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(54) **Eljárás szerkezeti elemek zajcsökkentésére és/vagy hangszigetelésére**

METHOD FOR THE SOUND DAMPING AND/OR SOUND INSULATION OF COMPONENTS

[0002] The present invention relates to a method for sound-damping and/or sound-insulating metal components and/or plastic components.

[0003] In the preparation of modern appliances, apparatuses and machines, very thin-walled metal sheets or plastic components are used almost exclusively nowadays. Mechanically moving parts, washing and rinsing cycles or running motors inevitably cause these thin-walled metal sheets or plastic components to vibrate, in many cases in the audible range of the human ear. These vibrations are transmitted in the form of structure-borne sound over the entire machine, the apparatus, or the appliance and can be radiated through the air to remote points in the form of disturbing sound. In order to attenuate the sound radiation and to damp structure-borne sound, these metal sheets or plastic components are therefore provided, for example, in automotive manufacture or during the preparation of domestic appliances, with sound-damping coverings known as anti-drumming coatings.

[0004] According to the conventional method, mixtures made of fillers having a high specific weight and bitumen are extruded to form films from which the corresponding molded parts can then be punched or cut. These films are then bonded to the relevant sheet metal parts, it possibly being necessary to adapt them to the shape of the metal sheet by heating.

[0005] According to the teaching in EP2407079 A2, in order to prepare a dishwasher, a prefabricated bitumen mat is glued to at least one component by application of a usable, flowable and reactively hardenable bituminous mixture upon the component and/or upon the bitumen mat in such a manner as to produce at least one adhesive bead—preferably one that is elongated, in particular, line-shaped or strand-shaped—which is surrounded at least partially by at least one region to which the mixture is not applied, i.e. remaining free of reactive bitumen mass, and by pressing together of the component and the bitumen mat before the hardening of the bituminous mixture.

[0006] Although these bitumen sheets are still often used because of their low material price, they are very brittle and tend, especially at low temperatures, to split away from the panel. The often-proposed addition of elastomers also results in only a slight improvement, which is insufficient for many uses. In addition, application of the preshaped bitumen parts onto complexly shaped or poorly accessible sheet-metal parts of machines or vehicles is not possible at all. A further disadvantage is the fact that in many cases a plurality of stamped parts are necessary for a single vehicle or appliance, requiring a large outlay to maintain stocks.

[0007] EP 0766714 A describes plastisol compositions based on vinyl chloride/vinyl acetate copolymers that have been manufactured using the suspension polymerization method. These plastisol compositions have a low viscosity even with a low polymer/plasticizer ratio, so they can be sprayed in airless fashion and have good gelling properties. The document additionally discloses that coatings based on the aforesaid plastisols exhibit a good noise-damping effect. This document proposes using these plastisols in the underbody region of motor vehicles, including the wheel wells, for structure-borne sound-damping coatings, and for corrosion protection and protection from abrasion.

[0008] In similar fashion, EP 702708 A describes sound-damping coatings for panels in the underbody region of motor vehicles, based on plastisols made up of 5 to 60 wt% of at least one powdered styrene copolymer or methyl methacrylate homopolymer or copolymers of methyl methacrylate, 5 to 65 wt% plasticizers, 0 to 40 wt% fillers, 2 to 40 wt% reactive additives, and optionally further additives. According to this document, the plastisol formulations described therein are suitable for the preparation of abrasion-resistant, single-layer linings, capable of application using a spray method, on panels, in particular in the underbody region of motor vehicles in order to reduce the noise caused by the impact of particles, for corrosion protection, and to achieve an abrasion-resistant coating.

[0009] WO 91/05819 describes thermoplastic compounds for use as sound-damping and vibration-insulating laminated or sheet elements, in particular for motor vehicles. The thermoplastic compounds should contain 0.6 to 50% chlorinated polyethylene, 20 to 95% fillers, and 4 to 60% plasticizers compatible with the chlorinated polyethylene. It is indicated that these thermoplastic compositions can be used as sheet material for sound damping and vibration insulation in motor vehicles, buildings, domestic appliances, and industrial machines.

[0010] US 2009/0042055 A1 pertains to a method and device for surface preparation and double polymer coating of rigid sheets in order to improve the adherence of the rigid sheets during the continuous production process. Then, the thermoplastic polymers are extruded directly onto rigid sheets at temperatures above the melting temperature, the coating not being declared to be sound-insulating.

