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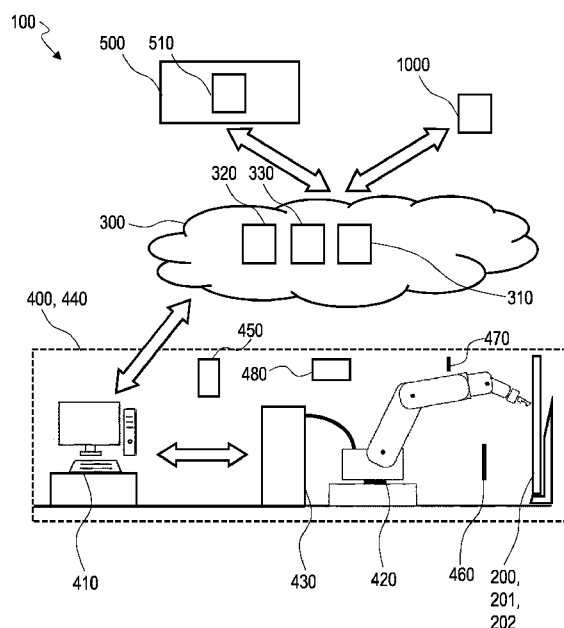


Fig. 1

(57) Abstract: The present application provides a method for operating an applicator (400) adapted to apply a polymerizing material, the applicator (400) to be located at a manufacturing site at a certain geographical location and comprising a local control computer device (410), the method comprising: obtaining (S120) geographical location information of the manufacturing site, the geographical location information indicative for expected climate conditions and/or insulation requirements of the to-be-manufactured part at the certain geographical location of the manufacturing site, and determining (S130), based on the obtained geographical location information, an applicator operating parameter set to be used to operate, by the local control computer device (410), the applicator (400) to manufacture the part in accordance with a product specification.

Method and system for operating a manufacturing-site applicator

The present application relates to operating a manufacturing-site applicator that is adapted to apply polymerizing material. In particular, the invention relates to a method of operating a manufacturing site applicator, an applicator for applying a polymerizing material, and a computing cloud for operating an applicator adapted to apply a polymerizing material.

An applicator that is adapted to apply polymerizing material may be used in different technical and/or industrial fields. By way of example, the polymerizing material may be used for insulation purposes, such as manufacturing an insulated member that can be used in many ways, for example, to achieve thermal insulation, sound insulation or the like. The field of application of such an insulated member is correspondingly wide and extends, for example, to applications in numerous industries, such as construction industry, automotive industry, packaging industry etc. By way of example, such insulated members may be used as an interior trim, as an exterior wall cladding, as a construction member, as packaging material, or the like, usable in a wide range of industries.

Typically, such insulated member is manufactured manually by applying insulation material to a carrier by a manufacturing personnel. The carrier may also be referred to as a raw part, wherein the raw part provided with the applied insulation material may be referred to as the insulated member or a part of the same. In this regard, it has been found that the manual production of such an insulated element can be hard work, labor-intensive and thus cost intensive. It may also pose a health risk for the manufacturing personnel, for example, with regard to the materials used, which may also require a protective equipment taken etc. It is therefore desired that production be at least partially automated.

During application of polymerizing material, such as a foam or the like, the application process itself or the polymerizing process may be affected by environmental conditions, and in particular by climate conditions, such as temperature and/or humidity, that occur during the application. This can further complicate automation, and manufacturing in general.

Therefore, there may still be a need for providing more efficient and effective means for manufacturing a part comprising a polymer. It is accordingly an object of the present invention to provide more efficient and effective means for manufacturing a part comprising a polymer.

A first aspect of the invention provides a, preferably computer-implemented, method for operating an applicator that is adapted to apply a polymerizing material. The applicator is to be located or is located at a manufacturing site at a certain geographical location and is operatively connected to a local computer device, which in at least some embodiments may be referred to as an edge computer device. The method may be implemented in computer program instructions, e.g. provided as a computer program element, and may be performed, for example, by one or more data processing or computer devices, in particular by one or more computer devices of a distributed computer system. Such a distributed computer system may particularly comprise a computing cloud, a client-server system or the like, and a local

manufacturing-site computer device, such as an edge-computer or the like. In some embodiments, it may be contemplated that individual computation steps can be processed on different processing units. This means that the distributed computer system may be implemented centrally via cloud computing or remotely via edge computing. In some
5 embodiments, the local manufacturing-site computer device may be adapted to work independently without a current and/or permanent connection to a computing cloud. It may, however, temporarily connectable to the computing cloud. In an independent operation mode, the local manufacturing-site computer device may be adapted to process locally stored data to operate the applicator locally. The computer devices may comprise a data processor, a
10 memory, a data interface, a communication interface, etc.

The method for operating an applicator adapted to apply a polymerizing material, such as a foamable material, comprises the steps of:

- 15 - Obtaining geographical location information of the manufacturing site, the geographical location information indicative for expected climate conditions and/or insulation requirements of the to-be-manufactured part at the certain geographical location of the manufacturing site.

The geographical location information may be generally understood as location and/or position
20 indication, which can be linked to coordinates, a map, or the like. It may be available in different levels of detail and optionally distinguish e.g. countries, states, regions, districts, cities, etc. Different locations may be associated with different expected values for climatic conditions at a certain time and/or date, such as a day time, a day, a calendar week, a month, a season, etc., through e.g. experience, analyzing weather records, obtaining weather forecasts, etc. Likewise,
25 different locations may be associated with different insulation requirements of the to-be-manufactured part. For example, insulation requirements may be lower at a location with a moderate climate than at a location with a severe climate. Some locations, such as on state level, may require a minimum value of insulation, in particular for buildings where the to-be-manufactured part may be used, for example, as a construction element, and may be referred
30 to as an insulated member. The climate conditions may comprise one or more of an ambient temperature, air humidity, in particular relative air humidity, etc.

As used herein, information, such as the geographical location information, the climate conditions, etc., may generally be provided, exchanged, etc., electronically as a data set.

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- Determining, based on the product specification and/or the obtained geographical location information, an applicator operating parameter set to be used to operate, by the local control computer device, the applicator to manufacture the part in accordance with its or a product specification.

