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(54) **SUBMERGED ENTRY NOZZLE**

(57) The present invention relates to a submerged entry nozzle in particularly to a submerged entry nozzle through which molten steel can be poured from a tundish into a mould.

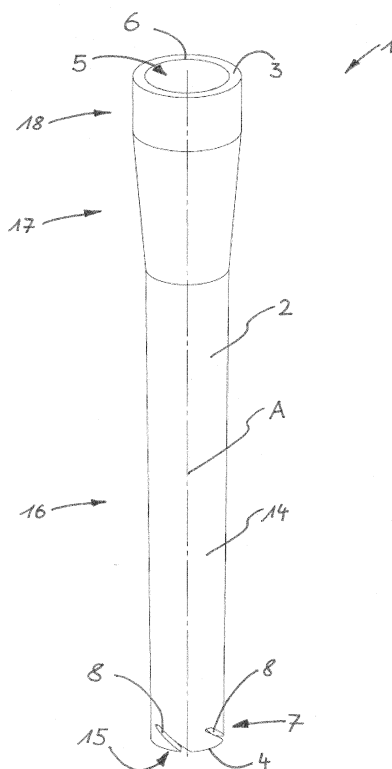


Fig. 1

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Description

[0001] The present invention relates to a submerged entry nozzle, particularly to a submerged entry nozzle through which molten steel can be poured from a tundish into a mould.

[0002] In the continuous casting of metal, especially of steel, the molten metal is poured from a tundish into a mould by means of a submerged entry nozzle. Such submerged entry nozzles are generally comprised of a substantially tubular body extending from a first end to a second end of said tubular body. For conducting molten metal through said tubular body, submerged entry nozzles comprise a passageway, i.e. a bore, extending through said tubular body along a longitudinal axis from said first end towards said second end. For conducting molten metal from a tundish into said passageway, the nozzle comprises at least one inlet port, opening into said passageway at said first end of said tubular body. Said at least one inlet port is capable of receiving molten metal from a tundish and conducting the same into said passageway. The molten metal is conducted from said inlet port through said passageway to a plurality of outlet ports, opening into said passageway in a region adjacent to said second end of said tubular body. Said plurality of outlet ports is capable of conducting molten steel, delivered from said passageway, through the outlet ports to the outside of said tubular body and into a mould of the continuous casting machine. In its use position in the continuous casting machine, the nozzle is arranged generally vertically, with the central longitudinal axis of the passageway extending vertically and with the first end of the tubular body positioned upside and the second end of the tubular body positioned downside. Accordingly, molten metal can be conducted through the nozzle from said inlet port into the passageway, through said passageway, and through the outlet ports into the mould by force of gravity. A submerged entry nozzle of this type is disclosed, for example, in EP 1 671 721 B1.

[0003] To improve the homogeneity of the metal melt and its solidification, in particular to avoid arbitrary solidification of the outer shell of the (metallic) strand during casting, continuous casting in some cases requires stirring of the metal melt in the mould. To achieve such stirring, it is known to install an electromagnetic stirrer around the metal stream at a distance below the nozzle bottom to induce a swirling motion to the metal melt, poured into the mould from the outlet ports of the nozzle.

[0004] EP 2 769 786 B1 discloses a submerged entry nozzle, comprising outlet ports having a geometry to provide the metal melt, flowing out of the outlet ports, with a certain twist.

[0005] A nozzle, providing the outflowing metal melt with a certain twist, allows to reduce or to even eliminate the need for an electromagnetic stirrer.

[0006] Accordingly, it is an object of the present invention to provide a submerged entry nozzle, inducing a swirling motion to the molten metal, flowing out of the

nozzle, i. e. flowing out of the outlet ports of the nozzle into the mould.

[0007] The inventors of the present invention found out that the stirring of the metal melt, flowing out of the nozzle, and hence the homogeneity of the melt and its solidification, can be improved when the swirling motion is increased, i.e. when the metal swirls with a higher velocity.

[0008] Accordingly, it is an object of the present invention to induce a swirling motion to the molten metal, flowing out of the nozzle, without the need of an electromagnetic stirrer, being higher than the swirling motion of molten metal issued from the known nozzles.

[0009] To increase the swirling motion of the molten metal, issued from the nozzle, the inventors of the present invention made extensive investigations. In the course of this investigations, the inventors found out that the swirling motion of the molten metal can be increased when the velocity of the molten metal, flowing through the outlet ports, is increased.

[0010] Accordingly, based upon this finding, it is a further object of the present invention to provide a submerged entry nozzle, inducing a swirling motion to the molten metal flowing out of the nozzle and, at the same time, inducing a velocity to the molten metal, flowing out of the nozzle, being higher than the velocity of the molten metal, flowing out of the known nozzles.

[0011] Accordingly, in accordance with the present invention, there is provided a submerged entry nozzle through which molten steel can be poured from a tundish into a mould, said nozzle comprising:

- a substantially tubular body, extending from a first end to a second end of said tubular body;
- a passageway, extending through said tubular body along a longitudinal axis from said first end towards said second end;
- at least one inlet port, opening into said passageway at said first end;
- a plurality of outlet ports, opening into said passageway in a region adjacent to said second end, wherein each of said outlet ports is slit-shaped and extending helically around said longitudinal axis;
- and wherein said passageway terminates in the axial direction of said longitudinal axis towards said second end with a distance to said second end in said region adjacent to said second end at a bottom, wherein said bottom comprises a protrusion, protruding into said passageway.

[0012] The submerged entry nozzle of the present invention comprises outlet ports being slit-shaped and extending helically around said central longitudinal axis. By means of such outlet ports, a swirling motion is induced to the molten metal, issuing from the nozzle, i. e. flowing out of the outlet ports of the nozzle.

[0013] To increase the velocity of the molten metal, flowing through said outlet ports, the passageway of the nozzle terminates - in the axial direction of its longitudinal

axis towards said second end - with a distance to said second end in said region adjacent to said second end at a bottom, wherein said bottom comprises a protrusion, protruding into the passageway. The provision of said protrusion is based upon the inventors' finding that such a protrusion, protruding into the passageway, divides the stream of molten metal, flowing through said passageway, and directs the stream of molten metal towards the outlet ports. Preferably, said protrusion may comprise a surface area, facing towards said outlet ports. By the aid of such surface area, facing towards the outlet port, the velocity of the stream of molten metal towards said outlet ports is increased when the molten metal flows over such surface area. Insofar, the inventors found out that with an increased velocity of the molten metal, flowing in the passageway towards the outlet ports, the velocity of the stream of molten metal, flowing through the outlet ports and finally flowing out of the outlet ports into the mould of the continuous casting machine, may be increased. Accordingly, with such a protrusion, the velocity of the molten metal, issued from the nozzle and, hence, the velocity of the swirling motion, induced to the molten metal, can be increased.

[0014] Generally, said protrusion at the bottom of the passageway may have any shape of a protrusion, for example the shape of a pyramid, a cone or a truncated cone. According to a preferred embodiment, the protrusion is dome-shaped. According to the invention, it was found out that with such a dome-shaped protrusion, the stream of molten metal can be divided and directed towards the outlet ports with an increased velocity and at the same time without the appearance of any turbulences in the stream of molten metal.

[0015] Generally, the protrusion preferably tapers in a direction from the second end towards first end of the tubular body, i.e. in a direction from the bottom of the passageway into the passageway.