[0011] EP 1 582 268 A1 refers to a method for applying an activatable material, wherein the activatable material is used, depending on the intended use, for the purpose of adherence, reinforcement, sound absorption, and/or vibration damping. Then, the material to be applied may exit in solid or preferably liquid form, and is applied below the activation temperature (below approximately 120°C) so that inflation and reacting off only take place later.

[0012] DE 10 2007 029644 A1 relates to a single-component, hot-curing reactive composition based on natural and/or synthetic olefinic double bond-containing elastomers and vulcanizing agents, as well as use thereof as a single-component adhesive, sealant, coating material, or reinforcing material in automotive body shop assembly, rail transport, or white goods. Therein, the composition contains thermoplastic polymers and may be produced in an extruder.

[0013] WO2006/076958 A1 discloses sprayable, low-viscosity rubber damping compositions based on liquid rubbers or elastomers and vulcanizing agents that containing low levels of structure-reinforcing fiber fillers; they are to be characterized by the absence of conventional solid rubber and have a very low viscosity in the usage state. Such acoustic compositions can be sprayed with the aid of fully automated application equipment, and, in vehicle construction, are preferably processed in the body shell.

[0014] The long dwell times at high temperatures in the coating line processes of automobile construction that follow shell construction are not available, however, in normal machine, apparatus, and device construction. There is thus a need to also provide these fields of use with a method with which sprayable or on-site extrudable products can be applied in very short cycle times, so as to simplify on-site storage.

[0015] The solution to the problem according to the present invention can be found in the claims. The solution consists essentially in providing a method for sound-damping and/or sound-insulating (damping) metal components and/or plastic components in which thermoplastic compounds are applied to the components as a defined profile by direct extrusion at melting temperatures of between 120 and 300°C, wherein the compounds are in granulate form and have a density of from 1.5 to 5 g/cm^3 before being heated.

[0016] Metal components are preferably thin-walled sheets of steel, aluminum, and, in particular, stainless steel. Plastic components can, for example, be made of thin-walled PVC polymers, polycarbonate polymers, polypropylene polymers, acrylonitrile butadiene styrene polymers (ABS polymers) or glass fiber-reinforced plastics materials (FRP). Plastic plates may be preferred components.

[0017] The method according to the present invention may preferably be used anywhere long residence times at high temperatures are not available in the coating line processes for automotive engineering.

[0018] Said components to be coated are preferably component parts of "white goods," i.e. domestic appliances or domestic machines such as dishwashers and washing machines, or of bath tubs, shower bases, shower trays, or sinks. However, they can also be component parts of data processing devices (computers), pump housings, compressors, agricultural vehicles and devices, medical devices, or housing turrets of wind turbines.

[0019] The granulate (also called pellets) may have a particle diameter of 0.5 to 30 mm, preferably 2 to 10 mm. The particle size may then be determined, for example, by sieve analysis. Preferably, the grain has a ball-shaped or lenticular shape, but may also be elliptical or cylindrical in shape. The surface of the granulate particles should preferably be adhesive- and block-free in order to prevent the granulate from bonding to larger aggregates during storage and transport thereof.

[0020] Thermoplastic compounds within the context of the present invention are mixtures of pure thermoplastic polymers with which fillers, optionally reinforcing materials and/or other additives, have also been admixed. The compounds then in granulate form have a density of 1.5 to 5 g/cm^3 before being heated. The prescribed density should thus correspond to the density at room temperature, preferably at 20°C. In order to achieve a high density of the thermoplastic compounds, the thermoplastic compounds should be highly filled, i.e., have a filler content of at least 60 wt%.

[0021] Examples of thermoplastic polymers to be used include vinyl polymers, in particular, ethylene vinyl acetate (EVA), polyolefins, polyamides (PA), polyesters, polyacetals, polycarbonates, polyurethanes, ionomers, or also bitumen. Optionally, mixtures of the aforementioned pure thermoplastic polymers may also be used. EVA, PA, or mixtures thereof are especially preferred.

