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(54) **Corrosion-protected construction in a pipe heat exchanger and a method for forming the construction**

(57) The invention relates to a corrosion-protected construction in a pipe heat exchanger, which construction includes a pipe (11) protected from corrosion by a surfacing (15) and a pipe plate (13) forming the frame of the heat exchanger and supporting the end of the pipe (11). In addition, a through-hole (14) is formed in the pipe plate (13) for the pipe (11). The construction also includes an attachment piece (16), made of corrosion-resistant material, arranged between the pipe (11) and the through-hole (14). The attachment piece (16) is of a hardening corrosion-protection substance, which essentially fills the entire space (17) between the pipe (11) and the through-hole (14). The invention also relates to a method for forming the corrosion-protected construction in a pipe heat exchanger.

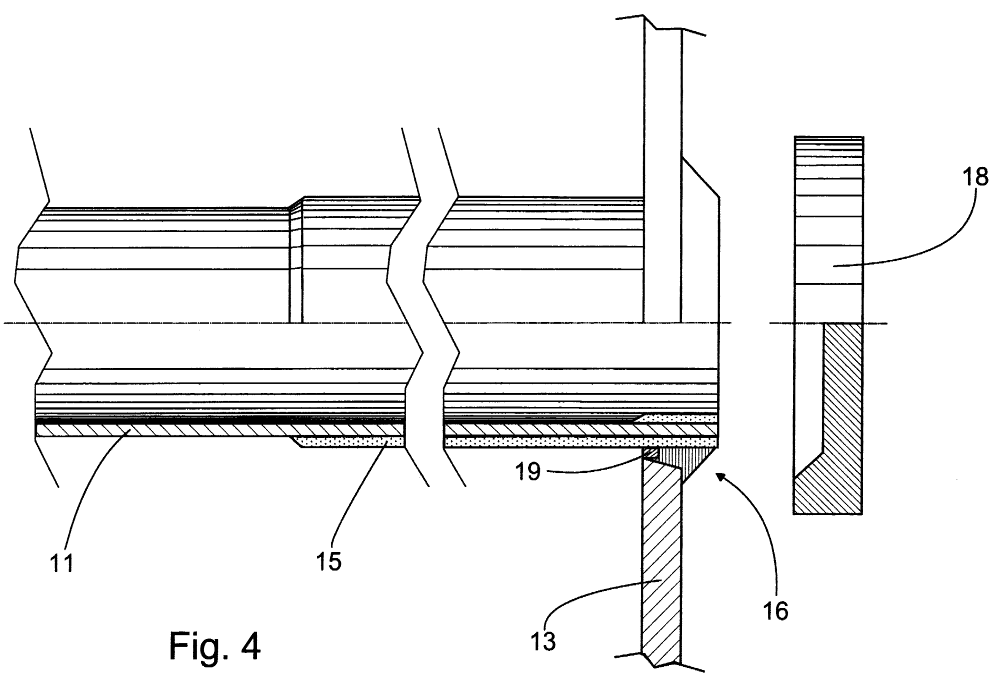

Fig. 4

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Description

[0001] The present invention relates to a corrosion-protected construction in a pipe heat exchanger, which construction includes

- a corrosion-protected pipe including a surfacing,
- a pipe plate forming the frame of the heat exchanger and supporting the end of the pipe, and in which a through-hole is formed for the pipe, and
- an attachment piece, made of a corrosion-resistant substance, arranged between the surfaced pipe and the through-hole. The invention also relates to a method for forming a corrosion-protected construction in a pipe heat exchanger.

[0002] Large heat exchangers are used particularly in power plants. One of the applications of heat exchangers is as a in a power plant used pre-heater for the air, the flue gases formed during production being lead through the pre-heater. Correspondingly, air is circulated through the pipes of a pipe heat exchanger, and is led to the process after being pre-heated. The pipes are usually arranged as banks of pipes, which are connected to each other to form the heat exchanger. In the banks of pipes, the pipes are attached by their ends to a pipe plate, which supports the pipes.