[0016] According to a preferred embodiment, the protrusion comprises at least one groove in the surface area thereof, particularly preferred in the surface area thereof facing towards the outlet ports. According to a particularly preferred embodiment, the protrusion comprises at least one groove in the surface area thereof extending helically around the longitudinal axis. According to a further preferred embodiment, the protrusion comprises at least two grooves in the surface area thereof extending helically around the longitudinal axis, particularly preferred two to five and even more preferred three to five grooves in the surface area thereof extending helically around the longitudinal axis. Preferably, the helically extending grooves have the same direction of rotation as the outlet ports. The inventors found out that which such helically grooves in the surface area of the protrusion, the stream of molten metal can be directed towards the outlet ports in such that the velocity of the molten metal leaving the outlet ports can be increased.

[0017] Generally, said grooves may have any shape. According to a preferred embodiment, the grooves have

a semicircular cross-section or a cross-section in the form of a circular segment.

[0018] The protrusion may seal the passageway in a direction along the central longitudinal axis of the passageway towards the said second end of the tubular body. In other words, the protrusion obstructs the passageway totally or partly towards the second end of the tubular body. This has the advantage, that the flow of molten metal is divided by said protrusion and directed towards the outlet ports. The passageway may totally be sealed by the protrusion. According to another preferred embodiment, the base of the protrusion obstructs at least 80 % of the cross-sectional area of the passageway.

[0019] According to a preferred embodiment, the protrusion tapers in a direction from said second end towards said first end and terminates in a peak (i.e. a top) laying on said longitudinal axis of the passageway. Accordingly, starting from said base of the protrusion, the protrusion tapers from its base towards a peak, wherein said peak of the protrusion is laying on said longitudinal axis of the passageway. In such case, the flow of molten metal can be divided symmetrically by the protrusion, i. e. in several identical streams with the same flow pattern. To further improve such symmetrical stream of molten metal, according to a preferred embodiment, the protrusion is disposed symmetrically about the longitudinal axis of the passageway. According to a further preferred embodiment, the protrusion is rotationally symmetrical to the longitudinal axis of the passageway.

[0020] The inventors found out that the angle between said surface area of the protrusion, facing towards the outlet ports, and said longitudinal axis has an influence on the velocity of the stream of molten metal conducted towards the outlet ports. Insofar, if this angle is too small, the molten metal is not conducted towards the outlet ports. On the other hand, if this angle is too high, the velocity of the stream of molten metal, flowing through the passageway, can be decreased. According to a preferred embodiment, the angle between said surface areas of the protrusion, facing towards the outlet ports, and said longitudinal axis of the passageway is between 20 and 60 degrees, more preferably between 30 and 50 degrees and most preferably between 30 and 45 degrees. This embodiment not necessarily requires that the angle between all surface areas of the protrusion and the longitudinal axis of the passageway is within this range but at least preferable the angle between the surface area of the protrusion, facing towards the outlet ports, and said longitudinal axis. Insofar, the protrusion may comprise surface areas, not facing towards the outlet ports, and wherein the angle between such surface areas and the longitudinal axis is not in the above range. For example, when the protrusion has said preferred dome-like shape, the angle between the surface areas of the protrusion in region of the peak (i.e. in the top region) of the protrusion and the longitudinal axis not necessarily have to include an angle in the above range. For example, only the angle between the surface area of the protrusion at the edge

of the protrusion, i.e. the side walls of the protrusion, and the longitudinal axis might be in the above-identified range. According to a preferred embodiment, at least 70 %, and even more preferably 90% of the surface area of the protrusion, in relation to the entire surface area of the protrusion, is a surface area, the angle between such surface area and the central longitudinal axis of the passageway is in the above range.

[0021] The inventors found out that the velocity of the stream of molten metal can be further increased when the orifices of the outlet ports, through which the outlet ports are opening into the passageway, and the protrusion run side by side along said longitudinal axis for a distance. Accordingly, according to one preferred embodiment it is provided that each of said outlet ports opens into said passageway through an orifice with each of said orifices running along said longitudinal axis for a first distance, and wherein said protrusion runs along said central longitudinal axis for a second distance, and wherein said second distance overlaps with said first distance for at least 50 % of the length of said first distance, more preferably for at least 70 % and even more preferably for 100 % of the length of said first distance. In other words: The orifices of the outlet ports and the protrusion run side by side (in relation to the central longitudinal axis) to each other over a length of at least 50 %, more preferably at least 70 % and even more preferably 100 % of the length of the orifices.

[0022] Said longitudinal axis of the passageway is the central longitudinal axis thereof. According to a preferred embodiment, the passageway has a circular cross-section and even more preferable has the shape of a cylinder, i.e. a cylinder with a circular cross section orthogonal (i.e. rectangular) to the longitudinal axis of the passageway.

[0023] The tubular body is preferably made of a refractory material, preferably of a ceramic refractory material or a carbon-bonded refractory material. The refractory material of the tubular body can be any known refractory material used for submerged entry nozzles, especially any such ceramic refractory material or carbon-bonded refractory material. As far as the tubular body is made of a carbon-bonded refractory material, such material can be at least one of the following materials: carbon-bonded magnesia, carbon-bonded alumina, carbon-bonded spinel (i.e. magnesia-alumina-spinel) or carbon-bonded zirconia.

[0024] The at least one inlet port, opening into the passageway at the first end of the tubular body, preferably lays in the longitudinal axis of the passageway.

[0025] According to one preferred embodiment, the outer contour of the tubular body has the shape of a cylinder at least in the region of the outlet ports. The inventors found out that with such cylindrical shape of the tubular body in the region of the outlet ports, the swirling motion of the molten, issued to the mould, can be further increased. According to a preferred embodiment, said part of the tubular body, having the outer contour of a

cylinder, has an axis, being coaxial with said longitudinal axis of the passageway.

[0026] According to one preferred embodiment, the outer contour of the tubular body is rotationally symmetrical in view of said central longitudinal axis of said part of the tubular body, having the outer contour of a cylinder.

[0027] According to a preferred embodiment, the outlet ports allow discharging molten metal out of the tubular body radially to said central longitudinal axis and at the same time axially to said central longitudinal axis of the passageway in a direction towards said second end. In other words, said outlet ports of the nozzle are arranged such that they allow discharging of molten metal out of the tubular body into the mould not only in a radial direction (in view of the longitudinal axis), but as well in a direction which runs parallel to the direction of the longitudinal axis. To allow such discharging of molten metal out of the tubular body radially and axially to the longitudinal axis of the passageway, according to one preferred embodiment, the outlet ports extend through the lateral wall of the tubular body and the end wall of the tubular body, delimiting the tubular body at said second end, at the same time. Accordingly, the orifices of each outlet port, opening to the outside of the tubular body, not only lay at the lateral wall of the tubular body but also extend into the end wall of the tubular body, delimiting the tubular body at its second end. Insofar, the outlet ports may have the shape as disclosed in figures 1-6 of EP 2 769 786 B1. The end wall of the tubular body, delimiting the tubular body at the second end thereof, may be even (i.e. flat), dome-like (i.e. convex when seen from the outside of the tubular body) or concave when seen from the outside of the tubular body.