[0022] Inorganic salts or oxides—preferably those having a high density between 2.5 and approximately 12 g/cm^3—serve as fillers. Examples of such fillers are zinc oxide (ZnO), tin dioxide (SnO_2), titanium dioxide (titanium (IV) oxide, TiO_2), iron oxide—in particular iron(II) oxide (FeO), iron (III) oxide (iron sesquioxide Fe_2O_3), iron (II,III) oxide (ferrous-ferric oxide Fe_3O_4, magnetite), barium sulfate ($BaSO_4$), lead sulfate (lead vitriol, $PbSO_4$), aluminum hydroxide (e.g. in the form of hydrargillite, bayerite, nordstrandite) or aluminum metahydroxide (e.g. in the form of disaspore or boehmite), hafnium boride, hafnium carbide, hafnium nitride, hafnium dioxide (HfO_2), tungsten oxides (e.g. tri-tungsten oxide (W_3O), tungsten dioxide (tungsten (IV) oxide, WO_2), tungsten trioxide (tungsten (VI) oxide, WO_3)), rhenium dioxide (ReO_2), rhenium trioxide (ReO_3) and rhenium heptoxide (Re_2O_7).

[0023] Another possibility is that of using the corresponding rock flours or ore meals as the filler. Examples thereof are dolomite, cassiterite (tin ore, SnO_2), bismuth blend (eulytine, eulytite, $Bi_4[SiO_4]_3$), bismuth glance (bismuthinite, bismuthine, Bi_2S_3), ilmenite (titanium iron, $FeTiO_3$) and granite stone flour.

[0024] The use of barite, iron oxides, aluminum hydroxides or mixtures thereof is very particularly preferred.

[0025] The fillers to be used have a grain size range of between 0.01 and 5,000 µm, preferably of between 0.1 and 100 µm, particularly preferably between 0.5 and 20 µm.

[0026] Examples of additives include hot-melt adhesives and/or adhesion promoters and release agents.

[0027] The thermoplastic compound to be used according to the present invention then preferably contains 10 to 30 wt%, especially preferably 15 to 25 wt% thermoplastic polymers, 70 to 90 wt%, especially preferably 65 to 85 w% filler(s), and 0 to 10 wt%, especially preferably 1 to 5 wt% a hot-melt adhesive, the sum of the components being 100 wt%.

[0028] The filling thermoplastic polymers and hot-melt adhesive may then each be present in granulated form as a mixture or a blend in the compound. Alternatively, the granulate particles of the filling thermoplastic polymers may be coated with the hot-melt adhesive.

[0029] A tendency for the granulate particles to agglutinate or agglomerate can also be prevented by a surface treatment of the surface of the granulate particles. To this end, the granulate particles are coated superficially with a suitable release agent; this release agent may be, for example, talc, pyrogenic silicic acid, molecular-sieve powder, carbon black, polyethylene powder, ethylene vinyl acetate powder, or another fine-particle, non-reactive polymer powder. In principle, release agents that are fusible at slightly elevated temperature, such as, for example, waxes, may also be sprayed onto the surface of the granulate.

[0030] The filled granulate and the hot-melt adhesive are compounded prior to the extrusion, and provided to the user as a finished product. Alternatively, the filled granulate and the hot-melt adhesive may be brought separately to the place of the application, and there mixed in-line and supplied to the extruder.

[0031] The ready-to-use thermoplastic compound can be fed to the extruder by means of gravity or pneumatic conveyor systems. Pneumatic conveyance systems are understood in this context to mean suction and/or blow conveyors.

[0032] The thermoplastic compound or the components containing the filled granulate and the hot-melt adhesive and/or other auxiliaries are preferably supplied by continuous gravimetric or volumetric metering such that, depending on the application, a defined profile having constant or predefined variable dimensions is directly applied to the optionally preheated substrate to be coated from the extruder. Alternatively, precise amounts of the individual material components can be fed to the extruder.

[0033] Prior to the coating step, the substrate can be pre-heated to a defined temperature in this case by means of infrared radiation, laser radiation, a supply of hot air or, for metal substrates, can also be pre-heated inductively. Inductive pre-heating can in particular be carried out dynamically, i.e. a sensor determines the substrate temperature, which is then compared with a predefined target value in order to determine and set the required heating capacity of the induction heater therefrom. Corresponding pre-heating apparatuses are preferably attached either directly to the extruder head or directly upstream thereof, so that pre-heating takes place shortly before coating.

[0034] In order to coat the substrate, the component to be coated and the extruder head, together with the nozzle mounted thereon, have to move relative to one another. In this case, in order to generate the relative movement, the following can be carried out:

- the component stays still and the nozzle moves, or
- both the component and the nozzle move, or
- the nozzle is stationary and the component moves.

[0035] The relative movement is preferably generated by manipulators. Within the context of this invention, manipulators are devices which allow for physical interaction with the surroundings. In this case, this is the movable part of the structure which carries out the mechanical work of the extruder head.

