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(54) **METHOD FOR PRODUCING A HEAT EXCHANGER**

(57) The invention relates to a method (1) for producing a heat exchanger (18) with a plurality of medium-conducting heat exchanger tubes (16) made of plastic, which in each case open into a tube plate (15) each at a longitudinal end side.

According to the invention, a frame (2) with two needle rows (3) consisting of a plurality of needles (4) which are spaced parallel from one another is first provided in the method. An endless plastic tube (5) is then stretched about the needles (4) meander-like so that the endless plastic tube (5) is wrapped about the needles (5) at wrap-

ping points (6). Here, at least two planes (8) located on top of one another are produced from the endless plastic tube (5) stretched meander-like. Then, the endless plastic tube (5) stretched meander-like is overmoulded with plastic at least at the wrapping points (6) and the tube plates (15) thereby produced. Following this, the endless plastic tube (5) is cut open at the wrapping points (6) on both sides and thus the heat exchanger tubes (16) held in the tube plates (15) produced.

The invention also relates to a heat exchanger (18) that is produced in the method (1).

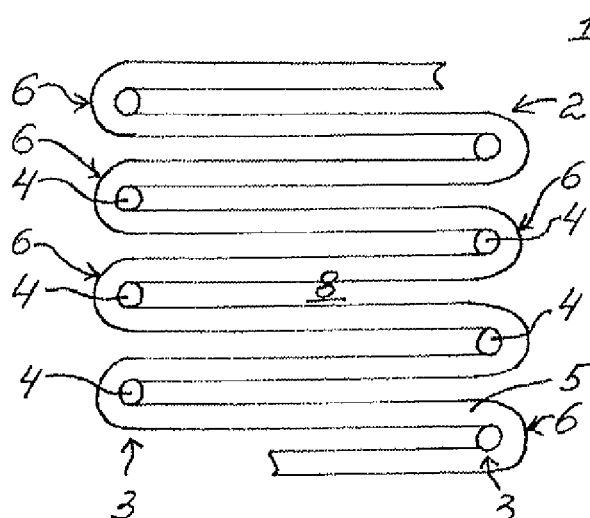


Fig. 1

Description

[0001] The invention relates to a method for producing a heat exchanger with a plurality of medium-conducting heat exchanger tubes made of plastic according to the preamble of Claim 1. The invention additionally relates to a heat exchanger produced according to this method.

[0002] Heat exchangers are already known from the prior art and are used for cooling a medium - for example a charge air or a coolant in a motor vehicle. A heat exchanger usually comprises a plurality of heat exchanger tubes in which the medium to be cooled flows. The medium is conducted into the heat exchanger via an inlet manifold and flows through the individual heat exchanger tubes. The heat exchanger tubes open into an outlet manifold and the cooled medium is conducted out of the heat exchanger. In the heat exchanger, a cooling medium - for example ambient air or a coolant - circulates about the heat exchanger tubes from the outside and a heat exchange between the medium to be cooled and the cooling medium takes place. In this way, the medium to be cooled can be cooled in the heat exchanger tubes by a colder cooling medium. The heat exchanger tubes can be produced both from metal - for example from aluminium - and also from plastic. Since plastics usually have a lower heat conductivity than metals, the number of the heat exchanger tubes in the heat exchanger has to be increased in order to achieve an adequate heat transfer between the medium to be cooled and the cooling medium.

[0003] A heat exchanger made of plastic is usually produced in an injection moulding method as described for example in JP 4398383 B2. Here, an injection mould is provided, into which the plastic is injected. Among other things, all hollow spaces in which the medium to be cooled flows later on also have to be kept clear in the injection mould. To this end, a plurality of core rods is arranged in the injection mould and overmoulded later on. Following this, the core rods are removed and the individual heat exchanger tubes in the heat exchanger formed in this way. Since the number of the heat exchanger tubes necessary for the adequate heat exchange is very high, providing such an injection mould and thus producing the heat exchange involves very high expenditure.

