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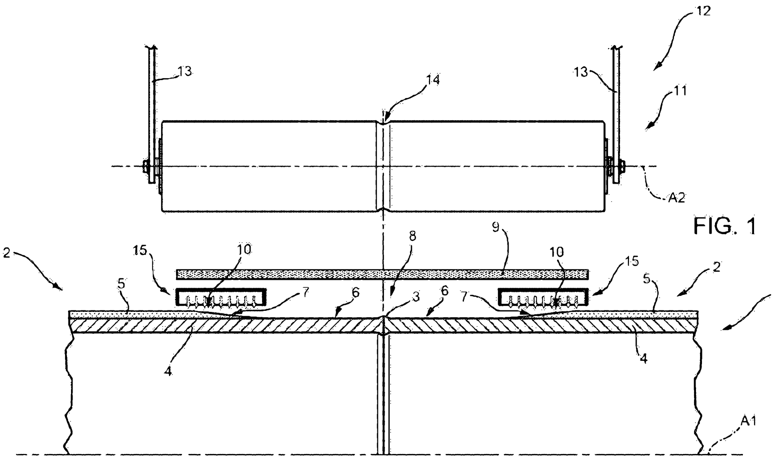

FIG. 1

(57) Abstract: A method of applying protective sheeting (9) of polymer material to a pipeline (1) extending along a longitudinal axis (A1) and having a cutback (8) bounded at opposite axial ends by two end portions (10) of respective protective coatings (5) of polymer material, the method including directly heating the free faces of the end portions (10); extruding and simultaneously winding about the pipeline (1) a protective sheeting (9) wide enough to cover the cutback (8) and the end portions (10); and compressing the protective sheeting (9) against the pipeline (1), the end portions (10) included.

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METHOD AND DEVICE FOR APPLYING PROTECTIVE SHEETING OF POLYMER MATERIAL TO A PIPELINE

TECHINCAL FIELD

The present invention relates to a method of applying protective sheeting of polymer material to a pipeline.

More specifically, the present invention relates to a method of applying protective sheeting of polymer material to a pipeline which has a longitudinal axis and comprises a cutback bounded at opposite axial ends by two end portions of respective protective coatings of polymer material. Generally, the method comprises winding the protective sheeting about the cutback and over the end portions; and compressing the protective sheeting onto the pipeline to ensure the protective sheeting adheres to the pipeline, and to prevent the formation of air bubbles.

BACKGROUND ART

The above method is employed in pipeline construction, in particular the construction of underwater pipelines to be laid on the bed of a body of water, and to which the following description refers purely by way of example. Underwater pipelines are normally constructed by joining the facing free ends of adjacent pipes aligned along a longitudinal axis to define a cutback; and winding protective sheeting about the cutback and said end portions. Pipelines, in fact, are composed of pipes joined to one another to cover distances of hundreds of kilometres. The pipes are of normally 12-metre standard length and of relatively large diameter ranging from 0.2 to 1.5 metres. Each pipe comprises a metal cylinder; and a polymer coating for protecting the metal cylinder. The opposite free ends of each pipe have no coating, so the metal cylinders can be welded to one another. The pipes may be joined at land-based installations, or on laying vessels which also provide for laying the pipeline as it is constructed.

The joining operation comprises welding the metal cylinders together, normally with a number of weld passes; and coating the cutback. Once an annular weld bead is formed between two adjacent metal cylinders, the cutback extends astride the annular weld bead, along an uncoated portion. In other words, the cutback is substantially defined by the free ends of the pipes, extends axially between two end portions of the protective coatings, and must be coated with a protective coating to prevent corrosion.

Coating the unprotected portion along the cutback is known as 'Field Joint Coating', and comprises winding thick, 2-10 mm thick, protective sheeting about the cutback. The protecting sheeting is extruded, and is simultaneously wound about the cutback as it is formed. This method is described in the Applicant's Patent Application WO 2008/071773 and in Patent Applications EP 1,985,909, WO 2010/049353, and WO 2011/033176. In the methods described in these documents, the protective sheeting is applied by an extrusion die mounted on a carriage which runs along an annular path about the longitudinal axis of the pipeline, and the polymer material is plastified by a plastifying device located close to the pipeline and either connectable selectively to the extrusion die, or connected to it by a hose or semirigid pipe.

The protective sheeting is also applied to the two end portions of respective pre-existing coatings, and is pressed onto the pipeline to ensure it adheres properly.

When field joint coating, it is essential to seal the protective sheeting to the end portions of the pre-existing coatings to prevent infiltration and form a seamless coating along the entire pipeline.

To seal the pre-existing coatings to the protective sheeting, document WO 2007/079720 A1 proposes heating the metal cylinder by means of an induction heater, so the metal cylinder transmits heat by conduction to the protective sheeting and the end portions.