[0028] The inventors further found out that the velocity of the stream of molten metal, issued from the outlet ports to the mould, can be further increased when the outlet ports taper in a direction from the passageway towards the outside of the tubular body, i.e. in a direction from the orifice of the respective outlet port, opening into the passageway, towards the orifice of the respective outlet port, opening to the outside of the tubular body. It is assumed that the outlet ports in such case act like a jet that increases the velocity of a fluid. In this regard, according to a preferred embodiment, it is provided a cross sectional area of said outlet ports, reducing in the direction from said passageway to the outside of the tubular body. In other words, the cross-sectional area of each outlet port tapers in the direction from the passageway towards the outside of the tubular body.

[0029] According to a preferred embodiment, the outlet ports are disposed symmetrically about the longitudinal axis of the passageway. Especially, it is preferred that the outlet ports are disposed evenly (uniformly) about the longitudinal axis, i.e. spaced at equal distance from one another about the longitudinal axis. In such case, a very symmetrical and homogenous swirling motion can be induced to the molten metal.

[0030] The inventors found out that at least two outlet

ports should be provided to induce a swirling motion to the molten metal issued from the nozzle. However, according to a preferred embodiment, at least three, especially three to five outlet ports are provided. According to a particularly preferred embodiment, four outlet ports are provided which preferably are disposed symmetrically about the central longitudinal axis of the passageway.

[0031] The outlet ports are slit-shaped, i.e. having a larger expansion in a first direction than in a second direction, running orthogonal (i.e. rectangular) to said first direction. Preferably, the outlet ports have a rectangular cross-section. According to a preferred embodiment, the orifice of each of said outlet ports has a length (i.e. the larger expansion of the slit) to width (i.e. the smaller expansion of the slit) ratio in the range from 2:1 to 8:1, and even more preferably in the range from 3:1 to 7:1.

[0032] The outlet ports are extending helically around said longitudinal axis, i.e. each of the outlet ports extends spiral-shaped about said longitudinal axis of the passageway. The inventors found out that the gradient angle of the outlet ports, i.e. the angle of the outlet ports in relation to a plane, extending orthogonally (i.e. rectangular) to the longitudinal axis of the passageway, should be within a certain range to induce a swirling motion to the molten metal. If the gradient angle of the outlet ports is too small, the velocity of the molten metal can be decelerated too much. On the other hand, if the gradient angle of the outlet ports is too high, the velocity of the molten metal is high but the swirling motion, induced to the molten metal, may be too small. Accordingly, the gradient angle of the outlet ports preferably is in the range from 20 to 80 degrees, more preferably in the range from 30 to 70 degrees and particularly preferred in the range from 30 to 60 degrees.

[0033] Further features of the nozzle according to the invention are disclosed in the claims and the exemplary embodiment, disclosed hereinafter and illustrated in the figures.

[0034] All features of the disclosed nozzle, either singular or in combination, can be combined with each other.

[0035] An embodiment of the nozzle according to the invention is described hereinafter.

[0036] In the accompanying figures,

Fig. 1 is a perspective view of a submerged entry nozzle in accordance with an embodiment of the present invention;

Fig. 2 is a perspective view of the nozzle according to Fig. 1 in the region adjacent to the second end thereof;

Fig. 3 is a perspective view of the nozzle according to Fig. 1, wherein the inner contour of the nozzle in said region is illustrated by dashed lines;

Fig. 4 is a perspective cutaway view of the nozzle according to Fig. 1 in the region adjacent to the sec-

ond end thereof;

Fig. 5 is another perspective cutaway view of the nozzle according to Fig. 1 in the region adjacent to the second end thereof;

Fig. 6 is a cross-sectional view of the nozzle according to Fig. 1, taken along the longitudinal axis thereof;

Fig. 7 is a cross-sectional view of the nozzle according to Fig. 1, taken along the longitudinal axis thereof, in the region adjacent to the second end thereof; and

Fig. 8 is a cross-sectional view of the nozzle according to Fig. 1, taken along the longitudinal axis thereof, in the region adjacent to the second end thereof, wherein the inner contour of the nozzle in said region is illustrated by dashed lines.

[0037] The nozzle 1 according to the illustrated embodiment comprises a substantially tubular body 2, extending from a first end 3 towards a second end 4 thereof. In the illustrated embodiment, the nozzle 1 is illustrated in its use position, i. e. with the first end 3 of the tubular body 2 positioned upside and the second end 4 of the tubular body 2 positioned downside. The tubular body 2 is made of a carbon bonded refractory material.

[0038] The submerged entry nozzle 1 further comprises a passageway 5, extending through said tubular body 2, along a longitudinal axis A from said first end 3 towards said second end 4. Said passageway 5 has the shape of a cylinder, i. e. a cylinder with a circular cross section orthogonal to the longitudinal axis A, wherein said passageway 5 is rotationally symmetrical about said longitudinal axis A. In the use position of the nozzle 1 according to the Figures, said longitudinal axis A is extending vertically.

[0039] At said first end 3, one inlet port 6 opens into said passageway 5.

[0040] In a region 7 adjacent to said second end 4, four outlet ports 8 open into said passageway 5. Each of said outlet ports 8 is slit shaped and extends helically around said longitudinal axis A.

[0041] In said region 7 adjacent to said second end 4, in the axial direction of said longitudinal axis A towards said second end 4, said passageway 5 terminates with a distance to said second end 4 at a bottom 9. Said bottom 9 comprises a protrusion 10, protruding into said passageway 5.

[0042] Said protrusion 5 is dome-shaped and, accordingly, tapers in a direction from said second end 4 towards said first end 3 and terminates in a peak 11, laying on said longitudinal axis A. Said protrusion 10 is disposed rotationally symmetrical about said longitudinal axis A.

[0043] The side walls 12 of the protrusion 10 provide a surface area of the protrusion 10, facing towards said outlet ports 8, whereas the top region of the protrusion 10, adjacent to the peak 11, is facing upwards towards

said inlet port 6 and provides a surface area 13 of the protrusion 10 which is not facing towards the outlet ports 8.

[0044] The angle α between said surface area 12 and said longitudinal axis A is between about 30 and 45°.

[0045] The four outlet ports 8 are disposed symmetrically about said longitudinal axis A. Insofar, the four outlet ports 8 are spaced at equal distance from one another about said longitudinal axis A. The four outlet ports 8 extend through the lateral wall 14 of said tubular body 2 and the end wall 15 of said tubular body 2, delimiting the tubular body 2 at its second end 4. The gradient angle of each of said outlet ports 8 is about 45°.

[0046] In said region 7 adjacent to said second end 4, the tubular body 2 has a cylindrical outer contour with said outer contour being rotationally symmetrical about said longitudinal axis A. The tubular body 2 features such cylindrical contour in a region 16, starting at said second end 4 and terminating at a distance of about 70 % of the length of said tubular body 2 towards said first end 3. The outer contour of the tubular body 2 continues in a coned portion 17, tapering slightly outwardly. The outer contour of the tubular body 2 further continues in a portion 18 with a cylindrical outer contour, forming a region adjacent to said first end 3. The entire outer contour of the tubular body 2 is rotationally symmetrical about said longitudinal axis A.

[0047] The cross section of each of said outlet ports 8 tapers in a direction from said passageway 5 towards the outside of the tubular body 2.