[0004] The object of the invention therefore is to state an improved or at least alternative method for producing a heat exchanger of the generic type, with which the described disadvantages are overcome.

[0005] According to the invention, this object is solved through the subject of the independent Claim 1. Advantageous embodiments are subject of the dependent claims.

[0006] The present invention is based on the general idea of using an endless prefabricated tube made of plastic in a method for producing a heat exchanger. Here, the heat exchanger is produced in the method with a plurality of medium-conducting heat exchanger tubes

made of plastic, which in each case open into a tube plate at each longitudinal end side. According to the invention, a frame with two needle rows of a plurality of needles spaced parallel to one another is provided initially. About the needles, at least one endless plastic tube is stretched meander-like so that the endless plastic tube is wrapped around the needles at wrapping points. At least two planes located on top of one another produced from the at least one endless plastic tube stretched meander-like and the at least one endless plastic tube stretched meander-like is then overmoulded at least at the wrapping points to the tube plates. Following this, the at least one endless plastic tube is cut open on both sides at the wrapping points and thereby the heat exchanger tubes held in the tube plates produced.

[0007] In the method according to the invention, the at least one endless plastic tube is stretched on a frame, wherein the at least one endless plastic tube is already prefabricated. In order to be able to stretch the endless plastic tube about the needles meander-like the endless plastic tube is practically flexible and can be bent about the needles. Because of this, the conventionally necessary arranging of the core rods for producing the individual heat exchanger tubes is advantageously avoided. The number of the needles in the respective needle row and the number of the planes are determined by the desired number of heat exchanger tubes in the heat exchanger. To simplify the method, the at least two planes can be produced from an individual endless plastic tube stretched meander-like about the needles. The frame including defined planes consisting of the at least endless plastic tube stretched meander-like is placed into a plastic injection mould and overmoulded at least at the wrapping points. In this way, the endless plastic tube is at least partially embedded in the tube plates on both sides. In order to produce a plate surface of the respective tube plate with the confluent heat exchanger tubes, the endless plastic tube is cut open at the wrapping points on both sides and the endless plastic tube divided into the plurality of heat exchanger tubes. Here, a part of the tube plates can for example be cut off and because of this the endless plastic tube also cut open at the wrapping points on both sides. Since the endless plastic tube is embedded in the tube plates, the newly formed heat exchanger tubes open into the respective plate surfaces of the tube plates. Thus, the heat exchanger tubes are already formed following the cutting-open and no further steps for exposing the heat exchanger tubes are necessary. In the method according to the invention, the already prefabricated endless plastic tube is used and the method thereby clearly simplified. In particular, the conventionally necessary arranging of the core rods and their removal is advantageously avoided.

[0008] [Question to the inventors: Is this correct?]

In the method, an endless plastic tube with an inner diameter of approximately 0.65 mm and/or an outer diameter of approximately 0.8 mm can be used. In this way, the heat exchanger with suitably dimensioned heat ex-

changer tubes can be produced with a reduced expenditure.

[0009] In order to be able to fix the endless plastic tube on the needles axially to these, it can be provided that the endless plastic tube is fixed in fixing recesses of the respective needles in a form-fit manner at least in regions. The fixing recesses in the respective needles can for example revolve about the respective needle and be arranged along the needle spaced from one another. Through the fixing recesses, the endless plastic tube can be fixed on the needles in a simplified manner and the individual planes formed from the endless plastic tube stretched meander-like.

[0010] In order to produce overmoulding forms for the two tube plates, before the overmoulding, two holder plates consisting of a plurality of holder plate pieces are arranged in the frame between the two needle rows and in parallel to these. There, the heat exchanger tubes are fixed in a form-fit manner in holder recesses. The holder recesses are formed in the holder plates between the two adjacent holder plate pieces and each of the heat exchanger tube is fixed in the respective holder recess in a form-fit manner. The dimensions of the holder recesses in the two holder plates are adjusted to the diameter of the endless plastic tube to separate an inner space of the frame from the two needle rows tightly. After this, an overmoulding case can be fixed on each of the two holder plates and around the two needle rows to form two overmoulding forms. Hence, the inner space of the frame is separated from the two needle rows and the wrapping points of the endless tube by the two overmoulding forms. During the overmoulding, the tube plates are formed in the two overmoulding forms and the inner space of the frame is not overmoulded. After the overmoulding, the overmoulding forms can be removed from the frame in known manner.

