manufacture of door and window frames or like structures, or can be cut into given, short lengths for use in the manufacture of loading pallets.

The primary characteristic features of a method for manufacturing an elongated member in accordance with the present invention are set forth in the characterizing clause of the following Claim 1, whereas the primary characteristic features of an apparatus for manufacturing such a beam are set forth in the characterizing clause of the following Claim 10.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail with reference to two preferred embodiments of apparatus

intended for the continuous manufacture of an elongated member from compressible and compressed material and with reference to the accompanying drawings, in which

Figure 1 is a side view, partially in section, of a first apparatus constructed in accordance with the invention;

Figure 2 is a simplified sectional view taken on the line II-II i Figure 1;

Figure 3 is a side view of a second embodiment of the inventive apparatus, which incorporates a compression section in the form of an extruder; and

Figure 4 illustrates schematically a nozzle mounted on the extruder and capable of being connected to a matrix, not shown in detail.

DESCRIPTION OF PREFERRED EMBODIMENTS

The reference 1 in Figure 1 identifies a known apparatus with which a plastics material can be mixed with a filler and/or a reinforcing material.

The apparatus shall be capable of enabling the plastics material to be heated and brought preferably to a molten state, and in all events, to a tacky state.

When the filling material comprises cut or shredded paper and the plastics material with which it is to be admixed is heated either to a molten or a tacky state, it is preferred that the proportion of plastics material contained in the mixture will be less than 50% and preferably about 10%. The normal value in this respect will preferably lie between 20 and 50%, say about 40%.

When the plastic material is polyethylene, it may be present in a proportion of 25-40%.

The apparatus 1 includes precompressing device in the form of a screw conveyor, by means of which a mixture A of plastics material and filler is fed to a first space 3, through a passage 2. The chamber 3 is conceived to be defined by the conically tapering shaft 4 and helix 8 of a further screw conveyor and also a tubular matrix 5 which embraces said conveyor. When leaving the passage 2, the material A exhibits a degree of precompression which is commensurate with the pressure exerted on the mixture as it moves through the passage 2. The mixture A is then compressed successively to a much greater degree of compression by the screw-conveyor and tubular matrix 5, and at a region referenced B downstream of the first space 3 the plastics material present in the mixture will be either in a molten or a tacky state.

As the mixture passes through the apparatus, in a direction to the right as seen in Figure 1, the plastics material solidifies gradually and when the mixture has reached the position referenced C, it is assumed that the plastics material, and thus also the elongated member, will be essentially solid, and that in all events the plastic/filler mixture will have been compressed to its final degree of compression when it reaches the region of the apparatus referenced D, so as to form a finished elongated member or organ.

As shown in Figure 1, the precompressed plastic/filler mixture is moved by means of the screw-feeder 4,8 from the region B, where the plastic material begins to solidify, through the tubular matrix 5 and into the beginning of a third space 7.

Compression of the mixture during its travel from region A to region B is effected with the aid of the screw-feeder 4, 8.The helix 8 of the screw-feeder has a pitch which decreases in a direction towards the third space 7, thereby providing the advantage that the mixture can be caused to have a predetermined degree of compression by the time it reaches the region B, due to the successive decrease in the pitch of the helix 8.

The screw-feeder, comprising the conically tapering shaft 4 and helix 8, is rotated by means of drive means not shown.

For the purpose of reducing friction between the outer surfaces of the compressed mixture, or elongated member, shown at 10, and the inner surfaces of the tubular matrix 5, it is proposed that the matrix is divided into sections. Figure 2 is a cross-sectional view which illustrates a matrix of rectangular cross-section divided into four sections 5a, 5b, 5c and 5d.

Each of these matrix sections is intended to coact with a hydraulic piston-cylinder device 15, the piston of which is reciprocatingly movable in the direction of the longitudinal axis of the elongated member 10. The different matrix sections can either be moved synchronously or asynchronously.

The matrix section 5a and 5c are held in position with the aid of rollers 16, 17, which extend along the whole length of the matrix 5 and which are present in numbers that will ensure that the rollers fullfil the function satisfactorily.