[0048] Each of said outlet ports 8 opens into said passageway 5 through an orifice 19, with each of said orifices 19 running along said longitudinal axis A for a first distance 20, and wherein said protrusion 10 runs along said longitudinal axis A for a second distance 21, and wherein said second distance 21 overlaps with said first distance 20 for about 80 % of the length of said first distance 20.

[0049] When using the submerged entry nozzle 1, the submerged entry nozzle 1 is arranged such at a tundish of a continuous casting machine that the outlet of the tundish opens into the inlet port 6 of the nozzle 1.

[0050] Further, according to the art, the region 7 of the tubular body 2 of the nozzle 1, adjacent to said second end 3, is arranged in a mould.

[0051] Accordingly, molten metal can be poured from the tundish through the inlet port 6 into said passageway 5, through said passageway 5 to the protrusion 10, is divided by the protrusion 10 and directed towards the orifices 19 of the outlet ports 8, and finally conducted through the outlet ports 8 to the outside of the tubular body 2 and into the mould.

[0052] When flowing through the nozzle 1, the velocity of the stream of molten metal is increased when it flows over the surface area 12, facing towards the outlet ports 8 or the orifices 19 thereof, respectively. The velocity of the stream of molten metal, running through the outlet ports 8, is further increased due to the cross-sectional area of the outlet ports 8, tapering from said passageway

5 towards the outside of the tubular body 2.

[0053] Consequently, the stream of molten metal, charged through the outlet ports 8 into the mould, has a high velocity, and thus a high swirling motion is induced to the molten metal, issuing from the nozzle 1.

Claims

- 10 1. Submerged entry nozzle (1) through which molten steel can be poured from a tundish into a mould, said nozzle comprising:
 - 1.1 a substantially tubular body (2), extending from a first end (3) to a second end (4);
 - 1.2 a passageway (5), extending through said tubular body (2) along a longitudinal axis (A) from said first end (3) towards said second end (4);
 - 1.3 at least one inlet port (6), opening into said passageway (5) at said first end (3);
 - 1.4 a plurality of outlet ports (8), opening into said passageway (5) in a region (7) adjacent to said second end (4), wherein each of said outlet ports (8) is slit-shaped and extends helically around said longitudinal axis (A);
 - 1.5 and wherein said passageway (5) terminates in the axial direction of said longitudinal axis (A) towards said second end (4) with a distance to said second end (4) in said region (7) adjacent to said second end (4) at a bottom (9), wherein said bottom (9) comprises a protrusion (10), protruding into said passageway (5).
- 35 2. Nozzle according to claim 1, wherein said protrusion (10) has the shape of a pyramid, a cone, a truncated cone or is dome-shaped.
- 40 3. Nozzle according to at least one of the preceding claims, wherein said protrusion (10) comprises a surface area (12), facing towards said outlet ports (8).
- 45 4. Nozzle according to at least one of the preceding claims, wherein said protrusion (10) comprises a surface area (12), facing towards each of said outlet ports (8).
- 50 5. Nozzle according to at least one of the preceding claims, wherein said protrusion (10) tapers in a direction from said second end (4) towards said first end (3).
- 55 6. Nozzle according to at least one of the preceding claims, wherein said protrusion (10) tapers in a direction from said second end (4) towards said first end (3) and ends in a peak (11) lying on said longitudinal axis (A).

7. Nozzle according to at least one of the preceding claims, wherein the angle (α) between said surface area (12) of said protrusion (10) and said longitudinal axis (A) is between 20 and 60 degrees. 5
8. Nozzle according to at least one of the preceding claims, wherein each of said outlet ports (8) opens into said passageway (5) through an orifice (19) with each of said orifices (19) running along said longitudinal axis (A) for a first distance (20), and wherein said protrusion (10) runs along said longitudinal axis (A) for a second distance (21), and wherein said second distance (21) overlaps with said first distance (20) for at least 50 % of the length of said first distance (20). 10 15
9. Nozzle according to at least one of the preceding claims, wherein said passageway (5) has a circular cross-section. 20
10. Nozzle according to at least one of the preceding claims, wherein said passageway (5) has a cylindrical contour.
11. Nozzle according to at least one of the preceding claims, wherein said tubular body (2) has a cylindrical outer contour at least in the region (7) of said outlet ports (8). 25
12. Nozzle according to at least one of the preceding claims, wherein said outlet ports (8) allow discharging of molten metal out of said tubular body (2) radially to said longitudinal axis (A) and axially to said longitudinal axis (A) in a direction towards said second end (4). 30 35
13. Nozzle according to at least one of the preceding claims, wherein said outlet ports (8) extend through the lateral wall (14) of said tubular body (2) and the end wall (15) of said tubular body (2), delimiting said tubular body (2) at said second end (4). 40
14. Nozzle according to at least one of the preceding claims, with a reducing cross-sectional area of said outlet ports (8) in the direction from said passageway (5) to the outside of said tubular body (2). 45

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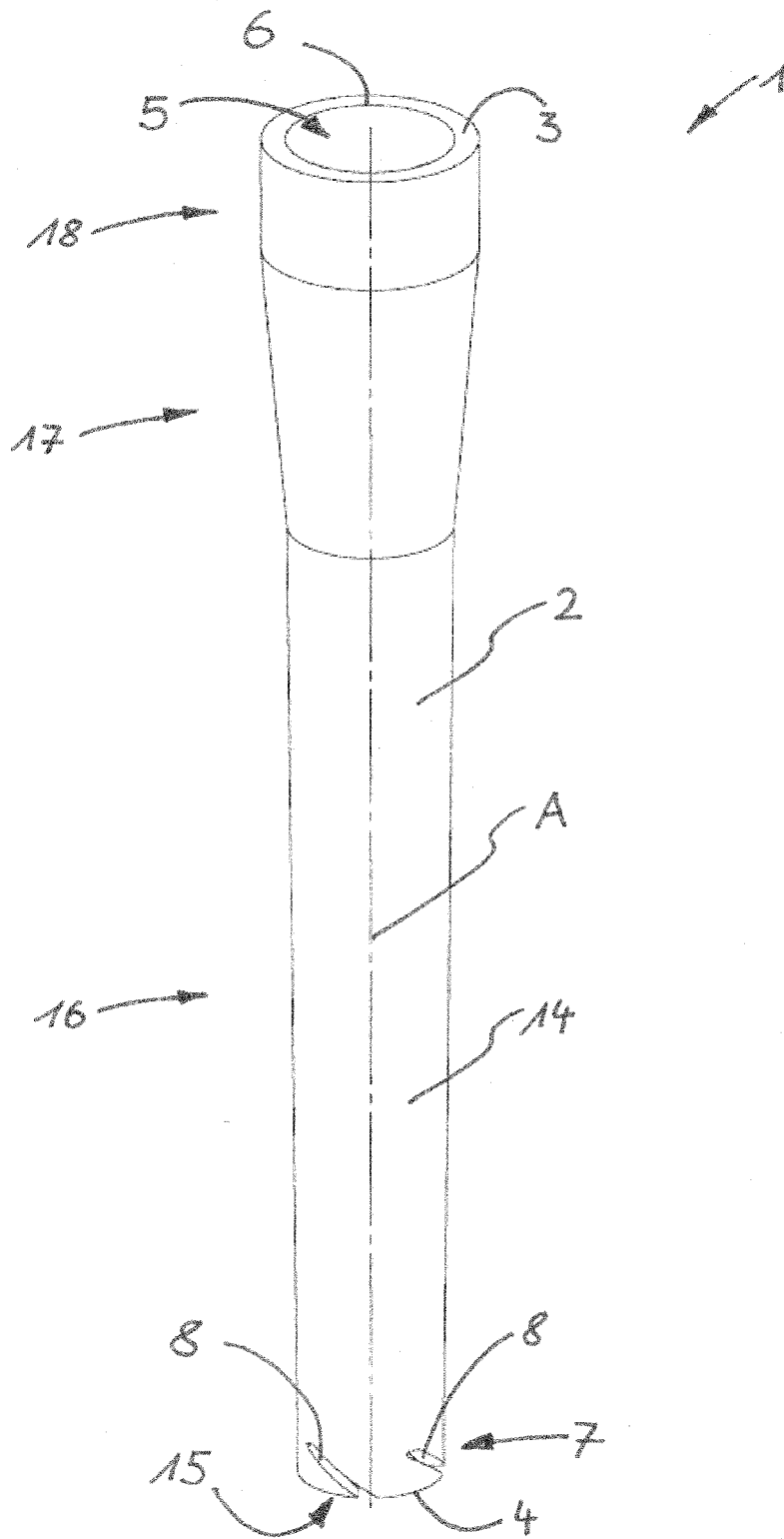