[0003] Corrosion forms a significant problem in terms of the service life of a heat exchanger. Corrosion is generally most rapid in the pipes through which cold air is led to the heat exchanger. Usually, these pipes are also the final pipes in the direction of circulation of the flue gases, when the temperature in the lower part of the pipe heat exchanger is at precisely the condensation point of acid. Thus, especially the sulphur compounds of the flue gas condense onto the surface of the pipes as sulphuric acid, causing the pipes to corrode rapidly. At the same time, the pipes corrode at the attachment welds, when the pipes can even become detached.

[0004] To prevent corrosion, the pipes are surfaced with a corrosion-protection substance. However, the protection of a completed bank of pipes is difficult, while the surfacing can also remain uneven. On the other hand, the use of surfaced pipes has been disadvantageous, because the anti-corrosion surface has been damaged during welding, or else welding has been impossible. Japanese patent publication number 7253289 discloses precisely an arrangement for attaching surfaced pipes to the pipe plate. According to this publication, special attachment members are used, being placed between the surfaced pipe and the through-hole in the pipe plate, to prevent the surfacing of the pipe from being broken. The attachment members themselves are made from corrosion-resistant material. The solution referred to avoids welding, but the installation of the attachment members is difficult and the tightness of the finished attachment is questionable. In addition, the tolerance requirements of the attachment members are disadvantageously tight, in terms of manufacture and installation.

[0005] The present invention is intended to achieve a simpler corrosion-protected construction for a pipe heat exchanger, which is both simpler and more durable than previously. The invention is also intended to achieve a method for forming the corrosion-protected construction, which can be used with different kinds of pipes and which is more economical than previously to implement. The characteristic features of the construction according to the invention are stated in the accompanying Claim 1, while the characteristic features of the method are stated in the accompanying Claim 7. According to the present invention, the attachment of the pipe exploits both a corrosion-protection substance and its properties. The construction is then corrosion-protected throughout. However, the corrosion protection and also the attachment of the pipe are considerably easier to implement than previously. In addition, the corrosion-protected construction is entirely tight and will withstand well both thermal and mechanical stress. The method according to the invention provides not only corrosion protection, but also easy attachment of the pipe. The final result is a corrosion-protected construction, which is durable and has little effect on the flow of the flue gases.

[0006] In the following, the invention is described in greater detail with reference to the accompanying drawings, which illustrate one application of the invention and in which

Figure 1	shows a side view of a pipe heat exchanger according to the invention,
Figure 2	shows a cross-section of Figure 1 at level A-A,
Figure 3	shows a partial cross-section of one corrosion-protected construction according to the invention, during construction,
Figure 4	shows the completed corrosion-protected construction of Figure 3.

[0007] Figures 1 and 2 show as an embodiment of the invention a air pre-heater, which applies the corrosion-protected construction according to the invention. The actual flue gas duct is not shown, but in the pipe heat exchanger of Figure 1 the flue gases travel from the top downwards. The direction of movement of the flue gas is shown with a thick arrow. Air, on the other hand, travels mostly horizontally in the pipe heat exchanger. In a way that is as such known, the pipe heat exchanger is formed of banks of pipes 10, 10', and 10", in which there are numerous pipes a small distance from each other. The banks of pipes 10, 10', and 10" are connected to each other by means of air ducts 12, 12', and 12", so that in the embodiment the air travels in an S-shaped route (thin line of dots and dashes).

[0008] In the solutions shown, air is fed into the pipe heat exchanger from the end of the first air duct 12 at the lower right, according to Figures 1 and 2. From the first air duct 12, the air travels through the pipes 11 of the lower bank of pipes 10 to the other side of the pipe heat exchanger. In the second air duct 12', already heated air turns upwards into the pipes of the second bank of pipes 10' and continues to heat. Finally, the preheated air is led from the end of the last air duct 12" and into the process. Figure 2 shows a cross-section of the pipe heat exchanger at the lower bank of pipes 10, in which the corrosion of the pipes 11 is a significant problem in the state of the art. This is because the gases in the lower part of the pipe heat exchanger have already cooled considerably, while cold air is simultaneously led into the pipes. In that case, moisture condenses especially on the surface of the lower pipes, which is, in addition, especially corrosive. The path of the air is shown in Figure 2 by solid arrows.