The matrix sections 5b and 5d are also held in position with the aid of rollers, although not shown.

It is also proposed that cooling passages are provided in the matrix sections 5a, 5b, 5c and 5d in a manner known per se, so that heat can be taken from the mixture in a controlled fashion and so that the mixture will have a more solid form at the region C.

The piston-cylinder devices acting on the matrix sections 5a, 5b, 5c and 5d, of which the device 15 acting on the section 5a is shown, can be operated to deliver a short or a long working stroke, so as to move respective matrix sections through a commensurate axial distance with each stroke performed by respective piston-cylinder devices, while at the same time enabling a full working stroke to be completed at different selected times.

Referring back to Figure 1, the filler material in the plastic/filler mixture charged to the first feeder and precompressed in the vertical passage 2 may comprise heated sawdust, and the heat given off by the sawdust is transmitted directly to the plastics material present in the mixture. This mixture is then fed by the horizontal screw-feeder comprising said conically tapering shaft and helix, the pitch of which decreases in a direction towards the centre of the matrix 5, therewith compressing the mixture to a greater degree of compression.

The space beneath the tubular passage 2 may be heated with the aid of heating coils, as can also the walls of the passage itself.

The matrix sections will preferably be held parallel, when the volume of the plastic material decreases at low temperature. It lies within the scope of the invention, however, to position the matrix sections so that the elongated member produced will not press against said sections with an unnecessarily high force.

It is a significant feature of the present invention that the plastics material present in the mixture is tacky and/or molten when the mixture is located within the regions B and C. Consequently, it is necessary to bring the mixture to a temperature at which this criterion is achieved.

In accordance with the invention, this temperature is controlled and held constant, by controlling the speed of the screw-feeder.

High friction losses occur when this speed is excessively high, and low friction losses occur at excessively low speeds.

The heat required can be obtained and controlled through the temperature of the starting material and/or by external heating.

Figure 3 is a side view of a compression section in the form of an extruder 30 in which there is mounted an internal screw-feeder 31 which carries a nozzle 32 on one end thereof. The nozzle 32 is shown schematically and in side-view in Figure 1.

Since the construction of the extruder is known, it will not be described here in any detail.It should be

noted, however, that the rotational speed of the screw-feeder 31 can be controlled.

The nozzle 32 has a flange 33, which is attached to the extruder 30, and a narrowing part 34, and an outlet 35. The outer parts 36, 37 of the outlet 35 are surrounded by the matrix-sections 5a and 5c, which are reciprocatingly movable in the manner aforedescribed with reference to Figure 1.

It will be understood that the invention is not restricted to the described and illustrated embodiments and that modifications can be made within the scope of the following claims.

CLAIMS

1. A method of producing an elongated member from compressible and compressed material with the aid, in part of a plastics material which is delivered to a space and there subjected to compression and which is then pressed into a further space in which it is able to solidify, characterized in that the thermal energy generated by said compression, or compression, is adapted such as to bring the plastics material to a temperature which is sufficiently high to soften and/or melt the material.

2. A method according to Claim 1, characterized in that the thermal energy generated is controlled by controlling the speed of a rotatable shaft.

3. A method according to Claim 1, characterized in that said compression is effected with the aid of a screw-feeder, the helix of which has a pitch which decreases in a direction towards a further space.

4. A method according to Claim 1, characterized by precompressing the material with the aid of a screw-feeder.

5. A method according to Claim 1, characterized by moving the material through a multi-section matrix; and by moving the matrix-sections backwards and forwards along the external surfaces of the elongated member under production.

6. A method according to Claim 3 or 4, characterized in that the precompression screw-feeder is fixed in rela-

tion to one section of the matrix, the upper section.

7. A method according to Claim 1, 2, 3 or 4, characterized by mixing the plastics material with filler in proportions such that the plastics material will be present in a proportion of between 20 and 60%, preferably about 40%.

8. A method according to Claim 1, characterized in that the plastics material used is waste-plastic, plastic domestic waste, or some like inexpensive plastic.

9. A method according to Claim 1 or 5, characterized by cooling the downstream part of the matrix, preferably with the aid of water.