Fig. 1

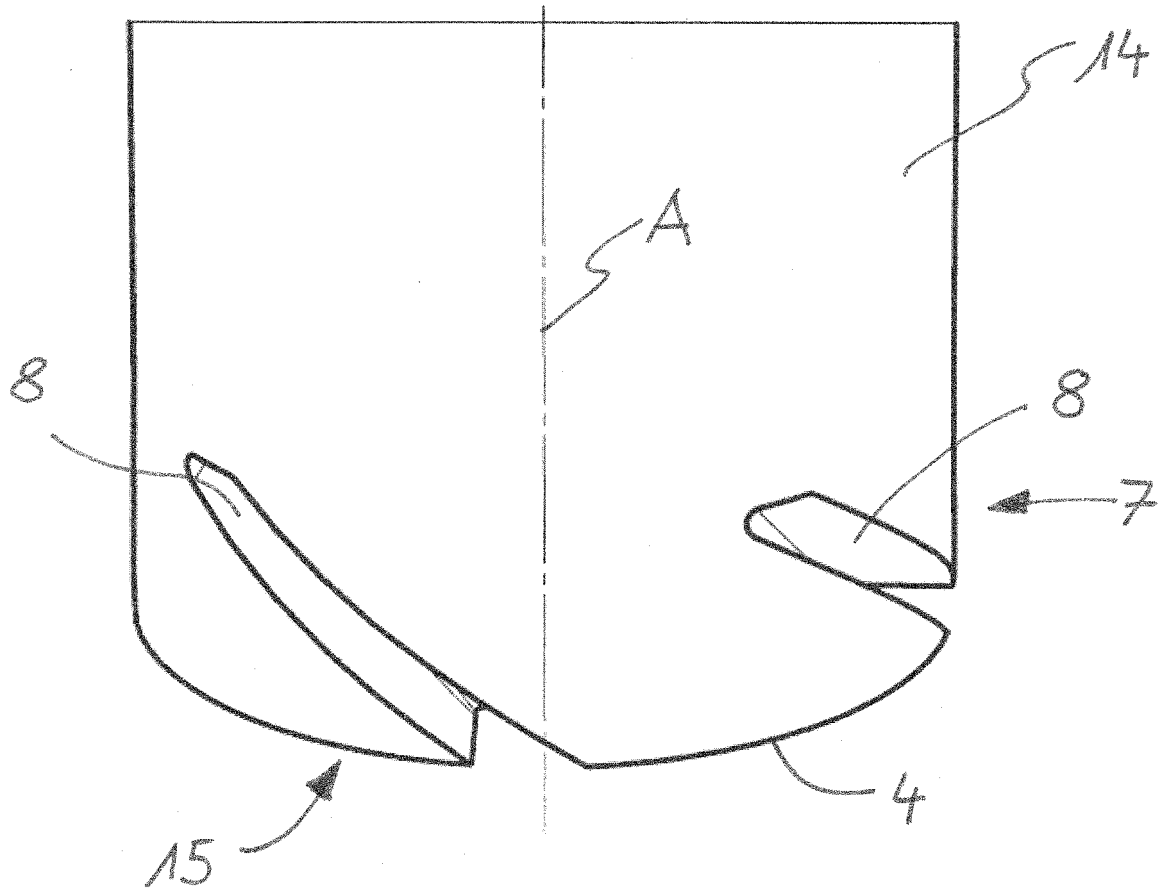


Fig. 2

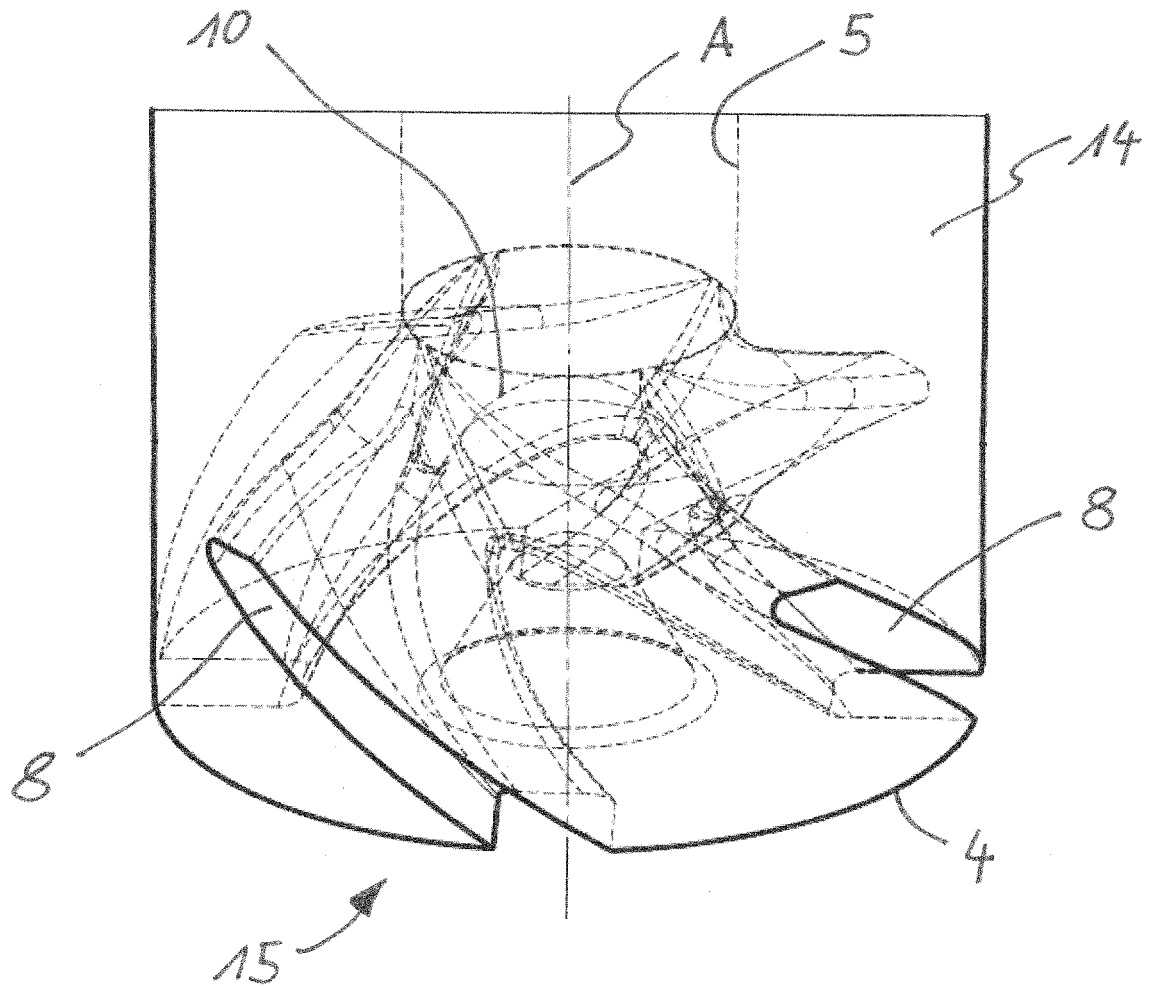