[0009] In the present invention, the problem of the corrosion and attachment of the pipes has been solved at one time. Figure 3 shows a partial cross-section of one pipe 11, which is being attached to the pipe plate 13, which carries the pipe 11. The pipe plate 13, which forms the frame of the pipe heat exchanger, also has a through-hole 14, into the pipe 11 including a surfacing 15 is pushed. The actual attachment takes place by means of an attachment piece 16 (Figure 4), made of corrosion-resistant material, arranged between the surfaced pipe 11 and the through-hole 14. According to the invention, the attachment piece 16 is made of hardening corrosion protection material, which essentially fills the entire space between the through-hole 14 and the pipe 11. Thus the attachment piece forms itself according to the shape of each space, so that the final result is a tight and durable attachment. Here, hardening means that the corrosion-protection substance can be freely shaped during installation, but dries to harden into an attachment piece. Figure 3 shows the construction according to the invention just before the corrosion-protection substance has set.

[0010] The surfacing of the pipe is preferably essentially the same substance as the corrosion-protection substance. This ensures the attachment of the materials to each other is ensured and simplifies the treatment. In addition, the corrosion-protection substance is preferably a polymeric composite substance, in which an epoxy resin filler reacts with an aliphatic or cycloaliphatic hardener. One such substance is a polymeric composite with the trade name ARC 858. The substance is manufactured by A. W. CHESTERTON CO., USA. The substance in question can be easily spread, but on hardening forms a joint that withstands various corrosive substances and mechanical and thermal stress. The substance with the trade name ARC PYRO S6, made by the same manufacturer, with which the pipes are also surfaced, can also be used for the attachment. ARC S4 is also highly suitable for surfacing.

[0011] To ensure that the corrosion-protection substance penetrates thoroughly, a suitable clearance must be arranged between the through-hole 14 and the pipe 11, when the aforesaid space 17 is formed. Generally, before the attachment piece 16 is arranged, the clearance is 2 - 10, preferably 4 - 8 mm. Though the manufacturing tolerances are thus loose, the corrosion-protection substance is able to fill the entire space between the through-hole and the pipe. Penetration can be further improved by forming the through-hole 14 as a conical hole, which is arranged to open out in the direction of the end of the pipe 11 (Figure 3). Thus, when the corrosion-protection substance is being installed, the space 17 opens out towards the fitter. Generally, the coning angle a is 10° - 50°, preferably 20° - 40°, when the thickness layer for the corrosion-protection substance remains reasonable, while the conicality of is, however, sufficient to ensure penetration.

[0012] According to the invention, the surfaced pipe is attached to the pipe plate by means of a hardening corrosion-protection substance, which is used to essentially fill the entire space between the through-hole and the pipe. The attachment is then always made absolutely tight in a simple manner. Because corrosion is a problem precisely at the start of the lower pipes, according to the invention, only the pipes of the lower bank of pipes are pre-surfaced. In addition, the pipes in question are preferably pre-surfaced by spraying a 100 - 1000-mm, preferably 250 - 650-mm length of pipe, beginning from the first end. Thus, the critical part of the pipe is surfaced, while most of the pipe remains uncoated. Besides achieving sufficient protection, the amount of corrosion-protection substance is reduced. Naturally, the length of the surfacing varies in individual cases, depending on the construction and operating conditions of the heat exchanger. In Figures 3 and 4, the layer thickness 15 is intentionally exaggerated, to illustrate the matter. By spraying, an even layer thickness is achieved and its size can be easily controlled. Generally, the layer thickness of the surfacing is 0,1 - 2 mm.