10. Apparatus for manufacturing an elongated member, preferably in accordance with any one of the preceding claims, comprising a compressing device and a matrix which are arranged concentrically with one another and which are intended to compress a mixture of plastics material and a filler material, said compressing device functioning to press the mixture through the matrix; characterized in that the thermal energy generated by said compression can be adapted so that the mixture is brought to a temperature at which the plastic content thereof is softened and/or melted.

11. Apparatus according to Claim 10, characterized in that the thermal energy generated by said compression can be adapted such that the mixture is brought to a temperature at which the plastic content thereof will soften and/or melt.

12. Apparatus according to Claim 10, characterized in that the thermal energy generated is controlled by controlling the speed of a rotatable shaft.

13. Apparatus according to Claim 10, characterized in that compression is effected by the external supply of thermal energy.

14. Apparatus according to Claim 10, characterized in that compression is achieved with the aid of an extruder comprising a controllable-speed screw-feeder.

15. Apparatus according to Claim 10, characterized by a multi-section matrix which embraces the elongated member during its manufacture, and in that one or more of said matrix sections is or are reciprocatingly movable.

16. Apparatus according to Claim 10, characterized in that the compressing device comprises a rotatable shaft which is rotated at a lower speed than the shaft of a precompressing device.

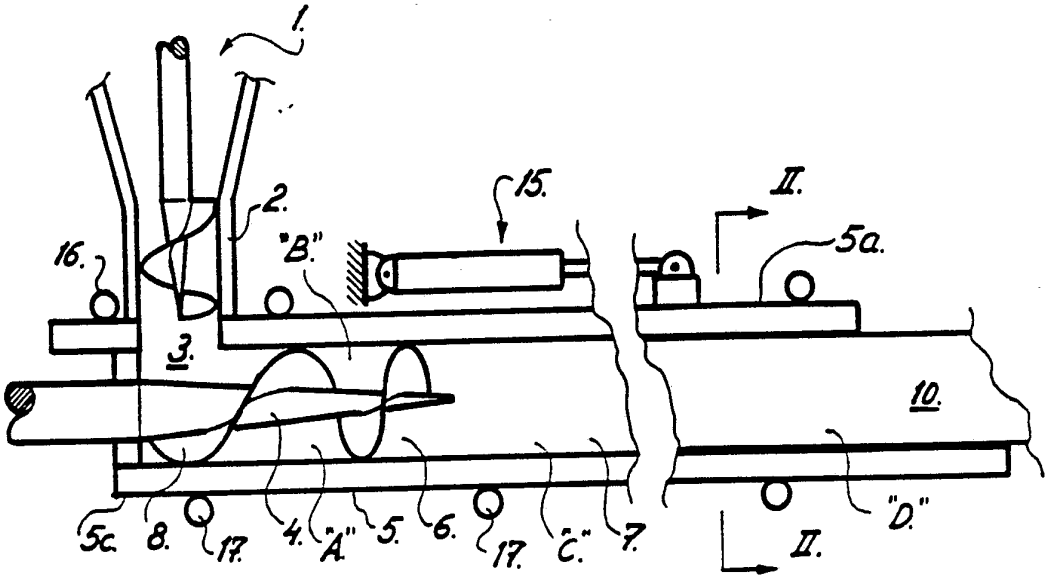


Fig. 1.

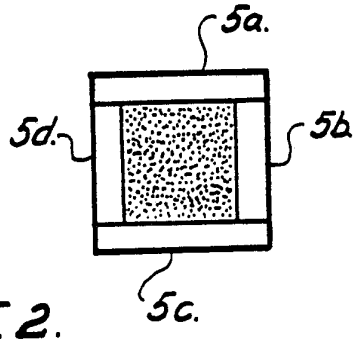


Fig. 2.