[0011] During the overmoulding, the endless plastic tube stretched meander-like is overmoulded at least at the wrapping point and the tube plates thus produced on both sides. In order to produce the heat exchanger and protect the heat exchanger tubes from deforming, it can be provided that the two tube plates are braced against one another to form a heat exchanger block using at least one spacer. The spacer can for example be a brace or a metal rod which fixes the two tube plates spaced from one another.

[0012] Alternatively, during the overmoulding, the endless plastic tube stretched meander-like can be overmoulded at the wrapping points and at two further sides of the frame located opposite one another and a heat exchanger frame with the two tube plates connected to one another be produced. The heat exchanger frame thus frames the heat exchanger tubes on four sides and on the sides which are not framed a flow surface for a cooling medium is formed in each case.

[0013] Advantageously it can be provided that a manifold is fixed onto the tube plates in a bonded manner. By way of the respective manifold, the medium to be

cooled can be fed into the heat exchanger and conducted out of the heat exchanger. The respective manifold in this case can be fixed on the respective tube plate for example by overmoulding with plastic, by gluing or ultrasound welding.

[0014] In the method according to the invention the already prefabricated endless plastic tube is used and the method for producing the heat exchanger made of plastic significantly simplified because of this. In particular, the conventionally necessary arranging of the core rods and their removal is advantageously avoided.

[0015] The invention also relates to a heat exchanger with a plurality of medium-conducting heat exchanger tubes made of plastic, which in each case open into a tube plate each at a longitudinal end side. According to the invention, the heat exchanger is produced in a method described above. Advantageously it can be provided that the heat exchanger tubes have an inner diameter of approximately 0.65 mm and/or an outer diameter of approximately 0.8 mm.

[0016] Altogether, the heat exchanger can be produced with reduced expenditure and the heat exchange between the medium to be cooled in the heat exchanger tubes and the cooling medium advantageously increased.

[0017] Further important features and advantageous of the invention are obtained from the subclaims, from the drawings and from the associated figure description by way of the drawings.

[0018] It is to be understood that the features mentioned above and still to be explained in the following cannot only be used in the respective combination stated but also in other combinations or by themselves without leaving the scope of the present invention.

[0019] Preferred exemplary embodiments of the invention are shown in the drawings and are explained in more detail in the following description, wherein same reference characters relate to same or similar or functionally same components.

[0020] It shows, in each case schematically

Fig. 1 a plane formed by a wrapping of an endless plastic tube in a method according to the invention;

Fig 2 a plane formed by wrapping of an endless plastic tube about the needles with a smooth surface in a method according to the invention;

Fig. 3 and 4 a plane formed by wrapping of an endless plastic tube fixed in a form-fit manner in fixing recesses in a method according to the invention;

Fig. 5 an overmoulding form formed by an overmoulding case and a holder plate consisting of a plurality of holder plate pieces

- in a method according to the invention;
- Fig. 6 and 7 a tube plate prior to a cutting-open and after a cutting-open in a method according to the invention;
- Fig. 8 and 9 possible configurations of heat exchangers produced in a method according to the invention.

[0021] As shown in Fig. 1, a frame 2 with two needle rows 3 spaced parallel from one another is initially provided in the method 1 according to the invention. The needle rows 3 have a plurality of needles 4 about which an endless plastic tube 5 is stretched meander-like. The endless plastic tube 5 is already prefabricated and flexible so that the endless plastic tube 5 can be bent about the needles 4. By using the frame 2 and the endless plastic tube 5, the conventionally necessary arranging of the core rods for producing the hollow spaces is advantageously avoided. The endless plastic tube 5 is wrapped about the needles 4 at wrapping points 6 and can be fixed on a smooth surface of the needles 4 as shown in Fig. 2. Alternatively, the endless plastic tube 5 can be fixed in a form-fit manner in fixing recesses 7 of the respective needles 4 in regions as shown in Fig. 3 and 4.