[0013] Further, during installation according to the method according to the invention, the pipe 11 is set in the through-hole 14 (Figure 3) and the corrosion-protection substance is extruded into the space 17 (not shown) delimited by the pipe 11 and the through-hole 14. Next, the corrosion-protection substance that has been squeezed is extruded in the direction of the pipe 11 and, at the same time, the part that has been pressed is smoothed. The amount of corrosion-protection substance is adjusted so that it essentially fills the space between the through-hole and the pipe. Figure 4 also shows the pressing tool 18, by means of which the corrosion-protection substance is pressed and smoothed. Once the smoothed corrosion-protection substance has dried, both the corrosion protection of the construction and the attachment of the pipe are ready for use. Before extrusion, it is preferable to place around the pipe 14 a centring ring 9 according to Figure 3. The centring ring 19 is supported on the sides of through-hole 14, thus centring the pipe 11. The pipe then needs no other support to remain in the correct place while the corrosion-protection substance is being extruded round it and setting. The centring ring also prevents the corrosion-protection substance from being extruded inside the heat exchanger. In addition, this avoids spurting and prevents the corrosion-protection substance from being extruded into only one place. The centring ring is preferably made from nylon, so that it will not adhere to the corrosion-protection substance used and can thus be easily removed if necessary, once the corrosion-protection substance has dried.

[0014] The construction according to the invention is highly resistant to corrosive substances, heat, and mechanical stresses. Nevertheless, the construction is economical to manufacture. The method according to the invention is simple and can be applied in connection with different kinds of pipes. The method can be implemented, despite minor structural deviations and dimensional errors. The method also permits structures of different materials to be combined and even for an unsurfaced pipe to be attached. Thus, the method according to the invention can be applied to attach all the pipes in a heat exchanger.

Claims

1. A corrosion-protected construction in a pipe heat exchanger, which construction includes

- a corrosion-protected pipe (11) including a surfacing (15),
- a pipe plate (13) forming the frame of the heat exchanger and supporting the end of the pipe (11), and in which a through-hole (14) is formed for the pipe (11), and
- an attachment piece (16), made of corrosion-resistant material, arranged between the pipe (11) and the through-hole (14),

characterized in that the attachment piece (16) is of a hardening corrosion-protection substance, which essentially fills the entire space (17) between the pipe (11) and the through-hole (14).

2. A construction according to Claim 1, characterized in that, before the attachment piece (16) is arranged, the clearance between the pipe (11) and the through-hole (14) is 2 - 10, preferably 4 - 8 mm.

3. A construction according to Claim 1 or 2, characterized in that the through-hole (14) is a conical hole, which opens out in the direction of the end of pipe (11).

4. A construction according to Claim 3, characterized in that the coning angle α of the conical hole is 10° - 50°, preferably 20° - 40°.

5. A construction according to one of Claims 1 - 4, characterized in that the corrosion-protection substance is a polymeric composite substance, in which an epoxy-resin filler reacts with an aliphatic or cycloaliphatic hardener.

6. A construction according to one of Claims 1 - 4, characterized in that the surfacing (15) of the pipe (11) is essentially the same substance as the corrosion-protection substance.

7. A method for forming a corrosion-protected construction in a pipe heat exchanger, in which method

- the pipe (11) that is part of the construction is surfaced prior to installation, to protect the pipe (11) from corrosion,
- the surfaced pipe (11) is attached at its ends in a through-hole (14) formed for the pipe (11) in a pipe plate (13) that forms the frame of the heat exchanger and supports the pipe (11),

characterized in that the surfaced pipe (11) is attached to the pipe plate (13) by means of a hardening corrosion-protection substance, by means of which essentially the entire space (17) between the pipe (11) and the through-hole (14) is filled.

8. A method according to Claim 7, characterized in that the pipe (11) is placed in the through-hole (14) and a centring ring (19) is used, which is arranged around the pipe (11) in the through-hole (14) and is pressed to the bottom of space (17), after which corrosion-protection substance is extruded into the space (17) delimited by the pipe (11) and the through-hole (14), from the side of the end of the pipe (11).

9. A method according to Claim 7 or 8, characterized in that the through-hole (14) is given a conical shape and opens out on the side of the end of the pipe (11).