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This may comprise, for example, using a dataset comprising expected climate conditions associated with a certain location, and generating, e.g. by computational steps, on that basis, the applicator operating parameter set. The applicator operating parameter set may be

computer-readable for automated processing, and may also be referred to as control data set capable of controlling movement, application rate, material feeding, material temperature, material pressure, etc. of the applicator.

- 5 This allows a control parameter set to be generated in which the process parameters are adapted to the climatic conditions at the certain location. This is based on the idea that knowledge of particularly temperature and/or humidity can significantly affect the processing of polymerizing material and/or compliance with the product specification of the to-be-manufactured part.

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According to an embodiment, the method further comprises the step of determining, before determining the applicator operating parameter set and based on the product specification and the obtained geographical location information, an insulation value of the to-be-manufactured part, the insulation value correlating with at least the expected climate conditions at the certain

15 geographical location of the manufacturing site.

15

The insulation value may also be referred to as R-value or thermal resistance. It may be understood as a measure of the degree to which a two-dimensional barrier, such as a layer of insulation, a window or a complete wall or ceiling, resists the conductive flow of heat. The

20 expected climate conditions may be obtained from a dataset, etc. Insulation dimensions, in particular the thickness in the heat transfer direction, may be obtained from the product specification. On this basis, the R-value may be determined, by e.g. computational steps, considering the expected climate conditions.

20

- 25 In an embodiment, the method further comprises the step of providing, before determining the applicator operating parameter set, the determined insulation value or a minimum value derived from it as signal data to a user interface adapted to display the determined insulation value to a user and/or to make it modifiable by a user, and using, if the insulation value is modified by the user, the modified insulation value for determining the applicator operating parameter set.

30

In some embodiments, the user may set the determined insulation value or the modified insulation value as default for future part manufacturing jobs.

- 35 According to an embodiment, the method further comprises the step of obtaining actual climate conditions at the certain geographical location of the manufacturing site, and combining the actual climate conditions with the expected climate conditions, and using the combined climate conditions for determining the applicator operating parameter set, or replacing the expected climate conditions by the actual climate conditions for determining the applicator operating parameter set.

40

In other words, the actual climate conditions may affect determining the applicator operating parameter set.

According to an embodiment, the method further comprises obtaining, by the data processing unit, a product specification of a to-be-manufactured part comprising the polymerizing material.

For example, the product specification may comprise at least a specification of the polymerizing material, e.g. one or more of a material type, an amount, etc., to be used to manufacture the part. Optionally, obtaining the product specification may comprise processing manufacturing design data to obtain the product specification.

The processing may be carried out locally by the local computer device or may be carried out remotely by a computing cloud, such as that of the third aspect below. The manufacturing design data may be provided as CAD data, such as a CAD file.

In an embodiment, the method further comprises the step of obtaining actual climate conditions at the certain geographical location of the manufacturing site, and comparing the actual climate conditions with the expected climate conditions, wherein, if the actual climate conditions match an acceptable value range, the applicator is operated with the determined applicator operating parameter set, and if the actual climate conditions do not match the acceptable value range, the applicator operating parameter set is adjusted to the actual climate conditions or to a combination of the actual climate conditions and the expected climate conditions.

In other words, the actual climate conditions may affect determining the applicator operating parameter set.

According to an embodiment, the method further comprises the step of obtaining the actual climate conditions by measurement in a booth adapted to at least partially accommodate the applicator.

The applicator and/or the booth may comprise climate conditions measurement means, such as a thermometer and/or hygrometer, etc., to electronically detect the actual climate conditions at place. This allows the climatic conditions in the direct vicinity of the applicator to be detected.

In an embodiment, the applicator operating parameter set comprises one or more of a polymerizing material type specification, an material application pressure specification, an material application temperature specification, an opening time of a material outlet, and a motion control program for an application robot.

In other words, the applicator operating parameter set may comprise information about the type of polymerizing material to be used, the pressure for application of the polymerizing material, the temperature, the material throughput, which can be controlled e.g. by the opening time of the material outlet, and/or along which trajectory or around which axes, etc., e.g. an application robot should move.

According to an embodiment, the applicator operating parameter set comprises a test application parameter subset adapted to operate the applicator in a test mode to be carried out to test the operational readiness of the applicator before starting to manufacture the to-be-manufactured part.

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The test mode allows for verifying the applicator operating parameter set before carrying out the actual part manufacturing job. For example, the test may comprise pre-spraying an amount of the polymerizing material to verify whether the spray pattern is according to specification.

10 In an embodiment, the test mode further comprises analyzing a pattern of the polymerizing material to be applied on a test surface.

The pattern may be analyzed by pattern recognition, e.g. by using one or more of a classification algorithm, a clustering algorithm, an ensemble learning algorithm, etc. For this purpose the applicator may further comprise image capturing means, such as an image sensor, a camera, or the like, adapted to capture an image of the test surface after applying the amount of the polymerizing material onto the test surface. The image data of the test surface may be subjected to the pattern recognition procedure. This allows for verifying the applicator operating parameter set before carrying out the actual part manufacturing job.

15

20 In an embodiment, a result of the test mode indicative for the quality of the applicator operating parameter set, may be used to adjust the applicator operating parameter set and/or the test application parameter subset.

25 According to an embodiment, the method further comprises the step of updating, at a computing cloud and based on actual climate conditions of the manufacturing site, the expected climate conditions associated with the certain geographical location or a region comprising it.

30 For example, the actual climate conditions may be provided to the computing cloud via a communications network, such as the internet. This allows more accurate data.

A second aspect of the invention provides a, preferably computer-implemented, method for operating an applicator that is adapted to apply a polymerizing material. The applicator is to be located or is located at a manufacturing site at a certain geographical location and is operatively connected to a local computer device, which in at least some embodiments may be referred to as an edge computer device. The method may be implemented in computer program instructions, e.g. provided as a computer program element, and may be performed, for example, by one or more data processing means or computer devices. The computer devices may comprise a data processor, a memory, a data interface, a communication interface, etc.

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40 The method for operating an applicator adapted to apply a polymerizing material, such as a foamable material or the like, is carried out by a computing cloud and comprises the steps of:

- Obtaining climate conditions associated with the certain geographical location of the manufacturing site.