The above method calls for an enormous amount of thermal energy, which is dispersed and may endanger

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adhesion of the end portions of the pre-existing coating to the metal cylinder.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present disclosure as it existed before the priority date of each of the appended claims.

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a method of applying protective sheeting, designed to eliminate or at least mitigate one or more of the drawbacks of the known art.

According to the present invention, there is provided a method of applying protective sheeting of polymer material to a pipeline; the pipeline extending along a longitudinal axis and comprising a cutback bounded at opposite axial ends by two end portions of respective protective coatings of polymer material; and the method comprising the steps of rotating a carriage about the pipeline; directly heating the free faces of the end portions; by means of a heat treating unit comprising at least two heaters designed to direct and confine heat onto the end portions; extruding and simultaneously winding about the pipeline a protective sheeting wide enough to cover the cutback and the end portions; and compressing the protective sheeting against the pipeline, the end portions included, wherein the extrusion die and the heat treating unit are mounted on the carriage so that the heaters are located between the extrusion die and the pipeline.

This way, effective adhesion between the end portions of the pre-existing coatings and the protective sheeting is achieved without impairing adhesion of the pre-existing coatings to the metal cylinder. Moreover, the amount of heat applied directly to the free faces of the end portions is independent of the thickness of the pre-existing coating, whereas the amount of heat applied to the free faces through the metal cylinder depends on the thickness of the pre-existing coating.

In a preferred embodiment of the present invention, the method comprises the steps of softening, by heating, a surface layer of each end portion; and applying the protective sheeting, not completely hardened, onto the softened surface layers.

The protective sheeting is thus sealed effectively to the end portions of the pre-existing coatings.

Preferably, the step of heating the free faces of the end portions comprises directing hot air or radiation or flame onto the free faces of the end portions.

The way in which the free faces of the end portions are heated may be selected according to the type of polymer material and the operating parameters. More specifically, heat may be transmitted to the end portions by convection, ‘flame spraying’, or irradiation.

Preferably, the heating step comprises generating heat by means of at least one heat source selected from the following : infrared lamp, electric resistor, gas emitter, and gas burner.

Preferably, the heating step comprises generating an airflow which intercepts the heat source; directing the hot airflow onto the free faces of the end portions; and moving the heat source and the hot airflow around the pipeline.

This way, heating is targeted and effective immediately.

In an alternative embodiment, the method according to the present invention comprises generating and directing flames onto the end portions by means of at least two heat sources; and moving the heat sources and the flames around the pipeline.

In other words, two heat sources facing the end portions generate and direct flames onto the end portions to immediately and temporarily increase the temperature along the surface layers of the end portions.

In another alternative embodiment, the method according to the present invention comprises generating electromagnetic radiation by means of at least two heat sources; directing the electromagnetic radiation onto the end portions; and moving the heat sources and the electromagnetic radiation around the pipeline.

This type of heat source can be supplied electrically, and so allows for implementing relatively straightforward construction solutions.

Preferably, the method comprises moving an extrusion die about the longitudinal axis of the pipeline, to extrude the protective sheeting and simultaneously wind the protective sheeting about the pipeline as it is extruded; and moving at least two heaters, located at respective end portions, about the pipeline, to concentrate heat transfer at the end portions.

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This way, heat can be transferred locally.

Preferably, the method comprises a first protective sheeting compression cycle performed simultaneously with winding the protective sheeting about the pipeline; and a subsequent second protective sheeting compression cycle; the first and second protective sheeting compression cycles being performed in opposite rotation directions about the longitudinal axis of the pipeline.

This way, the protecting sheeting and the end portions are kept contacting as they harden.

Preferably, the method comprises moving a roller, which rotates about an axis parallel to the longitudinal axis, about the longitudinal axis of the pipeline.

The roller thus exerts pressure in proportion to the plasticity of the protective sheeting, to assist adhesion to the pipeline without altering the conformation of the sheeting.

Preferably, the method comprises controlling the amount of heat transmitted per unit of time to the end portions as a function of the speed at which the protective sheeting is applied.

This way, it is possible to roughly determine the thickness of the surface layers of the end portions to be softened at the heating step.

A further object of the present invention is to provide a device for applying protective sheeting of polymer material to a pipeline, and in particular a device designed to eliminate or at least mitigate one or more of the drawbacks of the known art.