10. A method according to Claim 8, characterized in that the extruded corrosion-protection substance is pressed in the direction of the pipe (11), while at the same time a pressing tool (18) is used to smooth the part that has been pressed.

11. A method according to one of Claims 7 - 10, characterized in that the pipe (11) is pre-surfaced by being spraying over a length of 100 - 1000 mm, preferably 250 - 650 mm from the end of the pipe (11).

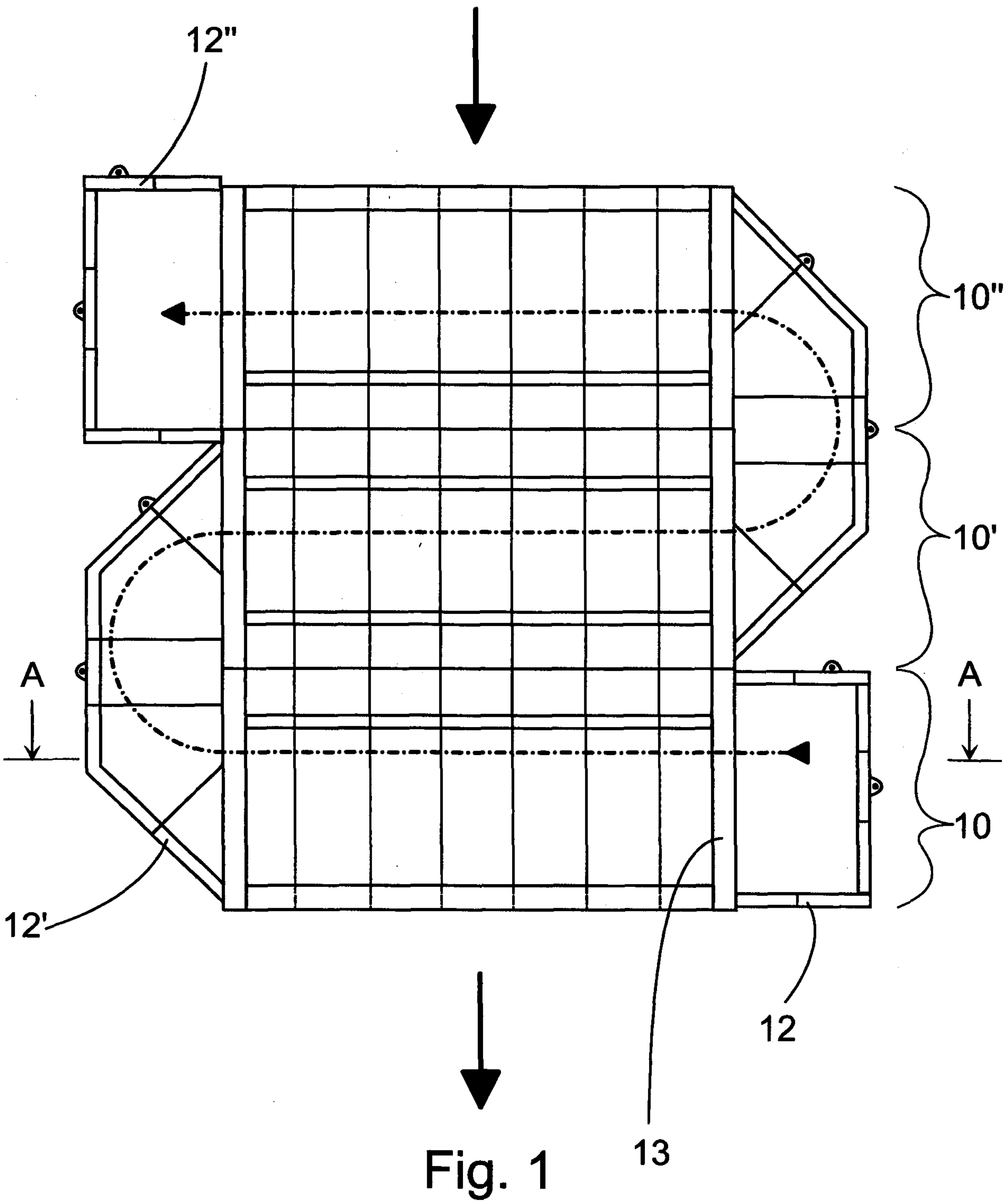