The obtained climate conditions may comprise expected, predicted and/or estimated climate conditions, which may be based on experience, e.g. weather records, weather forecasts, weather modeling, climate modeling, etc., and/or actual climate conditions at the certain geographical location of the manufacturing site.

- Determining, based on at least the obtained climate conditions, and optionally based on obtained product specification and/or, further optionally, based on an obtained applicator operating parameter set to be used to operate, by the local control computer device, the applicator to manufacture the part in accordance with its product specification, a polymerizing material processing and/or material type specification.

Different polymerizing material types may have different degrees of suitability for certain climatic conditions, in particular with regard to applying the material in accordance with product specification and good processing. For example, a first material type may be more suitable for winter conditions, while a second material type may be more suitable for summer conditions, wherein the primary parameter is the respective temperature and/or humidity during the processing of the polymerizing material. Further, the processing of a certain polymerizing material type may differ with different climatic conditions.

- Triggering provision and/or order of the material type defined by the determined polymerizing material type specification, preferably to be provisioned at or to be ordered to the manufacturing site.

For example, in the computing cloud, it may be known what material is available at the manufacturing site, what material is planned for manufacturing the part, how much of the material is available, etc. Using the climate conditions data, the material may be adapted to these to improve the process, and in particular improving the application of the polymerizing material. The trigger may be a data signal that is sent to and received by the manufacturing site and/or a logistic system, a warehouse, or the like. Further, it may also be triggered to adapt the material composition to climatic conditions.

According to an embodiment, the method further comprises the step of predicting, by a computational model, climate conditions associated with the certain geographical location of the manufacturing site, and using the predicted climate conditions for determining the polymerizing material type specification.

For example, a weather forecast, a weather check, or the like, may be obtained, generated, etc. Optionally, climate conditions collected at the manufacturing site may be analyzed and/or an estimation may be made. In this way, the suitable material for future climatic conditions may be provided or purchased and made available.

A third aspect of the invention provides an applicator for applying a polymerizing material, the applicator, the applicator to be located at a manufacturing site at a certain geographical location. The applicator comprises a computer device comprising a data interface adapted to at least obtain applicator operating parameter set capable of operating the applicator. Further, the applicator comprises an application robot adapted to be controlled by the computer device on basis of the applicator operating parameter set. The applicator is adapted to carry out the method according to the first aspect.

The advantages of the applicator correspond at least essentially to those of the method described above and are not described here again.

In an embodiment, the applicator further comprises climate conditions measuring means adapted to provide actual climate conditions measured at the manufacturing site. The applicator is further adapted to obtain geographical location information indicative for expected climate conditions at the certain geographical location of the manufacturing site, and compare the actual climate conditions with the expected climate conditions. If the actual climate conditions match an acceptable value range, the applicator is operated with the obtained applicator operating parameter set, and if the actual climate conditions do not match the acceptable value range, the applicator operating parameter set is adjusted to the actual climate conditions or to a combination of the actual climate conditions and the expected climate conditions.

This allows adapting the operation of the applicator to the actual climate conditions at the manufacturing site, which may generally affect the operation, and in particular the material processing.

A fourth aspect of the invention provides a computing cloud for operating an applicator adapted to apply a polymerizing material. The applicator is to be or is located at a manufacturing site and operatively connected to a local computer device and at least temporarily to the computing cloud remote to the manufacturing site. The computing cloud comprises a data processing unit, and a data interface, adapted to exchange data with the manufacturing site. The data processing unit is adapted to carry out the method according to the first and/or second aspect.

As used herein, the computing cloud may in particular be a computer system that provides shared configurable computer system resources and services that can be provided via a communications network, such as the Internet.

A fifth aspect of the present invention provides computer program element for operating an applicator adapted to apply a polymerizing material, the program, when being executed by a computer device, is adapted for carrying out the method according to the first and/or second aspect.

A sixth aspect of the invention provides a system comprising the applicator according to the third aspect and the computing cloud according to the fourth aspect.

These and other aspects of the present invention will become apparent from and elucidated with reference to the embodiments described hereinafter.

Exemplary embodiments of the invention will be described in the following with reference to the following drawings.

Figure 1 shows a schematic block diagram of a system for applying a polymerizing material according to an embodiment of the invention.

Figure 2 shows in a schematic block diagram a data processing step for operating an applicator for applying a polymerizing material according to an embodiment of the invention.

Figure 3 shows in a schematic block diagram a data processing step for operating an applicator for applying a polymerizing material according to an embodiment of the invention.

Figure 4 shows in a flow chart a method for operating an applicator for applying a polymerizing material according to an embodiment of the invention.

Figure 5 shows in a flow chart a method for operating an applicator for applying a polymerizing material according to an embodiment of the invention.

The drawings are merely schematic representations and serve only to illustrate the invention. Identical or equivalent elements are consistently provided with the same reference signs.

Figure 1 shows in a schematic block diagram a system 100 for applying a polymerizing material, which system 100 may be provided as a distributed computer system. In some embodiments, it may be contemplated that individual computation steps can be processed on different computer devices and/or processing units. This means that the system 100 may be implemented centrally via cloud computing or remotely via edge computing. In some embodiments, the application of the polymerizing material may be used to manufacture an insulated member 200 that may be an insulated construction member, such as a construction panel used for panelized buildings, in the prefabricated building industry, or the like. Of course, it may be contemplated that the insulated member 200 is configured different and is adapted to be used in other industries. The insulated member 200 at least comprises a raw part 201, such as a panel, etc., having at least one insulation material application section, e.g. a surface, a cavity or the like, and polymerizing material 202 applied thereon. In some embodiments, the polymerizing material 202 may be a foamable insulation material, such as polyurethane, or the like.

The system 100 comprises, at a computing cloud site, a computing cloud 300 which is adapted to provide computer system resources and services via a communications network, such as the Internet. Accordingly, the computing cloud 300 comprises data processing means 310, which comprises one or more processors, a data storage etc. Further, computing cloud 300 comprises a first data source 320, such as a dataset, a database, etc., for obtaining and/or providing expected climate conditions associated with a plurality of certain geographical locations. These

expected climate conditions may be obtained based on experience, e.g. from weather records, weather analyzes, or from weather forecasts, or the like. Further, computing cloud 300 comprises a second data source 330, such as a dataset, a database, etc., for obtaining and/or providing insulation requirements associated with a plurality of certain geographical locations.