[0022] The wrapping points 6 arranged spaced from one another along the respective needles 4 so that a plurality of planes 8 - here only one plane 8 is shown for the sake of clarity - consisting of the endless plastic tube 5 can be formed on top of one another. To simplify the method 1, each of the planes 8 can be formed by a separate endless tube 5.

[0023] As shown in Fig. 5, a holder plate 9 consisting of a plurality of holder plate pieces 10 is arranged in the frame 2 between the two needle rows 3 and parallel to these. There, the endless plastic tube 5 is fixed in a form-fit manner in holder recesses 11 formed in the holder plate 9 between the two adjacent holder plate pieces 10 in a form-fit manner. After this, an overmoulding case 12 is fixed on the holder plate 9 and around the needle row 3. In this way, the overmoulding form 13 is formed by the holder plate 9 and the overmoulding case 12. The overmoulding form 13 separates tightly an inner space 14 of the frame 2 from the enclosed wrapping points 6 of the endless tube 5.

[0024] The frame 2 with the defined planes 8 consisting of the endless plastic tube 5 stretched meander-like and with the overmoulding forms 13 is placed into a plastic injection mould and the endless plastic tube 5 stretched meander-like is overmoulded at the wrapping points 6 enclosed in the overmoulding forms 13 to form a tube plate 15, as shown in Fig. 6. During the overmoulding of the wrapping points 6, the endless plastic tube 5 is embedded into the tube plate 15 at least in regions and the endless plastic tube is fixed in the tube plate 15 in this manner. After this, the moulding form 13 is removed from the formed tube plate 15. In Fig. 7, the tube plate 15 is

now shown after a cutting-open of the endless plastic tube 5 at the wrapping points 6. During the cutting-open, a part of the tube plate 15 is cut off so that the endless plastic tube 5 is divided into a plurality of heat exchanger tubes 16. In this way, a plate surface 17 of the tube plate 15 is formed, into which the heat exchanger tubes 16 individually open. The heat exchanger tubes 16 are formed even after the cutting-open of the tube plate 15 and the conventionally necessary arranging and the removing of the core rods are advantageously avoided. The method 1 is clearly simplified because of this. The desired number of the heat exchanger tubes 16 in this case is determined by the number of the needles 4 in the respective needle row 3 and the number of the planes 8.

[0025] In Fig. 8, a possible embodiment of a heat exchanger 18 is shown, which is produced in the method 1. Here, during the overmoulding, the endless plastic tube 5 stretched meander-like is only overmoulded at the wrapping points 6 and the tube plates 15 produced. In order to protect the heat exchanger tubes 16 from deforming, the two tube plates 15 are fixed spaced from one another with a spacer 19 to form a heat exchanger block 20. The spacers can for example be brazes or metal rods. In addition, manifolds 21 are fixed on the plate surfaces 17 in a bonded manner so that the medium to be cooled can be conducted into the heat exchanger tubes 16 and conducted out of the heat exchanger tubes 16.

[0026] Fig. 9 shows the alternatively configured heat exchanger 18, which is produced in the method 1. Here, during the overmoulding, the endless plastic tube 5 stretched meander-like is overmoulded at the wrapping points 6 and at two further opposite sides of the frame 2 and a heat exchanger frame 22 produced. The heat exchanger frame 22 thus comprises the tube plates 15 and two side walls 23 and frames the heat exchanger tubes 16 on four sides. Here, too, the manifolds 21 are fixed on the plate surfaces 17 with the confluent heat exchanger tubes 16 in a bonded manner so that the medium to be cooled can be distributed into the heat exchanger tubes 16 and collected from the heat exchanger tubes 16.