Fig. 1

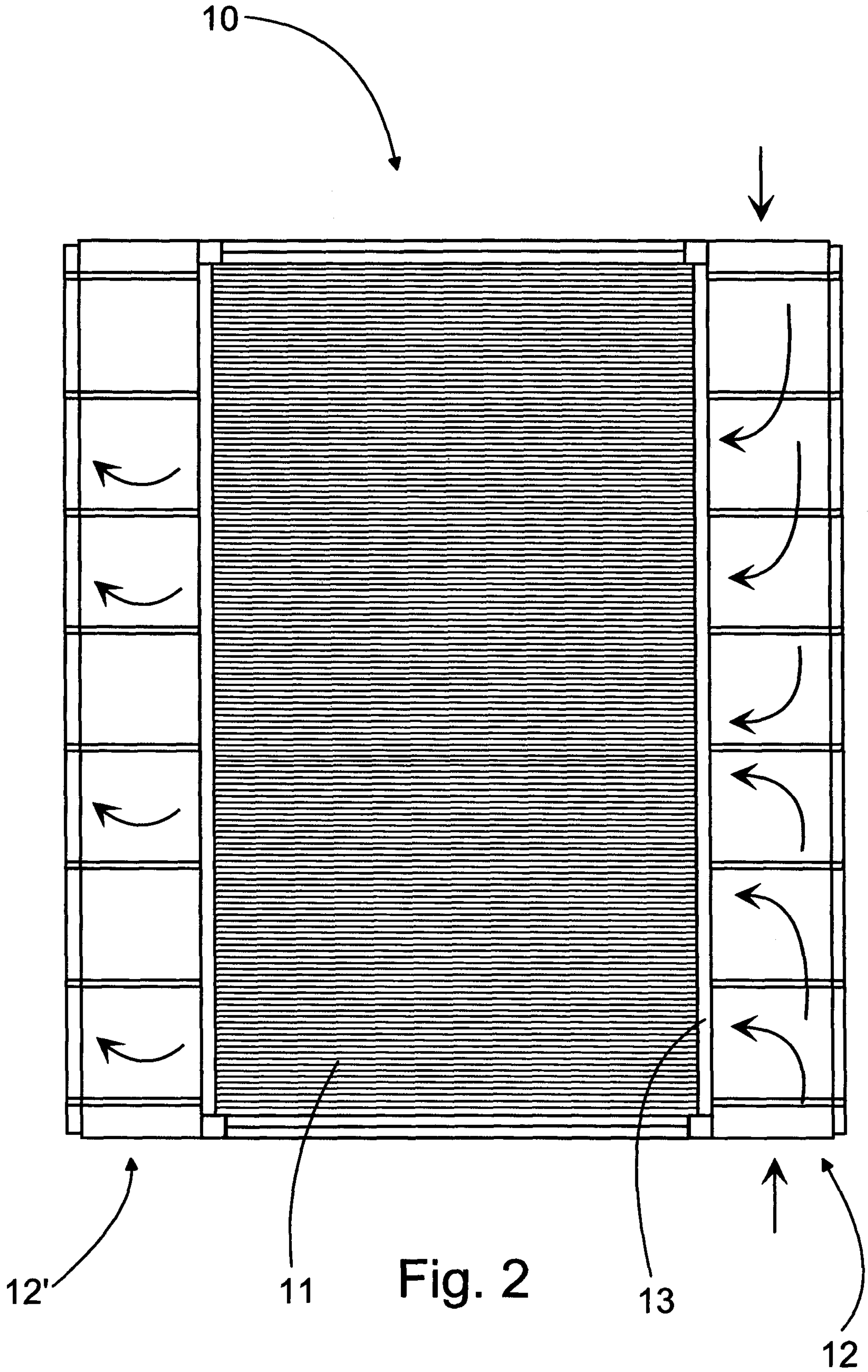

Fig. 2

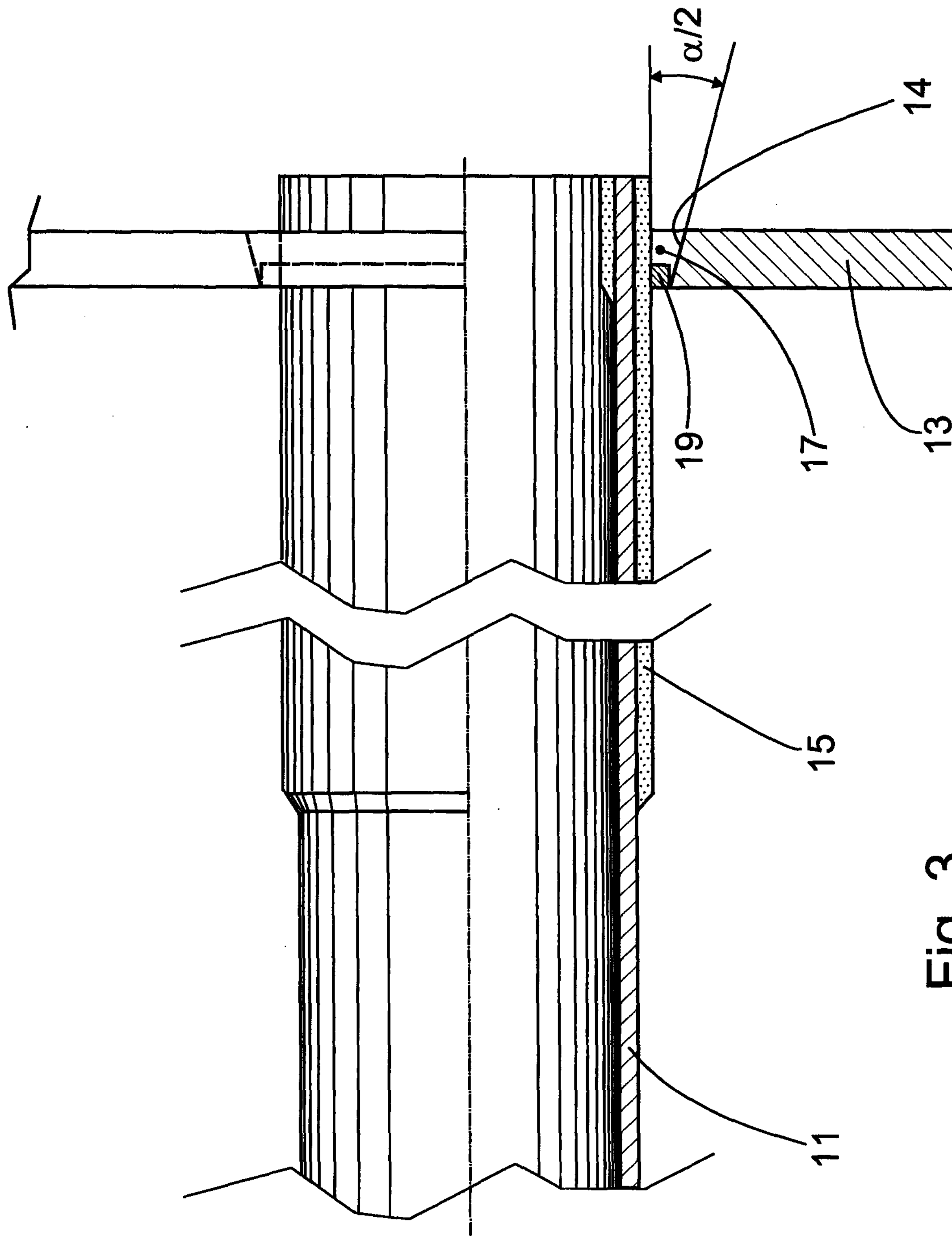

Fig. 3

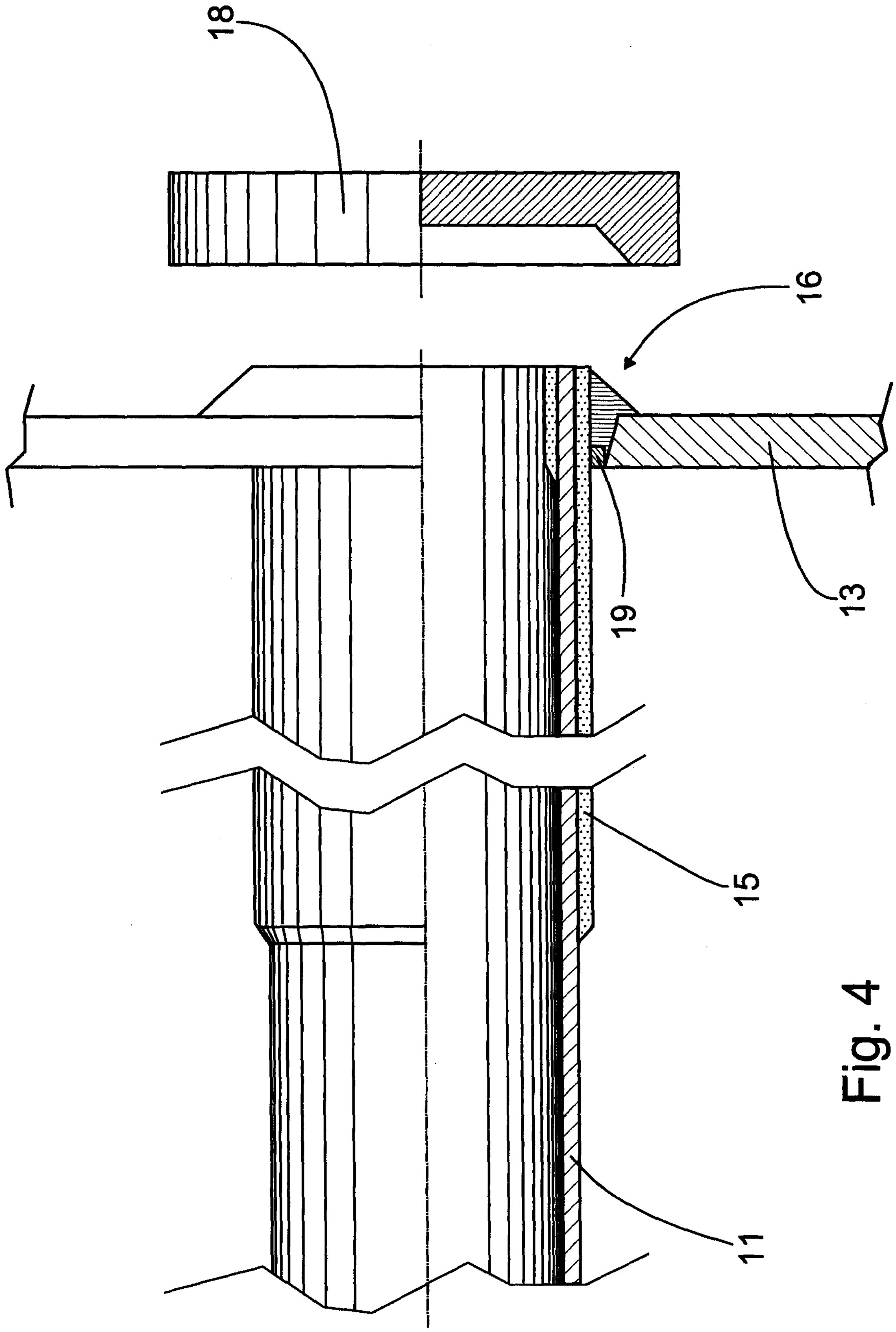

Fig. 4