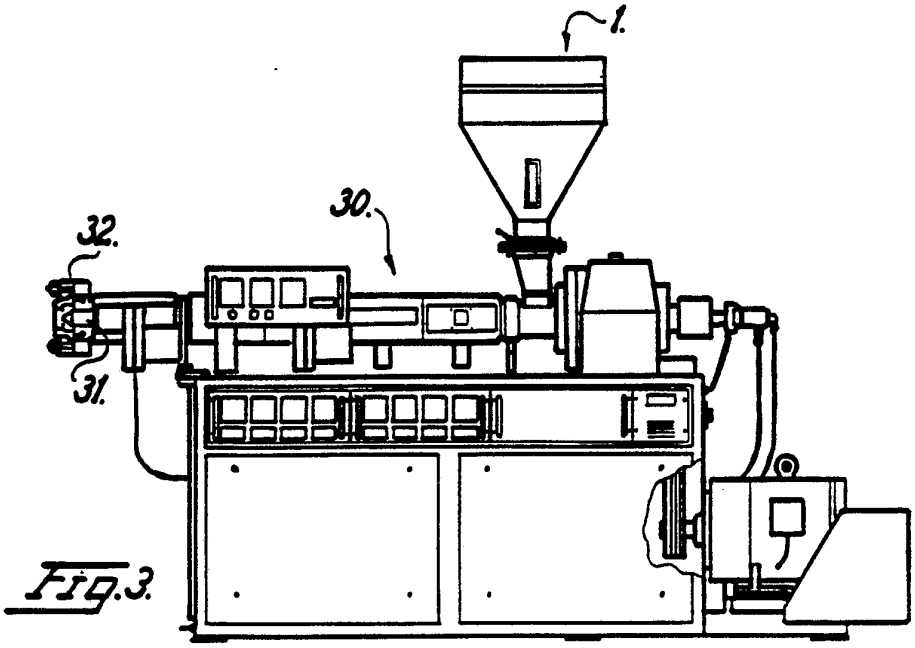
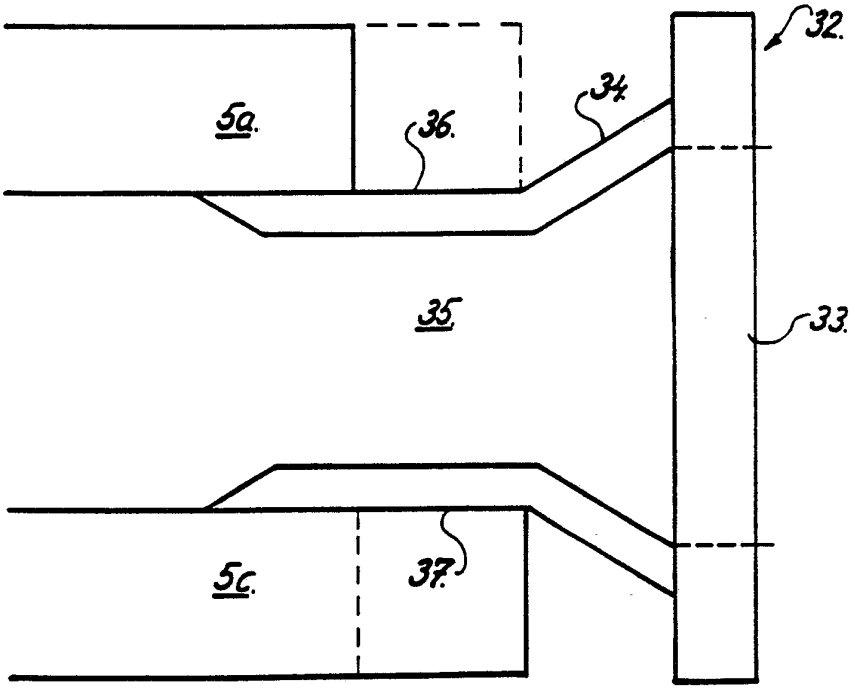


Fig.3.

Fig.4.



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 89/00652

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 29 C 47/36

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC5	B 29 C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
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A	--	2,12
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	--	
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A	DE, A1, 3412158 (BURKART) 3 October 1985, see page 11, line 1 - page 13, line 3; figure 2	2-4,8,11,12,14,16
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* Special categories of cited documents: [10]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
17th January 1990	1990 -01- 24
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Petter Sörsdahl

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

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ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 89/00652

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