Fig. 3

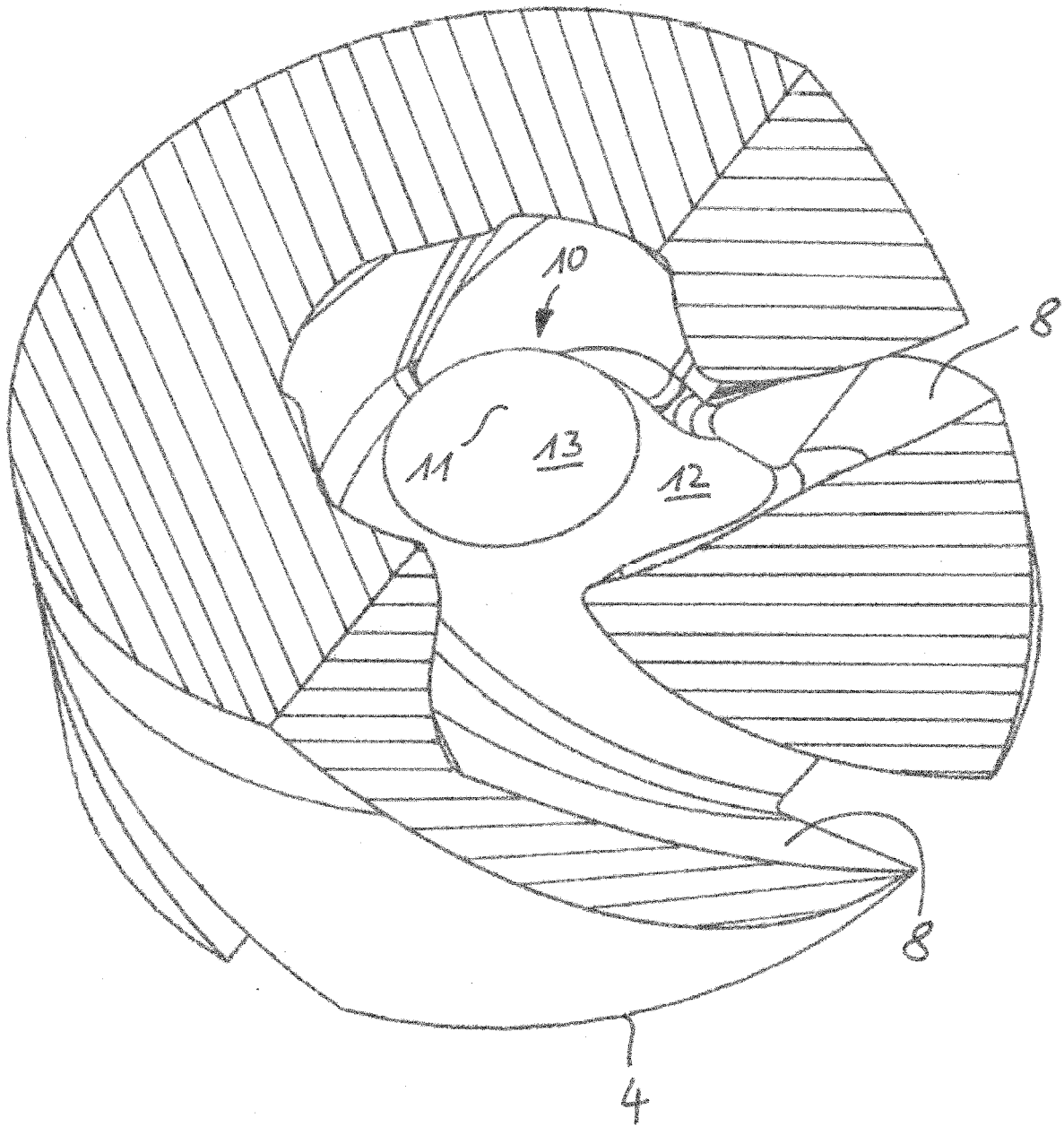


Fig. 4

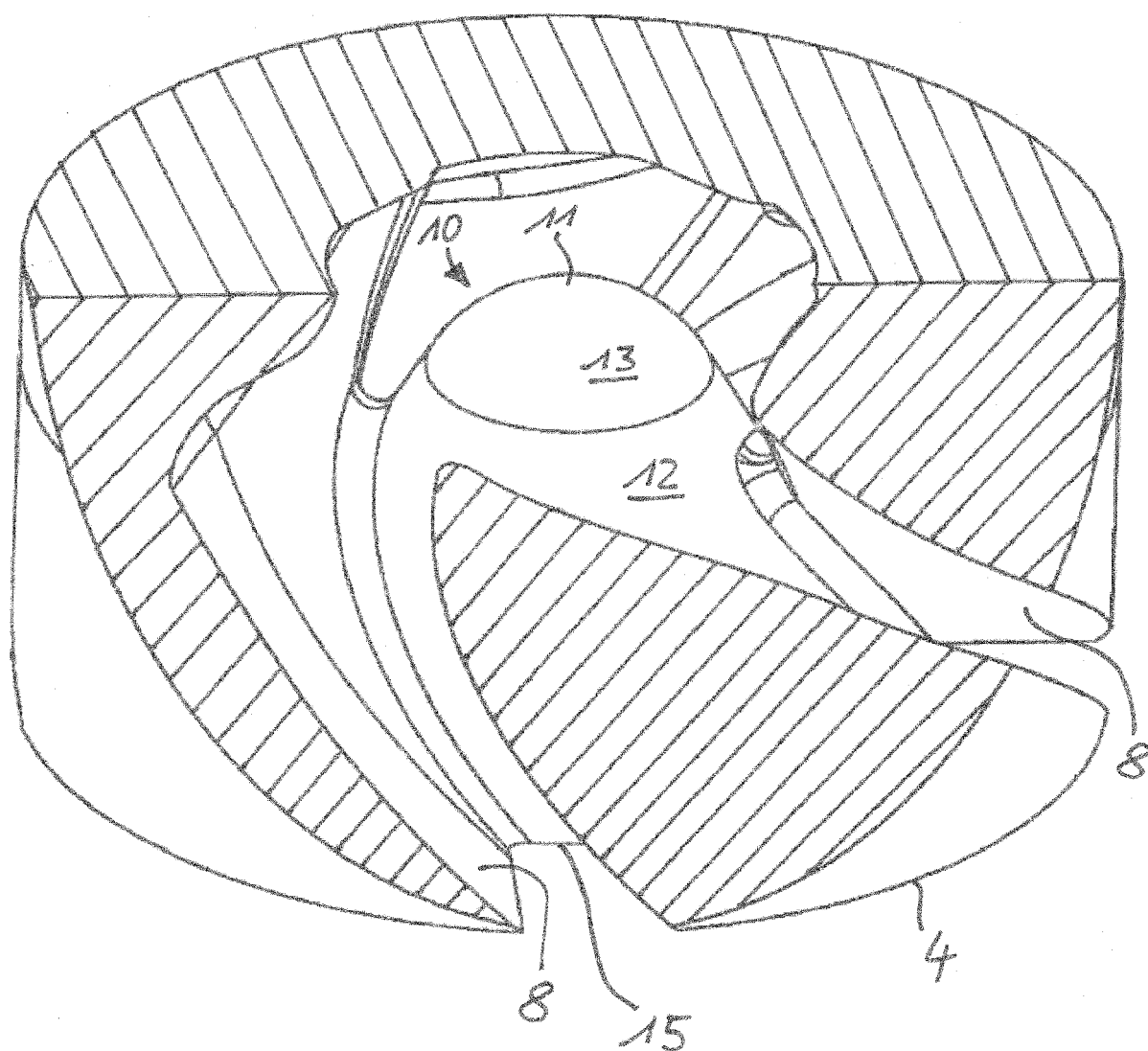
