



- (51) International Patent Classification:  
*B29C 47/22* (2006.01)    *B29C 47/28* (2006.01)
- (21) International Application Number:  
PCT/IT2016/000085
- (22) International Filing Date:  
6 April 2016 (06.04.2016)
- (25) Filing Language:  
Italian
- (26) Publication Language:  
English
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- (81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM,

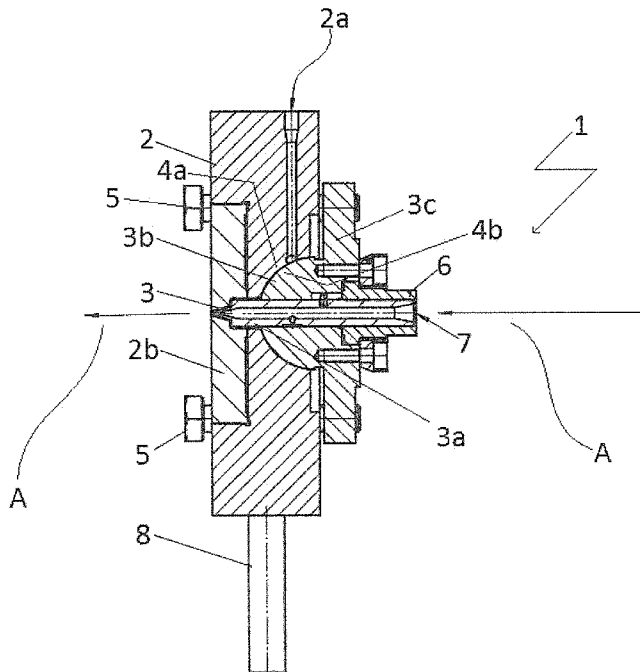
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:  
— with international search report (Art. 21(3))

(54) Title: EXTRUSION HEAD FOR MAKING TUBULAR ARTICLES

Fig. 1



(57) Abstract: An extrusion head for making tubular articles comprises an abutment element (2) and a male element (3) associated to the abutment element (2) in correspondence to an outlet opening to define a passage section for an extrusion material; the extrusion head further comprises means for adjusting (4) the position and/or relative orientation between the male element (3) and the abutment element (2) in order to vary the relative juxtaposition conditions at least with respect to an extrusion axis (A) and the adjustment means (4) comprise mating surfaces with complementary concavity and respectively associated with the abutment element and the male element: these mating surfaces with complementary concavity are in mutual proximity condition and/or contact.

WO 2017/175249 A1

## DESCRIPTION

### EXTRUSION HEAD FOR MAKING TUBULAR ARTICLES

#### Technical field

The present invention relates to an extrusion head for making tubular articles such as hollow-section extruded articles or surface coverages of cables or cables already provided with a sheath.

#### 5 Background art

As is known, the extrusion of certain three-dimensional geometric structures requires appropriate dimensional control systems, especially if the products to be achieved with this technique are of a particularly reduced size: for example, when the aim is to make tubular extruded  
10 articles (or even multi-layered articles such as cables covered by sheaths), it is of paramount importance to maintain a correct "straight" alignment during extrusion in order to avoid distortions of the extruded article or to avoid non-uniformity of the thicknesses along the axis of the article.

Nevertheless, in the case of the production of previously coated cables  
15 or wires, another problem to be taken into account when making the outermost layers by extrusion via deposition of the molten material through an extrusion line consists in the fact that it is necessary to obtain the shortest permanence time possible of the manufactured article (for example, of a cable to be covered with an extruded sheath or of an  
20 already sheathed cable which must be further coated) inside the head, where the temperature can reach over 450°C.

The state of the art provides, in this technical field, the presence of particular extrusion heads based on a central "pin-like" element that advances or retreats with respect to an abutment: the thickness of the  
25 extruded layer is determined depending on the airspace between the pin-like element (which in time may have a coaxial cable channel for the passage of a flow of air or of sacrificial material...or even a cable to be covered during extrusion) and the abutment.