5 The insulation requirements may be indicated by an insulation value, e.g. R-value, and may be specified, for example, on a state level. The computing cloud 300, and in particular the data sources 320, 330 may be adapted to exchange data, e.g. via a communications network, with a climate conditions and/or weather data source 1000, which may be operated by a scientific, governmental or commercial institution and which provides appropriate data.

10 The system 100 further comprises, at the manufacturing site remote to the computing cloud site, an applicator 400, and in particular a local manufacturing- site control computer device 410 having a data interface adapted to exchange data with the computing cloud 300, e.g. via a communications network, such as the Internet. Further, at the manufacturing site, system 100,
15 and in particular applicator 400, comprises an application robot 420 adapted to be controlled by the control computer device 410. In some embodiments, the application robot 420 is an industrial robot having six degrees of freedom. In addition, the application robot 420 is adapted to apply the polymerizing material 202 by spraying, pouring, or the like. For this purpose, the applicator 400, and in particular the application robot 420 comprises, for example, a material
20 outlet that may be provided as a spraying head or the like, a material feeding, a proportioner, a material reservoir 430, material temperature regulating means, material pressure regulating means, etc. Further, at the manufacturing site, system 100, and in particular applicator 400, comprises a booth 440, which is indicated in Figure 1 by a dotted line. Within this booth 440 or adjacent thereto, applicator 400 or system 100, respectively, may have one or more actual
25 climate conditions measuring means 450 at the manufacturing site, and in particular within the booth 440. The actual climate conditions measuring means 450 may be operatively connected to the control computer device 410, and thus to the computing cloud 300.

30 The applicator 400 may generally be operated by using an applicator operating parameter set, which comprises one or more of a polymerizing material type specification, an application pressure specification, an application temperature specification, an opening time of a material outlet, and a motion control program for an application robot.

35 Further, at the manufacturing site, system 100, and in particular the applicator 400, comprises cleaning means 460, adapted to remove at least material residues from the material outlet. The cleaning means 460 are arranged at a location and/or position that can be determined or is known and may be operated mechanically, pneumatically, or the like, and may, for example, comprise one or more of a metal brush, a drill, a compressed air system, etc., which may be arranged on a carrier that is fixed with respect to the application robot 420. It is understood that
40 the cleaning means 460 is arranged in an environment of application robot 420 to be physically reached by it.

Further, at the manufacturing site, system 100, and in particular the applicator 400, comprises a test surface 470, adapted to receive an amount of the polymerizing material. The test surface 470 may, for example, be formed as a flat panel or the like, and may be arranged at a location and/or position that can be determined or is known. The test surface 470 may be arranged on a carrier that is fixed with respect to the application robot 420. It is understood that test surface 470 is arranged in an environment of application robot 420 to be physically reached by it.

Further, at the manufacturing site, system 100, and in particular applicator 400, comprises detection means 480 for capturing, after applying the amount of the polymerizing material, the test surface 470 in captured verification data. The detection means 480 may, for example, comprise one or more of an image sensor, a camera, or the like, adapted to capture an image of the test surface 470. It is understood that detection means 480 is arranged in a manner to have a field of view of the test surface 470. The detection means 480 may be operatively connected to the control computer device 410, and thus to the computing cloud 300.

Cleaning means 460, test surface 470, and/or detection means 480 may be used in a test mode of the applicator 400, which test mode may be controlled and/or triggered by a test application parameter subset, which may be part of the applicator operating parameter set. Such a test mode may also be referred to as pre-spraying. The detection means 480 may comprise an image sensor, a camera, etc., adapted to capture an image of the test surface 470 and to provide corresponding image data to be processed by an image recognition and/or pattern recognition software, or the like, to verify a material pattern of an amount of the polymerizing material applied to the test surface 470 before carrying out the main job of manufacturing the to-be-manufactured part. The applicator operation parameter subset for this test mode may be affected by the climate conditions occurring at the manufacturing site.

Remote to the manufacturing site and/or the computing cloud site, the system 100 further comprises a manufacturing planning and/or monitoring site 500, adapted to provide product designing, manufacturing planning, manufacturing process monitoring facilities for a user, e.g. a customer. The manufacturing planning and/or monitoring site 500 is operatively connected to the computing cloud 300 and/or the manufacturing site, in particular to the control computer device 410, e.g. via a communications network, such as the Internet. For example, the manufacturing planning and/or monitoring site 500 comprises a user interface 510 adapted to create and/or manipulate a product specification and/or manufacturing design data comprising product specification, e.g. dimensions, shape, material specification, etc., of a to-be-manufactured part. Further, the manufacturing planning and/or monitoring site 500 is adapted, via the user interface 510, to display manufacturing process data captured at the manufacturing site and/or the computing cloud site, and/or to allow manipulating these manufacturing process data. At least some of the computational tasks provided to or obtained from the manufacturing planning and/or monitoring site 500 may be carried out by the computing cloud site.

The applicator 400, and in particular the control computer device 410, is optionally adapted to be operated locally, without being, in particular permanently, connected to the computing cloud 300, or may be temporarily or permanently connected to the computing cloud 300.

- 5 Figure 2 shows in a schematic block diagram a data processing step that can be used to operate the applicator 400. This data processing step may be carried out locally at the manufacturing site, e.g. by using the control computer device 410, or remotely by the computing cloud 300. In general, the data processing step processes geographical location information in order to adjust operation of applicator 400 to local requirements, including one or more of local
10 climate conditions, insulation requirements, material availability, or the like.