[0036] In the case of the moving nozzle, the manipulator used can be a robot having five or six rotation axes or displacement axes (rotary or translational axes), as a result of which the individual movements can be combined to form an overall movement.

[0037] In this case, the robot can carry the extruder, together with the pre-heating apparatus, and can carry out the relative movement. Similar robots are described for example in U.S. Pat. No. 5,358,397, EP 0787576 B1, and DE 10137214 A1.

[0038] When both the component and the extruder nozzle move, the manipulator is preferably fixedly arranged next to a conveyor belt, the manipulator moving the extruder mounted thereon or the extruder nozzle only along two axes that are orthogonal to one another. The component to be coated is horizontally guided past the manipulator station on a conveyor apparatus, said conveyor apparatus optionally being provided with guide apparatuses, transversely to the transport direction, which control the start and finish of the extrusion process of the coating material.

[0039] If the nozzle is arranged such that it cannot move, the component to be coated is guided past the nozzle of the extruder by means of a suitable robot. The robot has from two to six rotation and displacement axes, depending on the shape and size of the component to be coated.

[0040] Optionally, the components, having been thus coated, are completely hardened by taking advantage of existing process heat from coating apparatus, prior to the subsequent installation on or in the appliance or machine.

[0041] In another preferred approach, the component that has been coated with the sound-damping or -insulating compound is first installed in the appliance or machine, and the subsequent process heat—for example, from an existing coating apparatus—is used for the final curing of the compound.

[0042] Further features and details of the method according to the present invention shall be described in greater detail with reference to the drawings.

In the drawings,

Fig. 1	illustrates one possible embodiment of the direct extrusion apparatus,
Fig. 2	illustrates a complete structure for carrying out the method for coating components according to the present invention, and
Fig. 3	illustrates a detail on the arrangement of the extrusion nozzle.

[0043] Fig. 1 depicts the essential parts of a direct extrusion apparatus. The blower station 1 contains, *inter alia*, a filter for keeping the conveying air clean from suspended and dust parts. The conveying air is used to pneumatically transport the filled granulate to be extruded from the reservoir 2 via the hose 4 into the hopper 3 of the extruder 5. The granulate is conveyed from the hopper in an automatically controlled manner into the extruder in the predetermined amount. Not shown are the extruder nozzle and the apparatus for positioning the components to be coated.

[0044] Fig. 2 illustrates a coating installation in which both the component and the nozzle move. The transport device 6 supplies to components ("parts") to be coated from the storage or a preparation station of the coating installation. At the place 7, the components are supplied to the conveyor apparatus 8. This may, as depicted here, be performed manually or by machine, with the aid of suitable and known manipulators. The apparatus 8 effectuates the transport of the components in the horizontal direction to the predetermined coating station 9, which, in the case depicted, is a stationary manipulator or robot having, for example, three rotation or displacement axes. A device for heating up the component is not visible. In the specifically depicted case, the robot arm carries only the extrusion nozzle, and the compound that has already been fused on in the extruder 11 is conveyed via the hose connection 10 from the extruder to the extrusion nozzle at the end of the robot arm. After being coated, the components are conveyed to the station 12 and, once at this place, transported to another conveyor belt for packaging or further processing. In fig. 2, the supply of the coated components from the conveyor apparatus 8 to the conveyor belt 13 is also depicted as a manual process. Here, too, this can be done with the aid of suitable and known manipulators.

[0045] Fig. 3 illustrates a detailed view of the extrusion nozzle 14, which is guided over the substrate 16 coated with the compound 15 at a constantly held angle α. This is important so that the predetermined coating thickness and geometry can be met. The arrow 17 sets forth the relative movement of the component 16 relative to the nozzle 14.

[0046] As already described above, the specific design both of the conveyor apparatus and of the coating station is based on the size and geometry of the components to be coated. If the component to be coated is, for example, a complete washing container of a washing machine, a dishwasher, or a housing turret, the design of the conveyor apparatuses for feeding the components to the coating station has to be adapted to the components. The manipulator or robot performing the coating must also be designed accordingly. Such apparatuses are already known, for example, from the automotive industry.