This type of extrusion head, however, has some drawbacks, due to the

fact that the "pin-like" structure implies a geometrical need to have a minimum non-negligible length, and this makes temperature control (and therefore the aggregation and polymerization state) of the molten material passing into the head itself very critical: in addition, this minimum  
5 dimensional limit of this type of "pin-like" heads entails considerable probability of ruining by thermal shock any cables to be sheathed or already sheathed passing through them during a multi-layering process.

A further drawback of this type of extrusion heads is given by the fact that, the geometry of the extruded layer being dependent on an axial  
10 relative sliding between the pin-like element and its counterpart, and on the relative airspace that is formed between these two structural elements, this dependence reflects negatively on the transient phenomena of heat exchange and expansion of the molten material (known with the name of "dye swell" in the technical jargon of the field), thereby increasing the  
15 possibility of obtaining distorted or geometrically non-uniform extruded articles or, again, with harmful consequences of thermal/structural type on the possible "core" comprised inside the outer layer made by extrusion.

The machines of known type are therefore not free from drawbacks, and therefore the object of this invention is to provide an extrusion head  
20 for tubular articles that substantially bypasses the drawbacks presented above.

#### Detailed description of the invention

In comparison to the prior art and the above-mentioned problems, the object of the present invention is therefore to make available an extrusion  
25 head which provides much higher performance (compared to those of extrusion heads of the known type) in terms of accuracy of the obtained manufactured article, minimization of the risk of damaging any semi-finished articles entering the extrusion head and undergoing multi-layering or covering processes, or whatever, and in terms of adjustment/calibration  
30 possibility.

Still, an object of the present invention is to devise an extrusion head

which can be significantly more compact in terms of size, thus being easier to control in terms of thermal gradients and minimizing the dependency and/or the onset of transient flow phenomena (with the related control complications) in the molten material which is made to flow in the head  
5 itself.

An embodiment of the extrusion head according to the invention is now described, by way of example and not of limitation, and illustrated in the appended figures exemplifying (and therefore non-limiting) a possible embodiment, wherein the same figures are as follows:

10 - figure 1 shows a sectional view of the extrusion head in accordance with the invention; and

- figure 2 is a partially exploded perspective view of the head of figure 1.

Mainly, the extrusion head according to the invention is referred to with the reference 1 in the accompanying drawings and consists of an  
15 abutment element 2, which has at least one outlet opening oriented along an extrusion axis "A", which in turn is adapted to define at least an outer diameter of a tubular extruded article, and a male element 3 operatively associated with the abutment element 2 at least at the aforementioned outlet opening and which is adapted to define, in cooperation with the  
20 abutment element 2, a passage section for an extrusion material.

For the purposes of understanding the invention, it should be noted that the expression "outlet opening" may be considered as meaning the two-dimensional space in correspondence of the last material surface of the head 1 met by an extruded material through it (material that travels  
25 through the head along the extrusion axis A), while the expression "passage section" may mean all three-dimensional conformation space existing between the structural elements 2 and 3 and occupied by the extrusion material flow: from a topological point of view, the outlet opening is thus configured as an ideal surface that belongs to the ideal three-  
30 dimensional shape associated with the "empty space" consisting of the passage section.

Conveniently, the head 1 comprises adjustment means 4 of the position and/or relative orientation between the male element 3 and the abutment element 2 to vary the relative juxtaposition conditions at least with respect to said extrusion axis A (and therefore to control both the resulting weight  
5 of the extrusion and the direction of the extruded or co-extruded article, particularly so with reference to the extrusion axis A).

Advantageously, these adjustment means 4 comprise mating surfaces with complementary concavity and respectively associated to the abutment element 2 and the male element 3: thanks to this particular  
10 geometry (and to the consequent mutual coupling kinematic relationship), these mating surfaces with complementary concavity can be placed in a position of mutual proximity and/or contact in correspondence with the operating conditions of the head 1 and may then determine a very accurate and fast relative orientation condition in an extremely compact  
15 space.

In order to ensure a relative mobility free from jamming or geometric interference, the mating surfaces with complementary concavity are respectively shaped according to a sphere and in turn comprise:

- a first complementary surface 4a (which is concave in the  
20 accompanying figures) formed in the abutment element 2; and
- a second complementary surface 4b (which instead is convex in the accompanying figures) associated to the male element 3.