The illustrated block may represent the control computer device 410, or a processing unit or software module of it, or the cloud-based data processing means 310 or a processing unit or software module of it. The block obtains, receives, processes, etc., input data IN_Data1,
15 IN_Data2, ... IN_DataN, which at least comprises a first dataset comprising geographical location information of the manufacturing site where the applicator is to be located or is located, and, optionally, a second dataset comprising a product specification and/or manufacturing design data comprising product specification of a to-be-manufactured part that comprises the polymerizing material after manufacturing. The geographical location information of the
20 manufacturing site may be available from knowledge of a customer-service provider relationship, wherein the manufacturing site is assigned to the customer, from request data received from the manufacturing side, etc. Additional input data IN_Data may be obtained e.g. from the above data sources 320, 320, and 1000, and may comprise one or more of expected climate conditions associated with the geographical location information, insulation
25 requirements associated with the geographical location information, actual climate conditions associated with the geographical location information, polymerizing material specification, polymerizing material availability information indicative for type and/or amount of polymerizing material available at the manufacturing site, etc. The input data may be correlated to each other to obtain the above information associated with the geographical location.

30 Further, the block determines and/or provides, in response of processing, e.g. by computational steps, the above input Data IN_Data output data OUT_Data1, Out_Data2, ..., Out_DataN, which comprises one or more of an insulation value correlating with insulation requirements associated with the geographical location information, and/or a polymerizing material type
35 suitable to be processed at the manufacturing site at given climate conditions occurring, and/or an applicator operating parameter set to be used to operate, by the local control computer device, the applicator 400 to manufacture the part in accordance with its product specification. Some of the output data OUT_Data may be fed back to and/or used by the block to adjust the applicator operating parameter set before providing for operating the applicator 400. For
40 example, in a first step, the insulation value may be determined, e.g. calculated, and fed back to the block to generate, in a second step, the applicator operating parameter set. Alternatively or additionally, in a first step, the polymerizing material specification and/or availability may be

determined, and fed back to the block to generate, in a second step, the applicator operating parameter set.

Figure 3 shows in a schematic block diagram a data processing step that can be used to operate the applicator 400. In general, this data processing step may be based on that one of Figure 2, wherein the output data OUT_data is provided to the user interface 510 at the manufacturing planning and/or monitoring site 500. The system 100 may be adapted, e.g. by exchanging respective data between the manufacturing site, the computing cloud site and/or the manufacturing planning and/or monitoring site 500, to display, via the user interface 510, some or all of the output data OUT_data. For example, the above insulation value may be determined, in particular before the above applicator operating parameter set is automatically determined, and may be provided as signal data to the user interface 510 to display the determined insulation value to a user and/or to make it modifiable by a user. The user may then overwrite or otherwise manipulate the insulation value, which may be fed back to the manufacturing site and/or the computing cloud site to be used, if the insulation value has been modified by the user, for determining the applicator operating parameter set. Further, results of the above pattern recognition in the test mode or other process parameters may be provided to the manufacturing planning and/or monitoring site 500, e.g. to be displayed at the user interface 510, to create reports on manufacturing jobs, to create log files of the manufacturing job, to purchase additional polymerizing material, to request adjusting a composition of the polymerizing material, etc.

The System 100, and in particular the applicator 400, may be operated as described below.

Optionally, a user may create or select a product specification and/or manufacturing design data, i.e. a CAD file, comprising product specification, and provide it directly to the manufacturing site, in particular to the control computer device 410, or to the computing cloud 300, from where it may be distributed to the manufacturing site. This may create or initiate a manufacturing job. The product specification and/or the manufacturing design data may comprise information of one or more of the shape, dimensions, the material to be used, insulation properties, or the like, of a to-be-manufactured part, which is here the above insulated member 200. Based on the manufacturing design data a suitable software function may be able to determine movement control data, material-related control parameter, etc., of the applicator 400. Preferably at the computing cloud site, the manufacturing design data is processed to obtain product specification of the to-be-manufactured part that will comprise the polymerizing material.

Either at the manufacturing site or at the computing cloud site, it is known, e.g. by obtaining from a customer database, or the like, at which certain location, i.e. where the manufacturing site is located, the applicator 400 is located. This knowledge is provided as geographical location information, which may be a dataset stored in the respective computer, data processing unit, etc. Accordingly, the geographical location information of the manufacturing site is obtained, wherein the geographical location information is indicative for expected climate

conditions, e.g. temperature and/or humidity, and/or insulation requirements of the to-be-manufactured part at the certain geographical location of the manufacturing site. The geographical location information may be obtained from the second data source 330. The expected climate conditions may be obtained from the first data source 330 and/or the climate
5 conditions and/or weather data source 1000. Obtaining the expected climate conditions may comprise combining or correlating data from different data sources.

Optionally, the computing cloud 300 determines or preselects a suitable insulation value, i.e. R-value, based on the geographical location information. This information may be obtained from
10 the second data source 330, where required and/or optimal insulation values associated with a certain geographical location are stored. The preselected insulation value may be a minimum insulation value required for the certain geographical location, such as a certain state. Further optionally, the determined or preselected insulation value may be provided to the manufacturing planning and/or monitoring site 500, and in particular to the user interface 510, or to the
15 manufacturing site, and in particular to control computer device 410, to be displayed to a user. There, the user may adjust the insulation value, wherein the adjusted insulation value may fed back to the computing cloud 300 and/or the manufacturing planning and/or monitoring site 500 to, for example, be logged or used to create a manufacturing report, etc.

20 Then, based on the processed product specification and/or manufacturing design data and/or the obtained geographical location information, the applicator operating parameter set is determined, e.g. generated, and provided as a control dataset. The applicator operating parameter set may be adapted to cause the local control computer device 410 to operate the applicator 400 to manufacture the part in accordance with its product specification.

25 Optionally, actual climate conditions at the certain geographical location of the manufacturing site may be obtained, e.g. by measurements using the actual climate conditions measuring means 450. The actual climate may be combined with the expected climate conditions and used for determining the applicator operating parameter set. Alternatively, in e.g. a dataset, the
30 expected climate conditions may be replaced by the actual climate conditions for determining the applicator operating parameter set. This may depend on the accuracy of the respective climate conditions, wherein the actual climate conditions can be considered over a period of time.

35 Further optionally, actual climate conditions at the certain geographical location of the manufacturing site, e.g. by measurements using the actual climate conditions measuring means 450. The actual climate conditions may be compared to the expected climate conditions, wherein, if the actual climate conditions match an acceptable value range, the applicator is operated with the determined applicator operating parameter set. If, however, the actual climate
40 conditions do not match the acceptable value range, the applicator operating parameter set is adjusted to the actual climate conditions or to a combination of the actual climate conditions and the expected climate conditions.