According to the present invention, there is provided a device for applying protective sheeting of polymer material to a pipeline; the pipeline extending along a longitudinal axis and comprising a cutback bounded at opposite axial ends by two end portions of respective protective coatings of polymer material; and the device comprising a carriage which rotates about the pipeline; an extrusion die for extruding and simultaneously winding about the pipeline a protective sheeting wide enough to cover the cutback and the end portions; a heat treating unit comprising at least two heaters designed to direct and confine heat onto the end portions and for directly heating the free faces of the end portions; and a roller for compressing the protective sheeting against the pipeline, the end portions included, the extrusion die and the heat treating unit being mounted on the carriage so that the heaters are located between the extrusion die and the pipeline.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will be described by way of example with reference to the attached drawings, in which:

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Figure 1 shows a partly exploded, partly sectioned schematic, with parts removed for clarity, of one step in the method according to the present invention;

Figure 2 shows a larger-scale, partly sectioned, lateral elevation, with parts removed for clarity, of the device for applying protective sheeting to a pipeline in accordance with a first embodiment of the present invention;

Figure 3 shows a larger-scale, partly sectioned, lateral elevation, with parts removed for clarity, of the device for applying protective sheeting to a pipeline in accordance with a second embodiment of the present invention;

Figure 4 shows a larger-scale, partly sectioned, lateral elevation, with parts removed for clarity, of the device for applying protective sheeting to a pipeline in accordance with a third embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Number 1 in Figure 1 indicates a pipeline composed of two pipes 2 joined by a weld, of which is shown an annular weld bead 3. Each pipe 2 comprises a metal cylinder 4; and a coating 5 of polymer material, normally polyethylene or polypropylene, for corrosion-proofing metal cylinder 4.

Each pipe 2 has two opposite free ends 6 (only one shown in Figure 1) with no coatings 5. Each coating 5 has a bevel 7 at each free end 6. Two pipes 2 welded together form a cutback 8, which extends along a longitudinal axis A1, between two successive bevels 7.

In addition to welding metal cylinders 4, joining pipes 2 also comprises coating cutback 8. This comprises applying protective sheeting 9 of polymer material to pipeline 1, at cutback 8.

In the example shown, protective sheeting 9 is designed to wind around cutback 8, is wider than cutback 8 (measured along longitudinal axis A1) so as to overlap coatings 5 and relative bevels 7 of the two joined pipes 2, and is long enough to wind completely around the perimeter of cutback 8.

In other words, protective sheeting 9 is superimposed on two end portions 10 of respective coatings 5. Each end portion 10 comprises a bevel 7 and a cylindrical part of coating 5. The amount by which protective sheeting 9 overlaps the two pre-existing coatings 5 preferably ranges between 50 and 100 mm measured parallel to longitudinal axis A1, which means the width of each end portion preferably ranges between 50 and 100 mm.

Protective sheeting 9 is preferably extruded and wound simultaneously about pipeline 1, and is compressed onto pipeline 1 by a roller 11.

The newly extruded protective sheeting 9 is soft, in the sense that the polymer material has first been plastified to extrude it, and has not yet hardened. So the protective sheeting is highly flexible and adapts to the irregular shape of the part of pipeline 1 to which it is applied. Roller 11 ensures protective sheeting 9 adheres to the surface of pipeline 1 to which it is applied, and prevents the formation of air bubbles, without altering the thickness of protective sheeting 9.

Roller 11 rotates idly, or is powered to rotate, about an axis of rotation A2, and is pushed onto pipeline 1 by a supporting mechanism 12, of which only two supporting arms 13 are shown in Figure 1.

Roller 11 varies in elasticity along axis A2, and more specifically is of greater elasticity at the ends than at the centre. At the centre, roller 11 has a groove 14 designed to align with annular weld bead 3.

Number 15 in Figure 1 indicates a number of heaters which, in the example shown, define respective hot-air conductor outlets facing and positioned a short distance from end portions 10.

The main purpose of each heater 15 is to heat, and soften a thin surface layer of, the free surface of a respective end portion 10.

More specifically, concentrating heat on the free faces of end portions 10 softens the polymer material of

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coatings 5 along thin surface layers of respective end portions 10, so as to seal end portions 10 to protective sheeting 9, which is wound around pipeline 1 before it is completely hardened.

Number 16 in Figure 2 indicates as a whole a device for applying protective sheeting 9 to pipeline 1.

Device 16 comprises a carriage 17 which runs along an annular path around pipeline 1; an extrusion die 18 for extruding protective sheeting 9; roller 11 for compressing protective sheeting 9 onto pipeline 1; and a heat treating unit 19 for effectively sealing end portions 10 to protective sheeting 9.

Extrusion die 18 comprises an extrusion outlet 20 from which protective sheeting 9 comes out, and is mounted on carriage 17 to pivot about an axis A3 to enable actuators, not shown in the drawings, to adjust the tilt of extrusion die 18 and the distance between extrusion outlet 20 and pipeline 1.

Roller 11 is connected to carriage 17 by arms 13 and is adjustable by actuators not shown.