From the functional integration point of view, these mating surfaces with complementary concavity also define, in cooperation with the abutment  
25 element 2 and the male element 3, a part of the passage section for the material in extrusion, thus exerting two technical effects simultaneously: with reference to the ability to slide the material in extrusion it should be noted, however, that flow channels 4c may be present, suitably derived (for example by removal of material) in the first complementary surface 4a  
30 and/or in the second complementary surface 4b, so as to be in fluid communication with the outlet opening in the operating conditions of the

head 1.

In order to allow the relative movements permitted by the combination of the complementary concavity surfaces, the adjustment means 4 also comprise a predetermined number of adjustment bodies 5 simultaneously interconnected to the abutment element 2 and to the male element 3 to determine locally differentiated and/or selective relative distance configurations (or in other words, to be able to determine with sufficient precision and measurability the relative rotations between the two "main" structural elements 2 and 3 of the head 1): in the illustrated exemplary embodiment, these adjustment bodies 5 comprise a predetermined number of threaded rods meshed through the abutment element 2 and connected at a first end with the male element 3.

In order to ensure the maximum possibilities of spatial geometric choice in the settings, the threaded rods are arranged in a radially equispaced configuration around the extrusion axis A and, in order to be able to be operated by a common tool such as a wrench or similar, they are typically equipped with interface heads at a second end opposite to the first end just cited above.

In greater structural detail, it can be seen that the abutment element 2 is in turn composed of these sub-elements:

- a first base half-part 2a comprising a predetermined number of inflow ducts of the material in extrusion (these inflow ducts are in fluid communication with the flow channels 4c and the outlet opening) and further comprising the first complementary surface 4a; and
- a second base half-part 2b coaxially mounted on the first base half-part 2a at the extrusion axis A (in fact, in order to directly define the outlet opening) and defining the opening output in cooperation with the male element 3.

To operate properly in an extrusion cycle, the abutment element 2 (and, for example, the first base half-part 2a) comprises heating means 8 adapted to transfer a given heat flux to the head 1: these heating means 8

can more in general be of various nature (electrical inductors or means of irradiation by pointing a laser beam, as explained in another patent of the same applicant of this invention) and can be activated on a structural part of the head 1, provided that they are adapted to determine the correct  
5 temperature profile in the vicinity of the passage section of the material in extrusion.

As regards the structural details of the male element 3 and always with reference to the accompanying figures, it is possible to see that the latter comprises:

10 - a first operating portion 3a of prismatic conformation, and preferably cylindrical, adapted to penetrate the abutment element 2 and to define, in cooperation with it, a part of the passage section for the material in extrusion;

- a second shrink-fit portion 3b, connected and preferably integrated  
15 with the first operating portion 3a along the extrusion axis A (this second shrink-fit portion 3b in fact includes the second complementary surface 4b); and

- a third connecting portion 3c connected to the second shrink-fit portion 3b and destined to receive in engagement one or more adjustment bodies  
20 5.

To confer greater operational flexibility to the head 1, the male element 3 also comprises an axial adjustment portion 6 adapted to vary, preferably by means of relative sliding, a relative position of the first operating portion 3a with respect to the abutment element 2: that axial adjustment portion 6  
25 typically comprises an adjustment threaded ring meshed in a manner proportional to the third connection portion 3c (or more generally, kinematic arrangements with equivalent technical effect).

A further possibility of structural enrichment of the head 1 according to the invention is given by the possible presence of an axial insertion cavity  
30 7, which is substantially coaxial with the entire male element 3 and extends along the extrusion axis A until the outlet opening: this axial cavity

7 serves to slide in the head a body or a semi-finished product to be co-extruded, which is coupled geometrically in correspondence with the material in extrusion at the outlet opening.

The invention allows to obtain several advantages over the known art.

5 First, thanks to the peculiar constructive architecture of the above-described (and hereinafter claimed) head, it is possible to obtain a clear and considerable compaction in the longitudinal direction - that is to say, along the extrusion axis - of the structure, with evident advantages in terms of better constancy of thermal profiles, increased ease of feeding  
10 and heating of the various parts of the head itself and, ultimately, with a control degree of the working conditions of the head remarkably better and less sensitive to transient phenomena.