Further optionally, the computing cloud 300 may update its database based on the actual climate conditions at the manufacturing site the expected climate conditions associated with the certain geographical location or a region comprising it.

- 5 Optionally, the test mode or pre-spraying may be performed before executing the main manufacturing job. As explained above, the applicator operating parameter set comprises a test application parameter subset adapted to operate the applicator 400 in the test mode to be carried out to test the operational readiness of the applicator 400 before starting to manufacture the to-be-manufactured par, i.e. the insulated member 200. Optionally, the test mode may
- 10 comprise a cleaning process to clean the material outlet of the application robot 420 from e.g. material residues. For this purpose, the test application parameter subset may comprise at least a trigger for initiating the cleaning process in accordance with a suitable cleaning protocol, which may be stored as a dataset in the applicator 400 or the computing cloud 300. According to the protocol, the application robot 420 is controlled to align its material outlet with the
- 15 cleaning means 460 arranged in proximity to the application robot 420. The cleaning means 460 may comprise a metal brush, a compressed-air pistol, or the like, to remove e.g. material residues from the material outlet. After the optional cleaning process, the verification process is initiated. It may comprise the step of applying a predetermined amount of the polymerizing material onto the test surface 470. This and further applicator operating parameter, such as
- 20 material temperature, application pressure, etc., may be provided with the test application parameter subset. Then, the test surface 470 is captured by the detection means 480. The respective image data is then processed, e.g. by use of pattern recognition software, to compare the captured material pattern with expected values to verify whether the application quality is according to specification. After a successful test mode, the main manufacturing job
- 25 can be automatically initiated.

Optionally, the test application parameter subset may be adjusted based on the actual climate conditions at the manufacturing site.

- 30 Further, the applicator 400 and particularly the computing cloud 300 may be operated as described below.

- The computing cloud 300 obtains the product specification and/or manufacturing design data comprising product specification of the to-be-manufactured part comprising the polymerizing
- 35 material, i.e. the insulated member 200. Further, the computing cloud 300 obtains climate conditions associated with the certain geographical location of the manufacturing site, e.g. obtained from the first and/or second data source 320, 330 and/or from the climate conditions and/or weather data source 1000. Based on at least the obtained climate conditions and/or the obtained manufacturing design data, a polymerizing material type specification is determined.
- 40 Then, provision and/or order of the material type defined by the determined polymerizing material type specification is triggered. For example, if a strong winter is expected, a suitable material type may be ordered, or loaded into or provided by the material reservoir, such as a barrel, etc. The order may comprise a whole batch of material to be stored in a storage.

Optionally, the computing cloud 300 may predict, e.g. by use of a computational model, future climate conditions associated with the certain geographical location of the manufacturing site. The predicted climate conditions may then be used for determining the polymerizing material type specification.

Figure 4 shows in a flow chart a method for operating the applicator 400 for applying polymerizing material. The method may be carried out at the manufacturing site by the applicator 400, and in particular by the control computer device 410. The method may also be carried out by the computing cloud 300. In an optional step, a product specification is obtained, or a manufacturing design data is processed to obtain product specification of a to-be-manufactured part comprising the polymerizing material. In a step S110, geographical location information of the manufacturing site is obtained, wherein the geographical location information indicative for expected climate conditions and/or insulation requirements of the to-be-manufactured part at the certain geographical location of the manufacturing site. In a step S120, an applicator operating parameter set is determined, e.g. generated, based on the processed manufacturing design data and/or the obtained geographical location information, wherein the applicator operating parameter set is to be used to operate, by the local control computer device, the applicator to manufacture the part in accordance with its product specification.

Figure 5 shows in a flow chart a further method for operating the applicator 400. The method may be carried out by the computing cloud 300. In an optional step, manufacturing design data comprising product specification of a to-be-manufactured part comprising the polymerizing material is obtained. In a step S210, climate conditions associated with the certain geographical location of the manufacturing site are obtained. In a step S220, a polymerizing material type specification is determined based on at least the obtained climate conditions and/or the obtained product specification and/or manufacturing design data. In a step S230, provision and/or order of the material type defined by the determined polymerizing material type specification is triggered.

It is noted that embodiments of the invention are described with reference to different subject-matters. In particular, some embodiments are described with reference to method type claims whereas other embodiments are described with reference to the device type claims. However, a person skilled in the art will gather from the above and the following description that, unless otherwise notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject matters is considered to be disclosed with this application. However, all features can be combined providing synergetic effects that are more than the simple summation of the features.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The invention is not limited to the disclosed embodiments. Other variations to the

disclosed embodiments can be understood and effected by those skilled in the art in practicing a claimed invention, from a study of the drawings, the disclosure, and the dependent claims.

5 In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. A single processor or other unit may fulfil the functions of several items re-cited in the claims. The mere fact that certain measures are re-cited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A method for operating an applicator (400) adapted to apply a polymerizing material, the applicator (400) to be located at a manufacturing site at a certain geographical location and
5 comprising a local control computer device (410), the method comprising:
obtaining, by a data processing unit (310, 410), geographical location information of the manufacturing site, the geographical location information indicative for expected climate conditions and/or insulation requirements of the to-be-manufactured part at the certain geographical location of the manufacturing site, and
10 determining, by the data processing unit (310, 410), based on the obtained geographical location information, an applicator operating parameter set to be used to operate, by the local control computer device (410), the applicator (400) to manufacture the part in accordance with a product specification.
- 15 2. The method according to claim 1, further comprising the step of:
determining, before determining the applicator operating parameter set and based on the processed manufacturing design data and the obtained geographical location information, an insulation value of the to-be-manufactured part.
- 20 3. The method according to claim 2, further comprising the step of:
providing, before determining the applicator operating parameter set, the determined insulation value or a minimum value derived from it as signal data to a user interface adapted to display the determined insulation value to a user and/or to make it modifiable by a user, and
25 using, if the insulation value is modified by the user, the modified insulation value for determining the applicator operating parameter set.
4. The method according to any one of the preceding claims, wherein obtaining the product specification comprises processing manufacturing design data to obtain the product specification.
30
5. The method according to any one of the preceding claims, further comprising the step of:
obtaining (S110), by the data processing unit (310, 410), a product specification of a to-be-manufactured part comprising the polymerizing material.
- 35 6. The method according to any one of the preceding claims, further comprising the step of:
obtaining actual climate conditions at the certain geographical location of the manufacturing site, and
combining the actual climate conditions with the expected climate conditions, and using the combined climate conditions for determining the applicator operating parameter set, or
40 replacing the expected climate conditions by the actual climate conditions for determining the applicator operating parameter set.
7. The method according to any one of the preceding claims, further comprising the step of:

obtaining actual climate conditions at the certain geographical location of the manufacturing site, and

comparing the actual climate conditions with the expected climate conditions,

wherein, if the actual climate conditions match an acceptable value range, the applicator