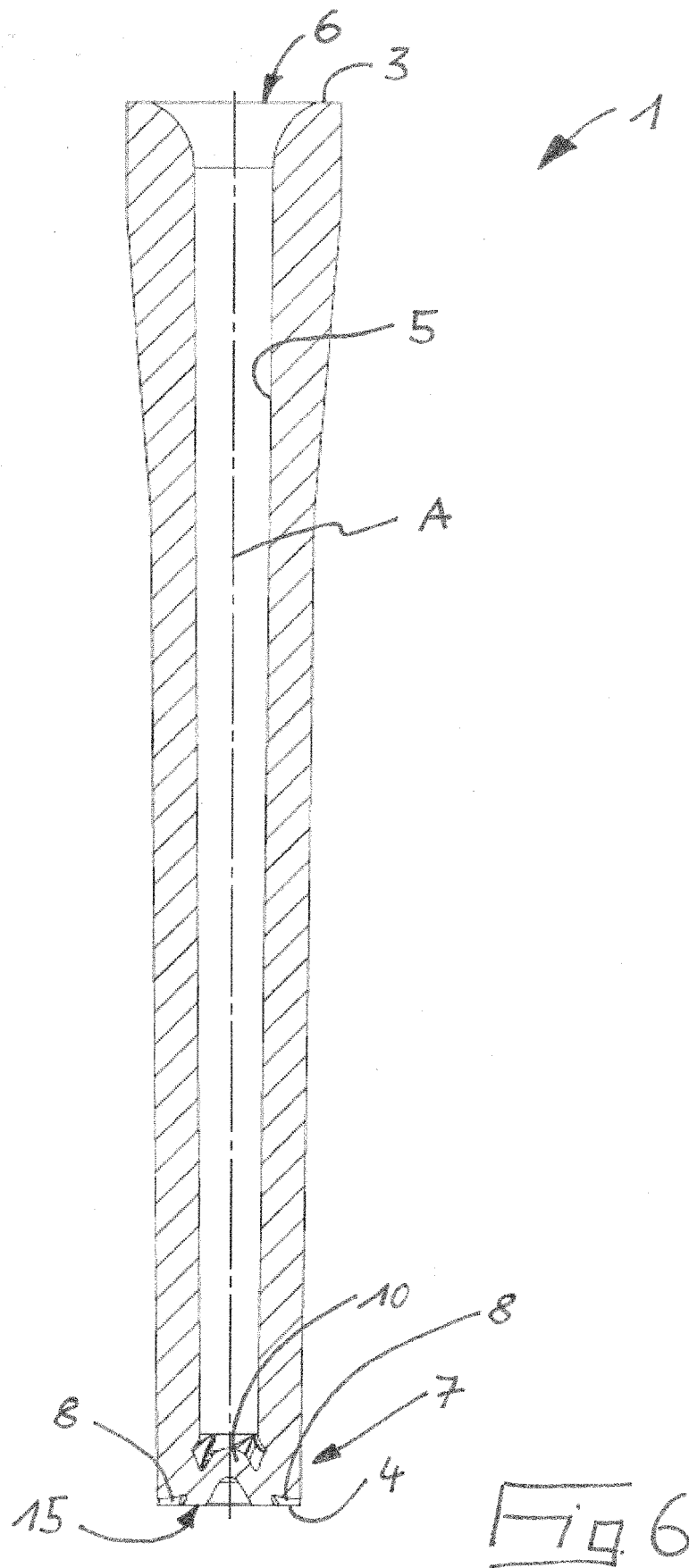
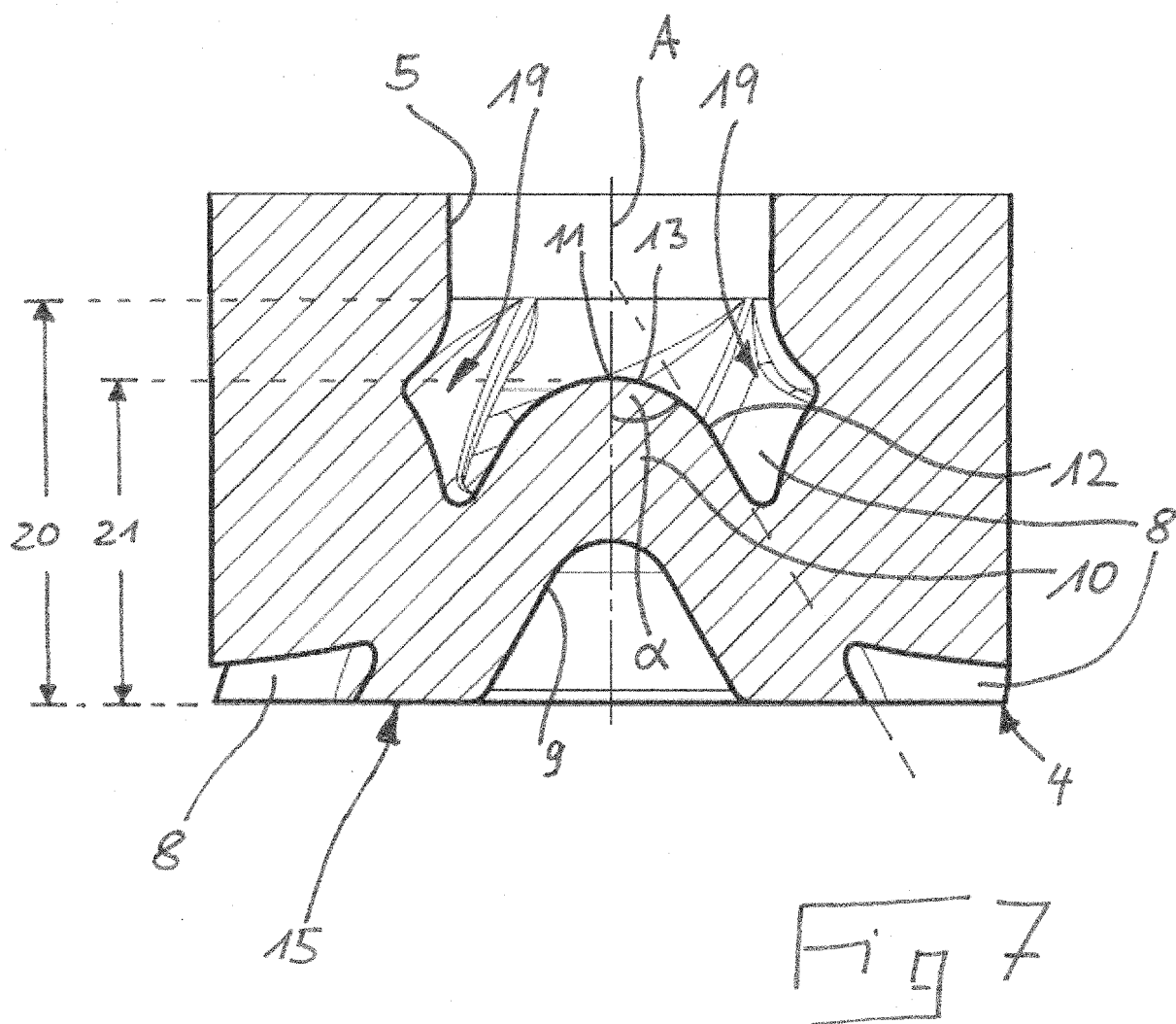