As a consequence of what has just been stated, there is an excellent opportunity to calibrate and orient/direct the extrusion air, at the same time  
15 remarkably minimizing any problems of potential localized thickness disparity, misalignment between the outer extruded layer and possible inner "core" of the product as a whole, distortion of the extruded article outside of the extrusion head and minimum dimensional limits which cannot be further reduced with the heads of the known type.

20 The present extrusion device (or "head") is therefore highly versatile in the operating field on tubular articles or in the multi-layered processing of products involving the insertion in the head of a core to be coated: this versatility is therefore reflected in terms of better and longer operating life, reduced maintenance and higher reliability...in addition to an easier and  
25 more accurate adjustment in terms of alignment and targeting of the outlet section of the extruded material with respect to the orientation/shrink-fitting axis of the part inside the extrusion head itself.

In practical terms, finally, it should be emphasized the fact that the technical possibility to derive the channels distributing the material in extrusion on the opposed spherical surfaces of the male and abutment elements (spherical surfaces that also simultaneously solve the problem of

moving the male element with respect to the abutment element so as to correct and uniform the velocity of the material in extrusion) allows to obtain these advantages in the final product:

- in the case of production of tubular bodies, the almost perfect concentricity between the outer and inner diameters; or

- in the case of production of cables or wires, the possibility of covering them with a film of uniform thickness over their entire circumference.

It should also be noted that the structure and functions of the present extrusion head allow to obtain with remarkable ease and repeatability cables or "micro-tubes" or thin wires with diameters equal to or lower than 0.01 mm.

**CLAIMS**

1. extrusion head for tubular products, comprising:
- an abutment element (2) having at least one outlet opening oriented along an extrusion axis (A), said outlet opening being adapted to define at least an outer diameter of a tubular extruded article;
  - a male element (3) operatively associated with said abutment element (2) at least in correspondence of said outlet opening and adapted to define a passage section for a material in extrusion in cooperation with the abutment element (2); and
  - 10 - adjustment means (4) for the positioning and/or relative orientation between said male element (3) and the abutment element (2) in order to vary the relative juxtaposition conditions, at least with respect to said extrusion axis (A),  
characterized in that said adjustment means (4) comprise mating  
15 surfaces with complementary concavities and respectively associated to the abutment element (2) and the male element (3), said mating surfaces with complementary concavity being in condition of mutual proximity and/or contact in correspondence with the operating conditions of the head (1).
- 20 2. head according to claim 1, wherein said mating surfaces with a complementary concavity are respectively shaped according to a sphere and include:
- a first complementary surface (4a), preferably concave, formed in the abutment (2); and
  - 25 - a second complementary surface (4b), preferably convex, associated with the male element (3).
3. head according to claims 1 or 2, wherein the surfaces coupled with complementary concavity define said passage section for said extrusion material in cooperation with the abutment element (2) and with the male  
30 element (3).
4. head according to claim 3, wherein there are also flow channels (4c)

at least partially formed in the first complementary surface (4a) and/or the second complementary surface (4b), said flow channels being placed in fluid communication with the outlet opening in the operating conditions of the head (1).

5 5. head according to any one of the preceding claims, wherein the adjustment means (4) further comprise a predetermined number of adjustment bodies (5) simultaneously interconnected to the abutment element (2) and the male element (3) to determine locally differentiated and/or selective distance configurations.

10 6. head according to claim 5, wherein said adjustment bodies (5) comprise a predetermined number of threaded rods meshed through the abutment element (2) and connected at a first end with the male element (3), said threaded rods being preferably arranged in a configuration radially equispaced around the extrusion axis (A) and being more  
15 preferably provided with interface heads at a second end opposite to said first end.

7. head according to any one of the preceding claims, wherein the abutment element (2) comprises:

- a first base half-part (2a) comprising a predetermined number of inflow  
20 ducts of the material in extrusion, said inflow ducts being in fluid communication with the flow channels (4c) and with the outlet opening, said first half-part of the base (2a) comprising said first complementary surface (4a); and

- a second base half-part (2b) coaxially mounted on the first base half-  
25 part (2a) in correspondence of the extrusion axis (A) and defining the outlet opening in cooperation with the male element (3).