717234/DO

ELJÁRÁS SZERKEZETI ELEMEK ZAJCSÖKKENTÉSÉRE ÉS/VAGY HANGSZIGETELÉSÉRE

SZABADALMI IGÉNYPONTOK

1. Eljárás fém és/vagy műanyag alkatrészek zajcsökkentésére és/vagy hangszigetelésére, azzal jellemezve, hogy a 120-300 °C olvadási hőmérsékleten termoplasztikus kompaundokat közvetlen extrudálással viszünk fel az alkatrészre, mint meghatározott profilra, ahol a granulált formájú kompaundok melegítés előtti sűrűsége 1,5–5 g/cm^3.

2. Az 1. igénypont szerinti eljárás, azzal jellemezve, hogy a szerkezeti elemek háztartási készülékekben vagy háztartási gépekben kerülnek felhasználásra vagy háztartási készülékek vagy háztartási gépek alkatrészei.

3. Az 1. igénypont szerinti eljárás, azzal jellemezve, hogy a szerkezeti elemek mosogatótálcák, fürdőkádak, zuhanykádak vagy zuhanytálcák.

4. Az előző igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy a bevonandó felület nemesacél vagy PVC-, polikarbonát-, polipropilén-, akrilnitril-butadién-sztirol-(ABS-) polimer vagy üvegszállal erősített műanyag (GFK).

5. Az előző igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy a termoplasztiks kompaundok töltőanyagtartalma legalább 60 tömeg%.

6. Az előző igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy a termoplasztikus kompaundok egy, szervetlen sókkal erősen töltött etilén-vinil-acetát (EVA), poliamid vagy bitumen és poliamid vagy poliolefin bázisú olvadó ragasztóanyag keverékét vagy elegyét tartalmazzák.

7. A 6. igénypont szerinti eljárás, azzal jellemezve, hogy a szervetlen sókkal erősen töltött etilén-vinil-acetát (EVA), poliamid vagy bitumen bázisú termoplasztikus kompaundgranulátumok, poliamid vagy poliolefin bázisú olvadó ragasztóanyaggal vannak bevonva.

8. Az előző igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy

- a szervetlen sókat bárium-szulfátból, alumínium-hidroxidból és/vagy vasoxidokból választjuk ki
- a kompaundok sűrűsége 2,1 és 4,5 g/cm^3 közötti

- a termoplasztikus kompaundokat 180 °C és 250 °C közötti hőmérsékleten visszük fel.

9. Az előző igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy a betöltött termoplasztikus polimert és az olvadó ragasztóanyagot az extrudálás előtt összekeverjük vagy, az extrudálás elé besorolva, azzal egy menetben az extruderbe külön komponensként adagoljuk és csak az extruderben keverjük össze.

10. Az 1–9. igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy a bevonandó szerkezeti elem és az extruderfej, a rászerelt fúvókával egymáshoz képest relatív mozgást végez, úgy, hogy

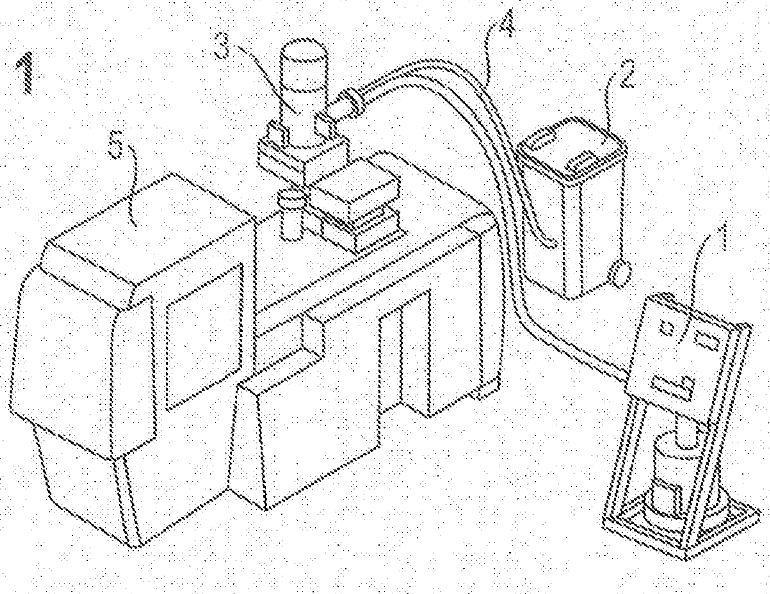
- az alkatrész mozdulatlan és a fúvóka mozog vagy
- mind az alkatrész mind pedig a fúvóka mozog, vagy
- a fúvóka áll és az alkatrész mozog.