5 is operated with the determined applicator operating parameter set, and

if the actual climate conditions do not match the acceptable value range, the applicator operating parameter set is adjusted to the actual climate conditions or to a combination of the actual climate conditions and the expected climate conditions.

10 8. The method according to claim 6 or 7, further comprising the step of obtaining the actual climate conditions by measurement in the vicinity of the applicator (400).

15 9. The method according to any one of the preceding claims, wherein the applicator operating parameter set comprises one or more of: a polymerizing material type specification, an application pressure specification, an application temperature specification, an opening time of a material outlet, and a motion control program for an application robot.

20 10. The method according to any one of the preceding claims, wherein the applicator operating parameter set comprises a test application parameter subset adapted to operate the applicator in a test mode to be carried out to test the operational readiness of the applicator before starting to manufacture the to-be-manufactured part.

25 11. The method according to claim 10, wherein the test mode further comprises: analyzing a pattern of the material to be applied on a test surface (470).

30 12. The method according to any one of the preceding claims, further comprising the step of: updating, at a computing cloud (300) and based on actual climate conditions of the manufacturing site, the expected climate conditions associated with the certain geographical location or a region comprising it.

35 13. A method for operating an applicator (400) adapted to apply a polymerizing material, the applicator to be located at a manufacturing site at a certain geographical location and comprising a local control computer device, the method carried out by a computing cloud (300) remote to the manufacturing site, and the method comprising:

obtaining (S210) a product specification of a to-be-manufactured part comprising the polymerizing material,

obtaining (S220) climate conditions associated with the certain geographical location of the manufacturing site,

40 determining (S230), based on at least the obtained climate conditions and/or the obtained product specification, a polymerizing material type specification, and

triggering (S240) provision and/or order of the material type defined by the determined polymerizing material type specification.

14. The method according to claim 13, further comprising the step of:
predicting future climate conditions associated with the certain geographical location of
the manufacturing site, and

5 using the predicted climate conditions for determining the polymerizing material type
specification.

15. An applicator (400) for applying a polymerizing material, the applicator (400) to be located
at a manufacturing site at a certain geographical location at a manufacturing site, comprising:

10 a computer device (410), comprising a data interface adapted to at least obtain applicator
operating parameter set capable of operating the applicator (400),

an application robot (420), adapted to be controlled by the computer device (410) on basis
of the applicator operating parameter set,

15 wherein the applicator (400) is adapted to carry out the method according to any one of
claims 1 to 11.

16. The applicator according to claim 15, further comprising:

climate conditions measuring means (450), adapted to provide actual climate conditions
measured at the manufacturing site,

20 wherein the applicator (400) is further adapted to:

obtain geographical location information indicative for expected climate conditions at
the certain geographical location of the manufacturing site, and

compare the actual climate conditions with the expected climate conditions,

25 wherein, if the actual climate conditions match an acceptable value range, the

applicator is operated with the obtained applicator operating parameter set, and

30 if the actual climate conditions do not match the acceptable value range, the
applicator operating parameter set is adjusted to the actual climate conditions or to a
combination of the actual climate conditions and the expected climate conditions.

30 17. A computing cloud (300) for operating an applicator adapted to apply a polymerizing
material, the applicator (400) located at a manufacturing site and operatively connected to a
local computer device (410) and at least temporarily to the computing cloud remote to the
manufacturing site, comprising:

a data processing unit (310),

35 a data interface, adapted to exchange data with the manufacturing site,

wherein the data processing unit (310) is adapted to carry out the method according to
any one of claims 1 to 14.

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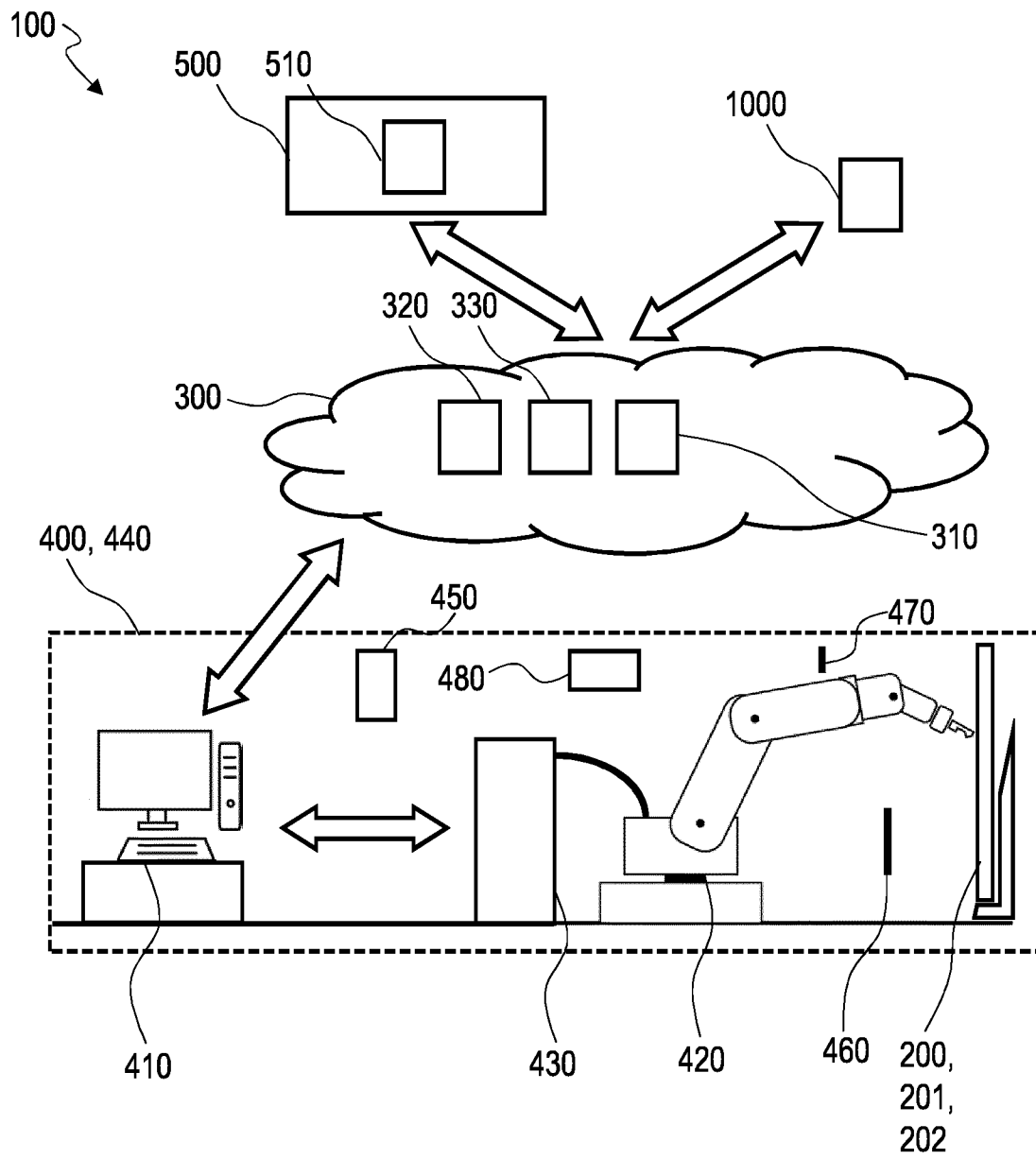