[0027] In the method 1 according to the invention, the already prefabricated endless plastic tube 5 is used and the method 1 for producing the heat exchanger 18 made of plastic significantly simplified because of this. In particular, the conventionally necessary arranging and the removing of the core rods is advantageously avoided.

Claims

1. A method (1) for producing a heat exchanger (18) with a plurality of medium-conducting heat exchanger tubes (16) made of plastic, which in each case open into a tube plate (17) in each case at a longitudinal end side,
characterized in that

- a frame (2) with two needle rows (3) consisting

- of a plurality of needles (4) spaced parallel from one another is provided,
- at least one endless plastic tube (5) is stretched about the needles (4) meander-like so that the endless plastic tube (5) wraps about the needles (4) at wrapping points (6),
 - at least two planes (8) lying on top of one another are produced from the at least one endless plastic tube (5) stretched meander-like,
 - the at least one endless plastic tube (5) stretched meander-like is overmoulded with plastic at the wrapping points (6) and thereby the tube plates (15) produced, and
 - the at least one endless plastic tube (5) is cut open at the wrapping points (6) on both sides and thus the heat exchanger tubes (16) held in the tube plates (15) produced.
2. The method according to Claim 1,
characterized in that
the at least one endless plastic tube (5) is fixed in a form-fit manner in fixing recesses (7) of the respective needles (4) at least in regions.
3. The method according to Claim 1 or 2,
characterized in that
the at least two planes (8) are produced from an individual endless plastic tube (5) stretched about the needles (4) meander-like.
4. The method according to any one of the preceding claims,
characterized in that
- before the overmoulding, two holder plates (9) consisting of a plurality of holder plate pieces (10) are arranged in the frame (2) between the two needle rows (3) and parallel to these, and
 - the endless plastic tube (5) is fixed in holder recesses (11) in a form-fit manner formed between the two adjacent holder plate pieces (10) in a form-fit manner.
5. The method according to Claim 4,
characterized in that
- before the overmoulding, an overmoulding case (12) is fixed on each of the two holder plates (9) and around the two needle rows (3) to form two overmoulding forms (13), and
 - during the overmoulding, the tube plates (15) are formed in the two overmoulding forms (13).
6. The method according to one of the preceding claims 1 to 5,
characterized in that
the two tube plates (15) are braced against one another with at least one spacer (19) to form a heat
- exchanger block (20).
7. The method according to one of the preceding claims 1 to 5,
characterized in that
during the overmoulding, the endless plastic tube (5) stretched meander-like is overmoulded at the wrapping points (6) and at two further opposite sides of the frame (2) and thus a heat exchanger frame (22) with the two tube plates (15) connected to one another is produced.
8. The method according to any one of the preceding claims,
characterized in that
a manifold (21) is fixed on the tube plates (15) in a bonded manner.
9. The method according to any one of the preceding claims,
characterized in that
an endless plastic tube (5) with an internal diameter of approximately 0.65 mm and/or an outer diameter of approximately 0.8 mm is used.
10. A heat exchanger (18), with a plurality of medium-conducting heat exchanger tubes (16) made of plastic, which in each case open into a tube plate (15) each at the longitudinal end side,
characterized in that
the heat exchanger (18) is produced in the method (1) according to any one of the preceding claims.
11. The heat exchanger according to Claim 10,
characterized in that
the heat exchanger tubes (16) have an inner diameter of approximately 0.65 mm and/or an outer diameter of approximately 0.8 mm.