Heat treating unit 19 is mounted on carriage 17, preferably to pivot about an axis A4 and adjustably by means of actuators not shown in the drawings, and comprises a heat source 21, two fans 22 (only one shown in Figure 2), heaters 15 (only one shown in Figure 2), and conduits 23 (only one shown in Figure 2) for

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connecting heat source 21, fans 22, and heaters 15. Heat source 21 is selected on the basis of energy demand and other contingencies. The types of heat sources 21 comprise: infrared lamps, gas burners, and electric resistors.

In actual use, carriage 17 is run in direction D1 in Figure 2. And, as carriage 17 runs along, heat treating unit 19 heats end portions 10, substantially by convection, to soften surface layers of end portions 10; extrusion die 18 extrudes protective sheeting 9 close to pipeline 1, so that protective sheeting 9 is deposited, still partly softened, onto pipeline 1, and in particular onto end portions 10; and roller 11 compresses protective sheeting 9 onto pipeline 1, and in particular onto end portions 10, so that surface layers of the still-soft protective sheeting 9 adhere firmly to the soft surface layers of end portions 10.

Once the whole length of protective sheeting 9 is wound about pipeline 1, extrusion is stopped, extrusion die 18 and heaters 15 may be withdrawn from pipeline 1, but roller 11 continues to exert pressure on pipeline 1.

Next, carriage 17 is run in the opposite direction to direction D1 to perform a rolling operation, i.e. with roller 11 still exerting pressure to compress protective sheeting 9 as it hardens.

In the example shown, heaters 15 concentrate the hot airflow within circumscribed areas.

In the Figure 3 embodiment, the heat treating unit 24 comprises two heaters 25 (only one shown in Figure 3); and two heat sources 26 (only one shown in Figure 3) inside respective heaters 25 which, in the example shown, are outlets facing end portions 10 and designed to house respective heat sources 26.

In the example shown, each heat source 26 is defined by a gas burner designed to generate and direct a flame onto a respective end portion 10. More specifically, each heat source 26 - in the example shown, each burner - comprises an arc-shaped diffuser 27 which, in use, is positioned facing and close to a respective end portion 10.

Heat treating unit 24 also comprises a flame sensor 28 and an ignition device 29, both located inside heater 25.

Heat treating unit 24 comprises a fan 30; a mixer valve 31; a conduit 32 for conducting air and the air/gas mixture to diffuser 27; and a conduit 33 for feeding gas to mixer valve 31.

In actual use, heat treating unit 24 provides for igniting the heat source 26 and moving carriage 17. The flame is evenly distributed along diffuser 27, sweeps the outer face of a respective end portion 10, and softens a thin surface layer of end portion 10 to join

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it more effectively to protective sheeting 9.

Number 34 in Figure 4 indicates as a whole a heat treating unit comprising a heater 35; and a radiant heat source 36, e.g. infrared lamps, electric resistors, or a gas emitter.

Heat source 36 is housed inside heater 35, which serves to concentrate radiation along a respective end portion 10.

Clearly, changes may be made to the embodiments of the present invention described with reference to the attached drawings without, however, departing from the protective scope of the accompanying Claims.

More specifically, the free faces of the end portions may be heated directly by conduction, using heated rollers designed to roll along the end portions, or other heated elements designed to slide along the end portions.

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CLAIMS

1) A method of applying protective sheeting of polymer material to a pipeline; the pipeline extending along a longitudinal axis and comprising a cutback bounded at opposite axial ends by two end portions of respective protective coatings of polymer material; and the method comprising the steps of rotating a carriage about the pipeline; directly heating the free faces of the end portions; by means of a heat treating unit comprising at least two heaters designed to direct and confine heat onto the end portions; extruding and simultaneously winding about the pipeline a protective sheeting wide enough to cover the cutback and the end portions; and compressing the protective sheeting against the pipeline, the end portions included, wherein the extrusion die and the heat treating unit are mounted on the carriage so that the heaters are located between the extrusion die and the pipeline.

2) A method as claimed in Claim 1, and comprising the steps of softening, by heating, a surface layer of each end portion; and applying the protective sheeting, not completely hardened, onto the softened surface layers.

3) A method as claimed in any one of Claims 1 or 2, wherein the step of heating the free faces of the end

portions comprises directing hot air or radiation or flame onto the free faces of the end portions.

4) A method as claimed in any one of the preceding Claims, wherein the heating step comprises generating heat by means of at least one heat source selected from the following: infrared lamp, electric resistor, gas emitter, and gas burner.

5) A method as claimed in Claim 4, wherein the heating step comprises generating an airflow which intercepts the heat source; directing the hot airflow onto the free faces of the end portions; and moving the heat source and the hot airflow around the pipeline.