Fig. 1

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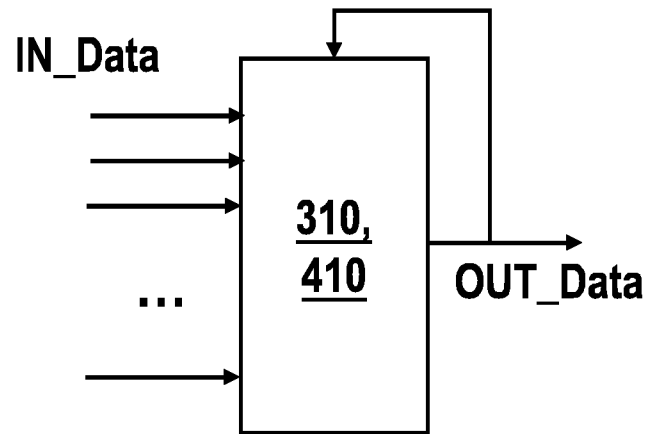


Fig. 2

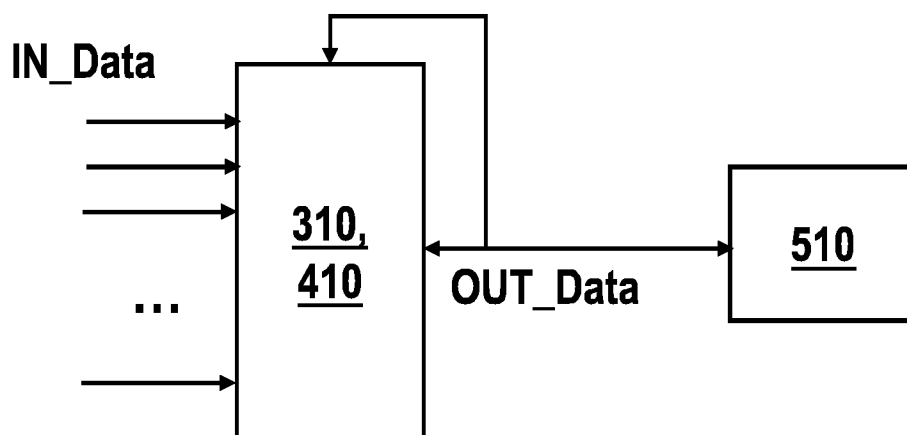


Fig. 3

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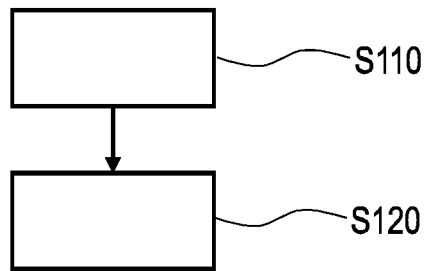


Fig. 4

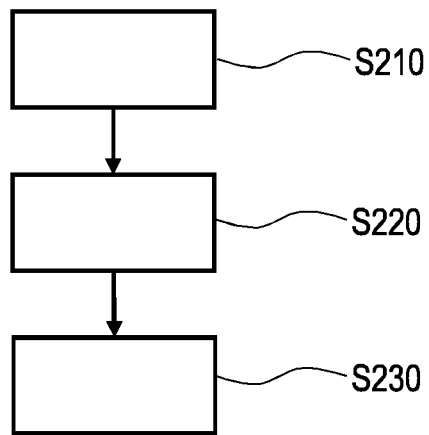


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/056681

A. CLASSIFICATION OF SUBJECT MATTER
INV. B05B12/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 3 584 726 A1 (COVESTRO DEUTSCHLAND AG [DE]) 25 December 2019 (2019-12-25) the whole document	1,13,15, 17
A	WO 2006/081232 A2 (GLIDDEN CO [US]; HOLZKNECHT LOUIS [US] ET AL.) 3 August 2006 (2006-08-03) the whole document	1,13,15, 17
A	RU 2 664 889 C1 (PPG IND OHIO INC [US]) 23 August 2018 (2018-08-23) the whole document	1,13,15, 17
A	US 2020/050223 A1 (LANGE CHRISTOPHER M [US] ET AL) 13 February 2020 (2020-02-13) the whole document	1,13,15, 17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

11 May 2021

Date of mailing of the international search report

01/06/2021

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2021/056681

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