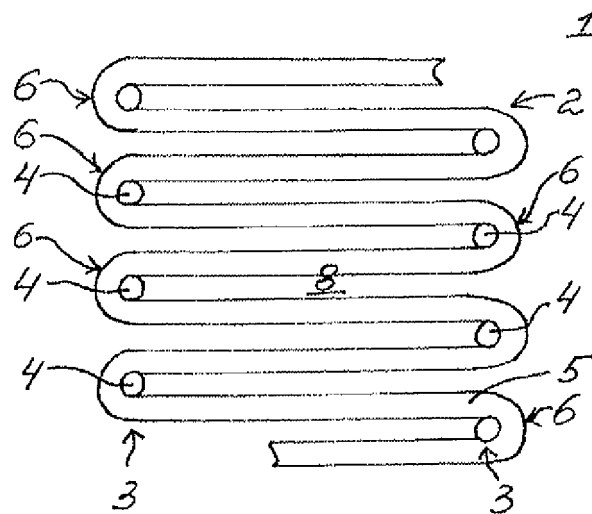


Fig. 1

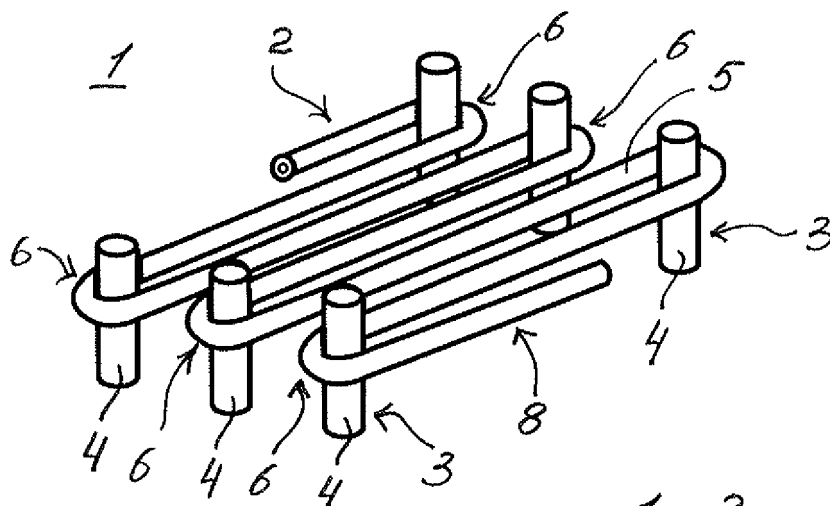


Fig. 2

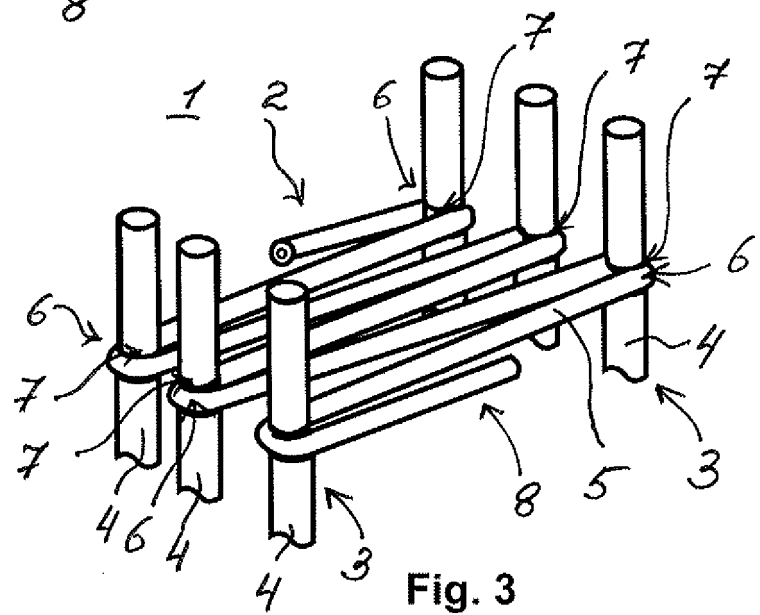


Fig. 3

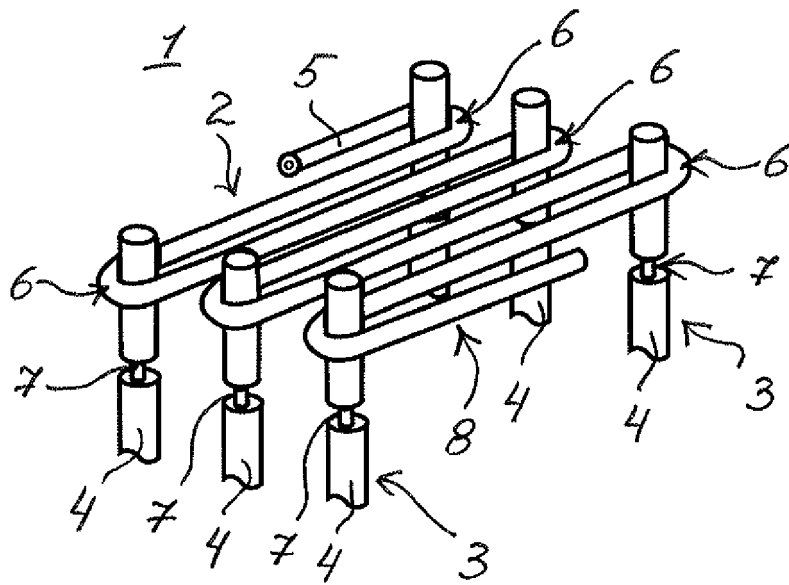