6) A method as claimed in Claim 4, and comprising the step of generating and directing flames onto the end portions by means of at least two heat sources; and moving the heat sources and the flames around the pipeline.

7) A method as claimed in Claim 4, and comprising the step of generating electromagnetic radiation by means of at least two heat sources; directing the electromagnetic radiation onto the end portions; and moving the heat sources and the electromagnetic radiation around the pipeline.

8) A method as claimed in any one of the preceding Claims, and comprising the steps of moving an extrusion die about the longitudinal axis of the pipeline, to

extrude the protective sheeting and simultaneously wind about the pipeline the protective sheeting as it is extruded; and moving heaters around the end portions to concentrate heat transfer at the end portions.

9) A method as claimed in any one of the preceding Claims, wherein the step of compressing the protective sheeting comprises a first protective sheeting compression cycle performed simultaneously with winding the protective sheeting about the pipeline; and a subsequent second protective sheeting compression cycle; the first and second protective sheeting compression cycles being performed in opposite rotation directions about the longitudinal axis of the pipeline.

10) A method as claimed in any one of the foregoing Claims, wherein the compressing step comprises moving a roller, which rotates about an axis of rotation parallel to the longitudinal axis, about the longitudinal axis of the pipeline.

11) A method as claimed in any one of the preceding Claims, and comprising the step of controlling the amount of heat transmitted per unit of time to the end portions, preferably as a function of the speed at which the protective sheeting is applied.

12) A device for applying protective sheeting of polymer material to a pipeline; the pipeline extending along a longitudinal axis and comprising a cutback

bounded at opposite axial ends by two end portions of respective protective coatings of polymer material; and the device comprising a carriage which rotates about the pipeline; an extrusion die for extruding and simultaneously winding about the pipeline a protective sheeting wide enough to cover the cutback and the end portions; a heat treating unit comprising at least two heaters and designed to direct and confine heat onto the end portions and for directly heating the free faces of the end portions; and a roller for compressing the protective sheeting against the pipeline, the end portions included, the extrusion die and the heat treating unit being mounted on the carriage so that the heaters are located between the extrusion die and the pipeline.

13) A device as claimed in Claim 12, wherein the heat treating unit comprises heaters for softening, by directly heating, a surface layer of each end portion before applying the protective sheeting, not completely hardened, onto the softened surface layers.

14) A device as claimed in Claim 13, wherein the heaters are designed to direct and confine hot air or radiation or flame onto the free faces of the end portions.

15) A device as claimed in any one of Claims 12 to 14, wherein the heat treating unit comprises at least

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one heat source (selected from the following : infrared lamp, electric resistor, gas emitter, and gas burner.

16) A device as claimed in Claim 15, wherein the heat treating unit comprises a fan for generating an airflow which intercepts the heat source; and a heater for directing and confining the hot airflow onto the free faces of the end portions.

17) A device as claimed in Claim 15, wherein the heat treating unit comprises at least two heat sources designed to generate and direct flames onto respective end portions.

18) A device as claimed in Claim 15, wherein the heat treating unit comprises at least two heat sources designed to generate and direct electromagnetic radiation onto the end portions.