8. head according to claim 7, wherein the abutment element (2), and preferably the first base half-part (2a), comprises heating means (8) adapted to transfer a given heat flux to the head (1).

30 9. head according to any one of the preceding claims, wherein the male element (3) comprises:

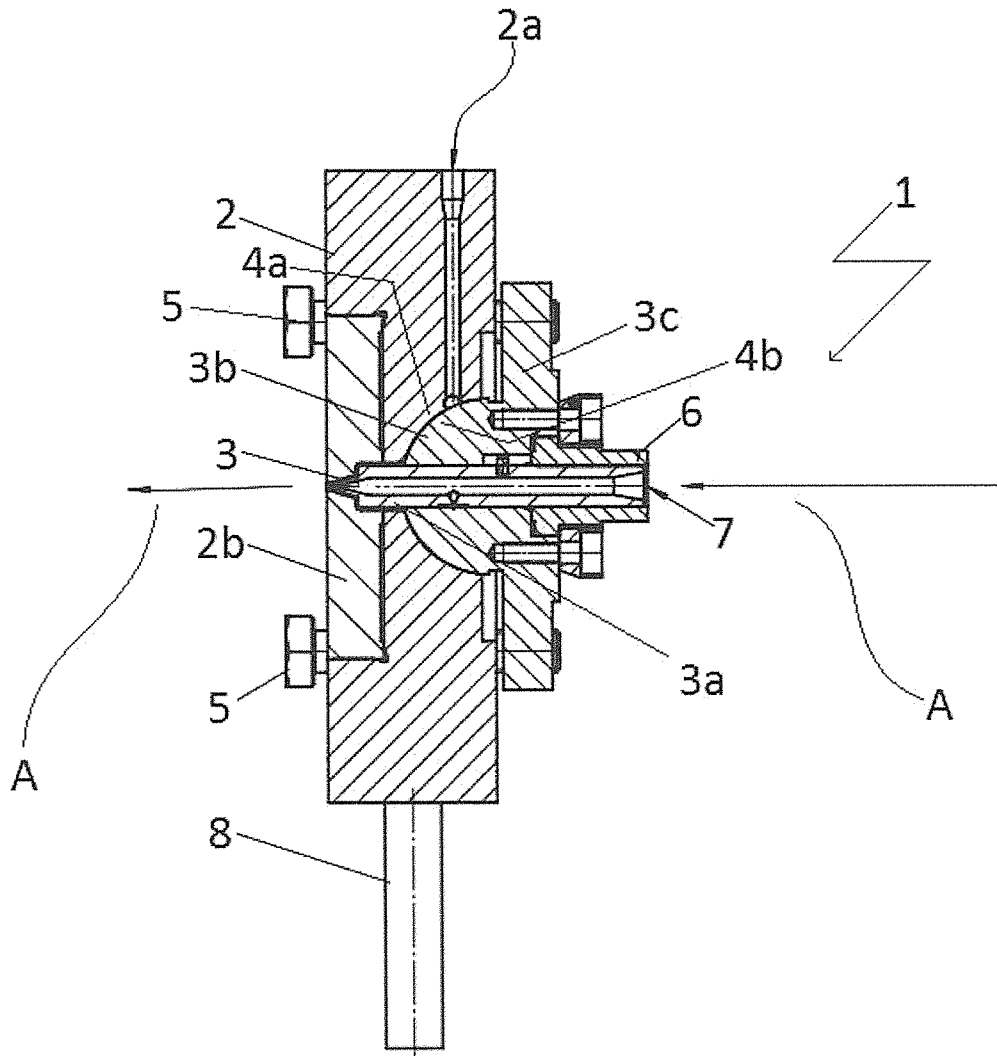
- a first operating portion 3a of prismatic conformation, preferably cylindrical, adapted to penetrate the abutment element 2 and to define, in cooperation with it, a part of said passage section for the material in extrusion;

5 - a second shrink-fit portion (3b), connected and preferably integrated with said first operating portion (3a) along the extrusion axis (A), said second shrink-fit portion (3b) including said second complementary surface (4b); and

10 - a third connecting portion (3c) connected to the second shrink-fit portion (3b) and destined to receive in engagement one or more adjustment bodies (5).