Fig. 4

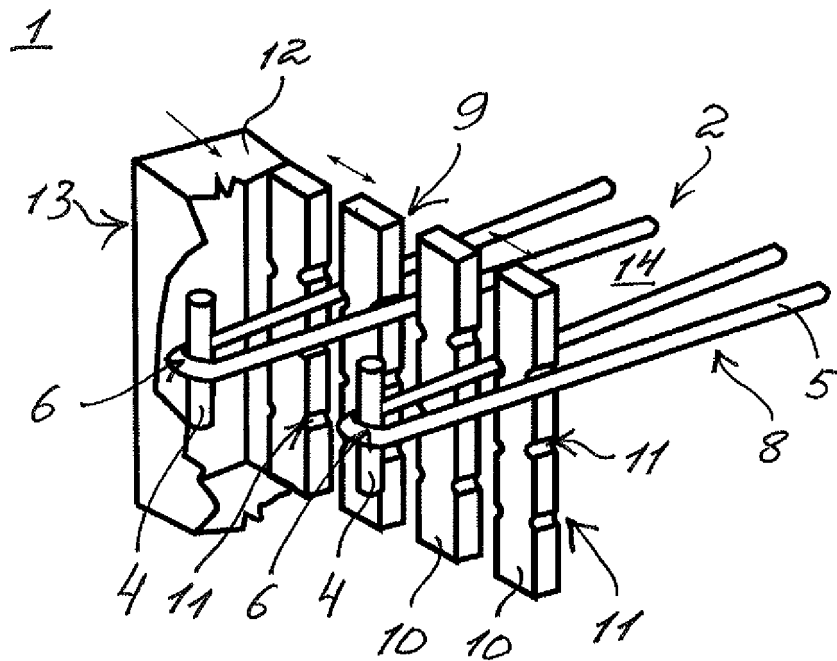


Fig. 5

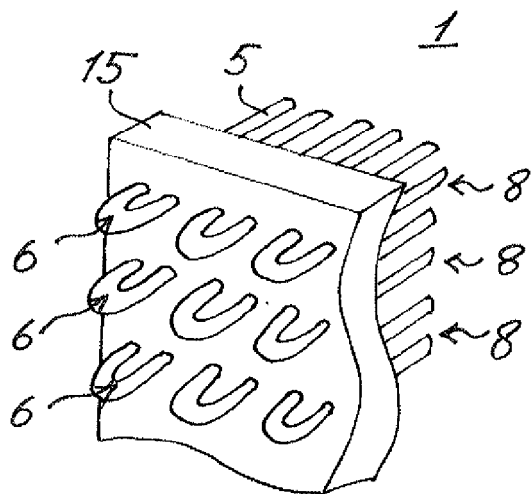


Fig. 6

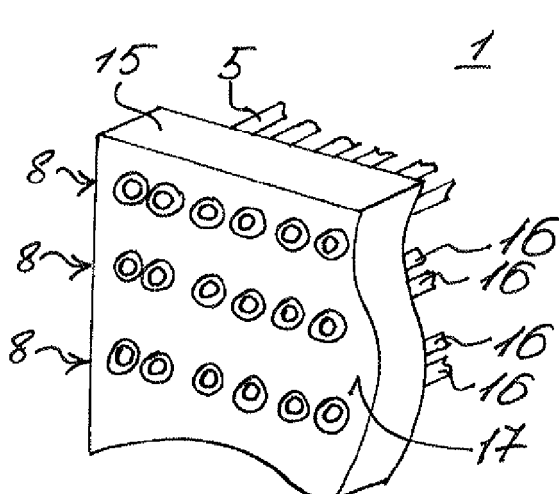


Fig. 7

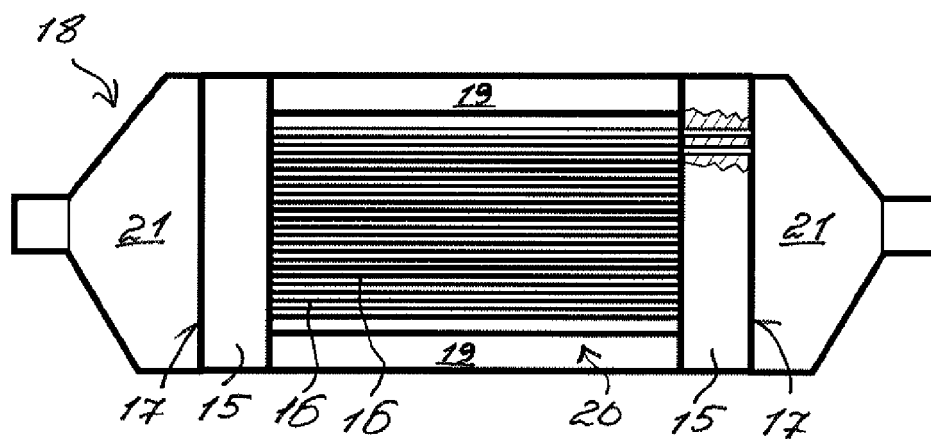