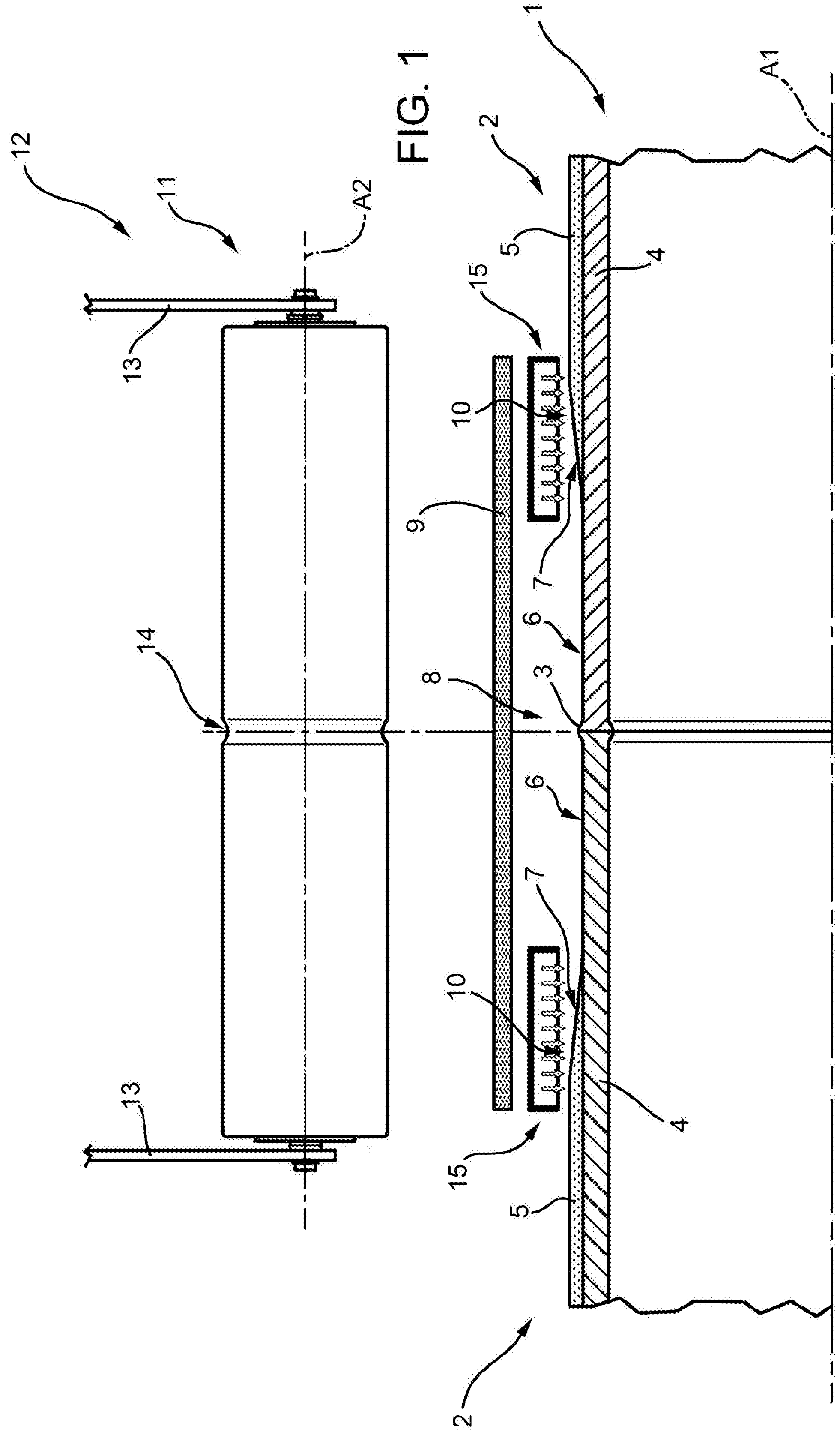

FIG. 1

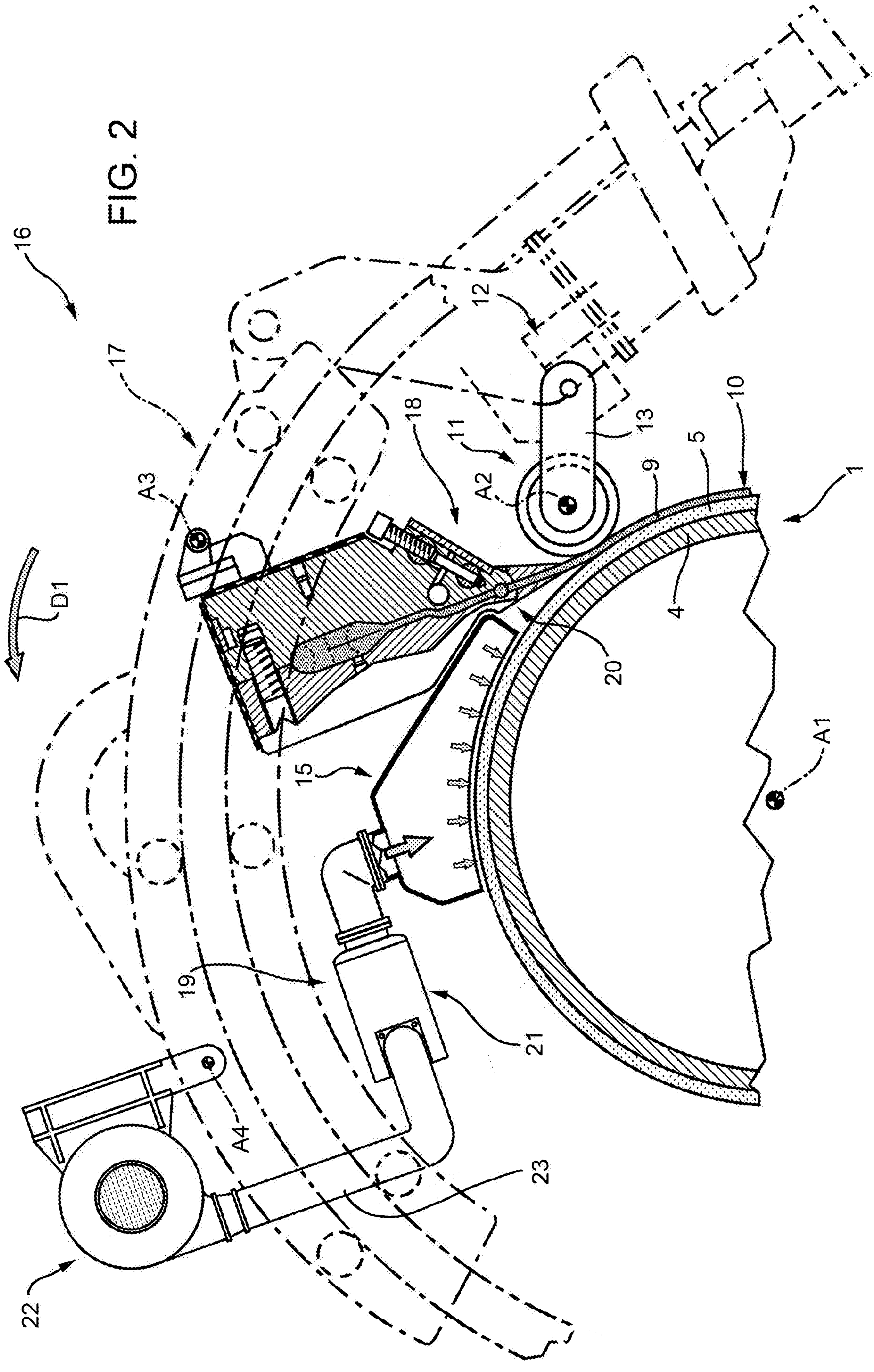

FIG. 2