10. head according to claim 9, wherein the male element (3) also comprises an axial adjustment portion (3d) adapted to vary, preferably by means of relative sliding, a relative position of the first operating portion  
15 (3a) relative to the abutment (2), said axial adjustment portion (3d) comprising even more preferably an adjustment threaded ring meshed in a manner proportional to the third connection portion (3c).

Fig. 1



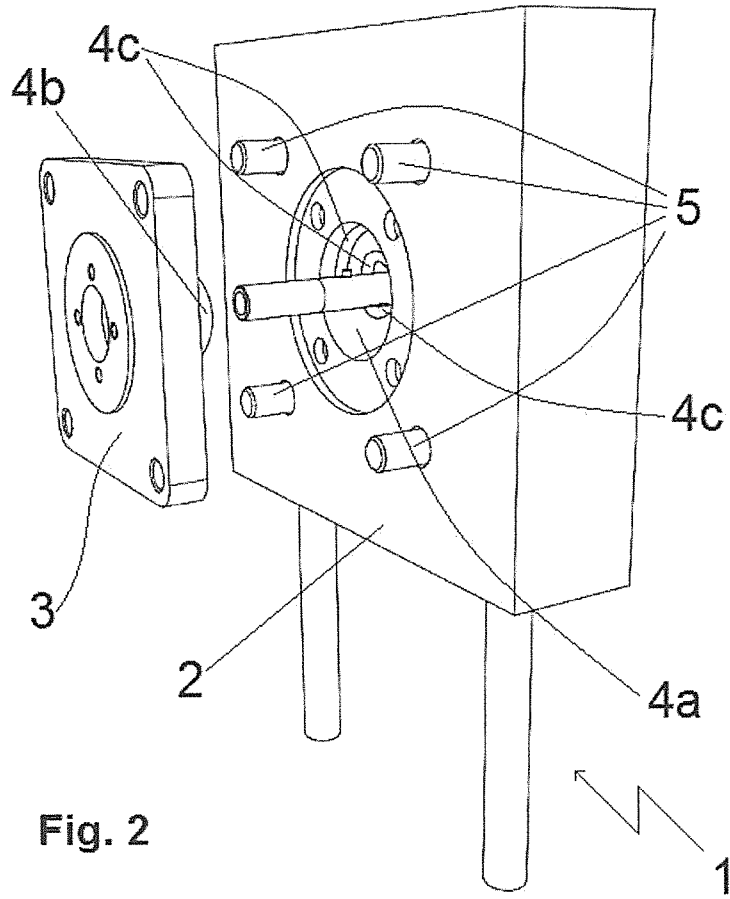


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No  
PCT/IT2016/000085

A. CLASSIFICATION OF SUBJECT MATTER  
INV. B29C47/22 B29C47/28  
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)  
B29C  
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.
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X	----- US 3 856 448 A (IIJIMA A ET AL) 24 December 1974 (1974-12-24) column 2 - column 5; claims 1-11; figures 1, 2	1-10
X	----- JP H03 66722 U (SEKISUI CHEMICAL CO., LTD.) 28 June 1991 (1991-06-28) figures 1, 3 the whole document	1,2,5-10
X	----- SU 880 779 A2 (EX K T I MINAVTOPROMA SSSR [SU]) 15 November 1981 (1981-11-15) column 1 - column 4; figure 1 ----- -/--	1,2,5-10

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

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- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search  5 December 2016	Date of mailing of the international search report  16/12/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Brunswick, André

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/IT2016/000085

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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X	US 6 514 341 B1 (ALBERHASKY CRAIG ALAN [US] ET AL) 4 February 2003 (2003-02-04) abstract; figures 4, 12, 13 column 3 - column 5; claims 1-22 -----	1,2,5,6, 8-10

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Information on patent family members

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