Fig 5





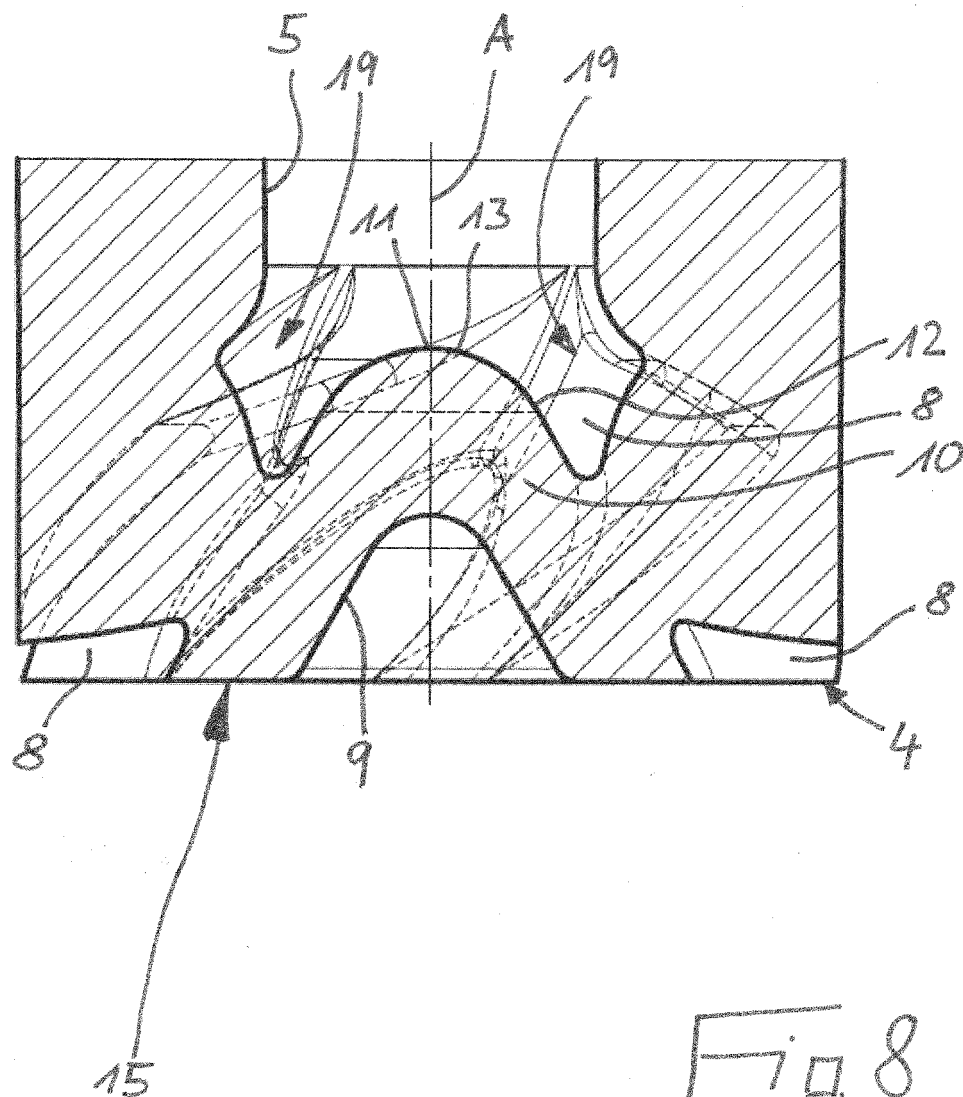


Fig 8



EUROPEAN SEARCH REPORT

Application Number
EP 17 20 3004

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y,D	EP 2 769 786 B1 (REFRACTORY INTELLECTUAL PROPERTY GMBH & CO KG [AT]) 19 April 2017 (2017-04-19) * paragraph [0001] - paragraph [0004] * * paragraph [0015] - paragraph [0016] * * paragraph [0028] * * claims 1,5 * * figures 1-7 *	1-14	INV. B22D41/50 B05B1/14 B05B1/34
Y	US 5 227 078 A (AUGUSTINE III ROBERT B [US]) 13 July 1993 (1993-07-13) * column 3, line 24 - column 3, line 30 * * column 3, line 59 - column 3, line 66 * * column 5, line 11 - column 5, line 39 * * figures 3,4 *	1-14	
Y	JP 2008 000810 A (KOBE STEEL LTD) 10 January 2008 (2008-01-10) * automated translation; paragraph [0016] - paragraph [0022] * * figures 6, 16 *	1-14	
A	CN 2 770 832 Y (LUOYANG REFRACTORY MATERIAL IN [CN]) 12 April 2006 (2006-04-12) * Automated translation : "the utility model is... and two tapping holes"; page 2 - page 2 * * figure 3 *	14	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC) B22D B05B
Place of search The Hague		Date of completion of the search 4 May 2018	Examiner Desvignes, Rémi
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 20 3004

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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04-05-2018

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ORM P0459

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
EP 2769786	B1	19-04-2017	BR 112015015980 A2	11-07-2017
			CA 2896182 A1	28-08-2014
			CN 104884192 A	02-09-2015
			EP 2769786 A1	27-08-2014
			ES 2627861 T3	31-07-2017
			JP 6108324 B2	05-04-2017
			JP 2016508448 A	22-03-2016
			KR 20150100713 A	02-09-2015
			PL 2769786 T3	31-08-2017
			RU 2015126641 A	30-03-2017
			US 2015352636 A1	10-12-2015
			WO 2014127921 A2	28-08-2014

US 5227078	A	13-07-1993	NONE	

JP 2008000810	A	10-01-2008	NONE	

CN 2770832	Y	12-04-2006	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1671721 B1 [0002]
- EP 2769786 B1 [0004] [0027]