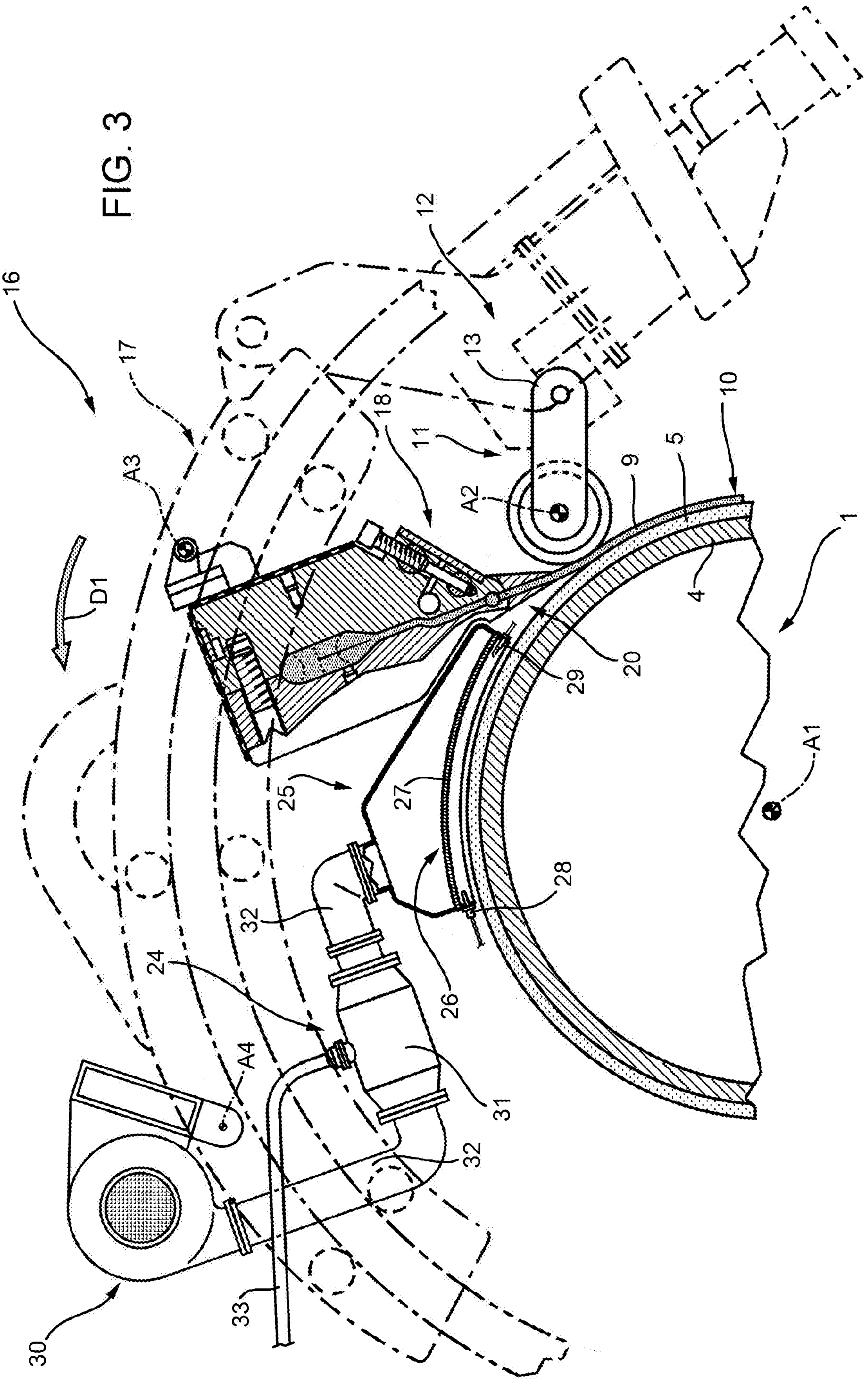
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FIG. 3