Fig. 8

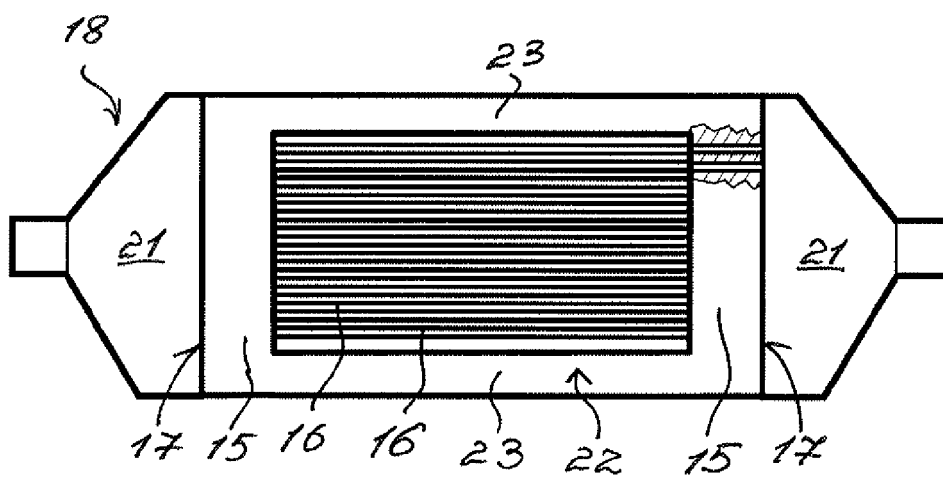


Fig. 9



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EP 17 19 0572

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