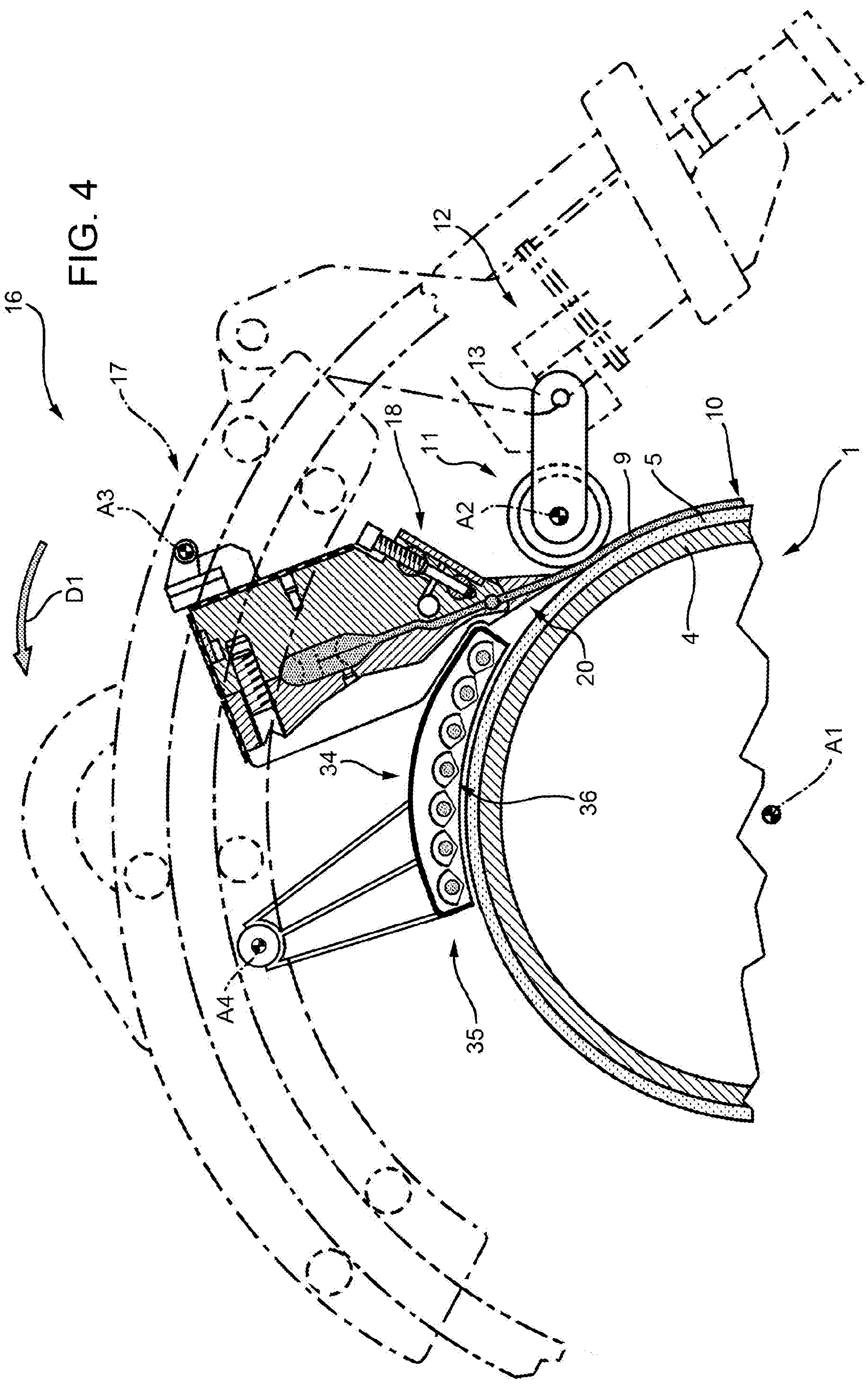

FIG. 4