11. Az előző igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy a granulátumot vagy a granulátumokat a közvetlenül az extrudálás során gravitációs úton vagy sűrített levegővel, előnyösen folyamatosan volumetrikusan vagy gravimetrikusan adagolják.

12. Az előző igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy az extruder egy manipulátorra vagy robotkarra van felszerelve.

13. Az előző igénypontok legalább egyike szerinti eljárás, azzal jellemezve, hogy a bevonandó felületet lézersugárral vagy előnyösen dinamikus induktív eljárással a bevonás előtt egy meghatározott hőmérsékletre temperáljuk.

Fig. 1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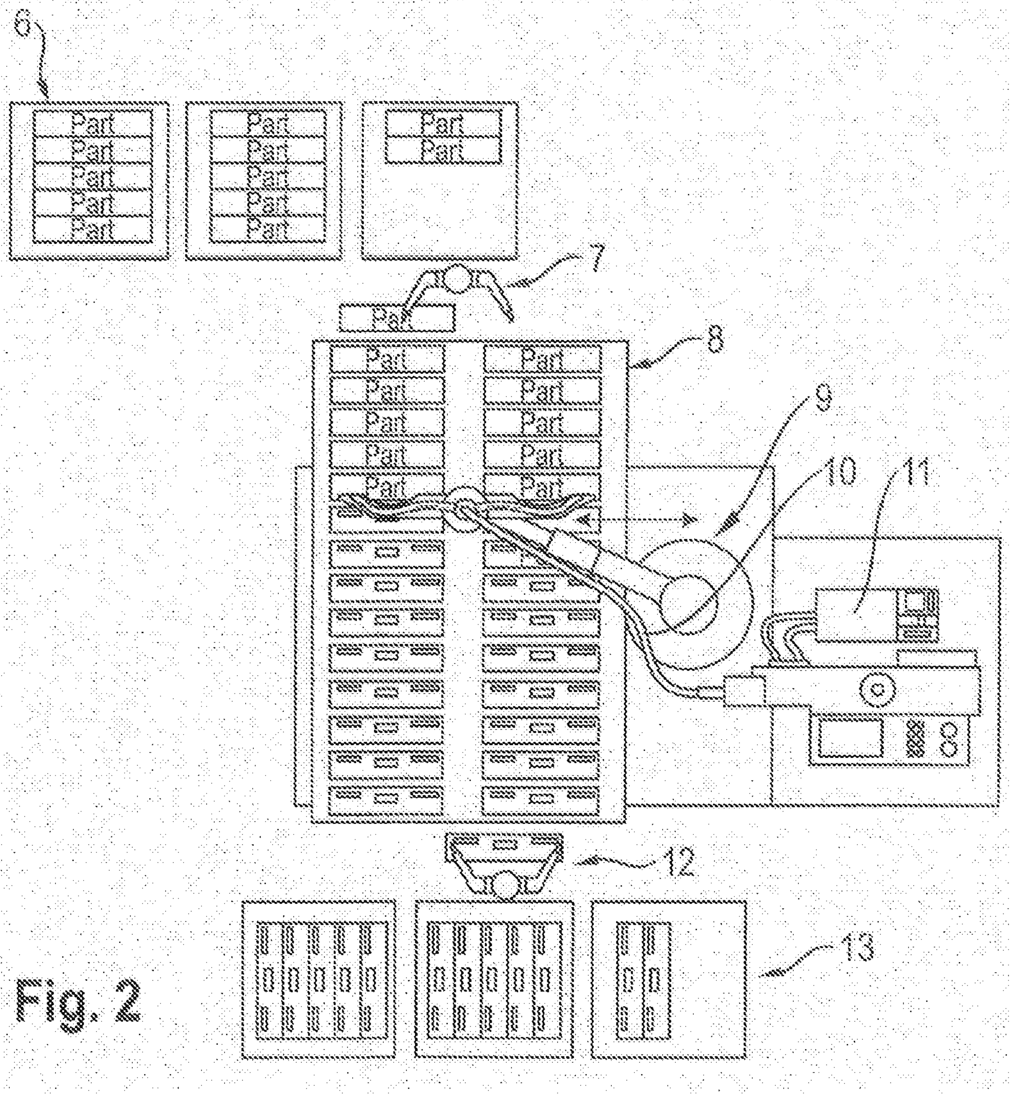
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Fig. 2

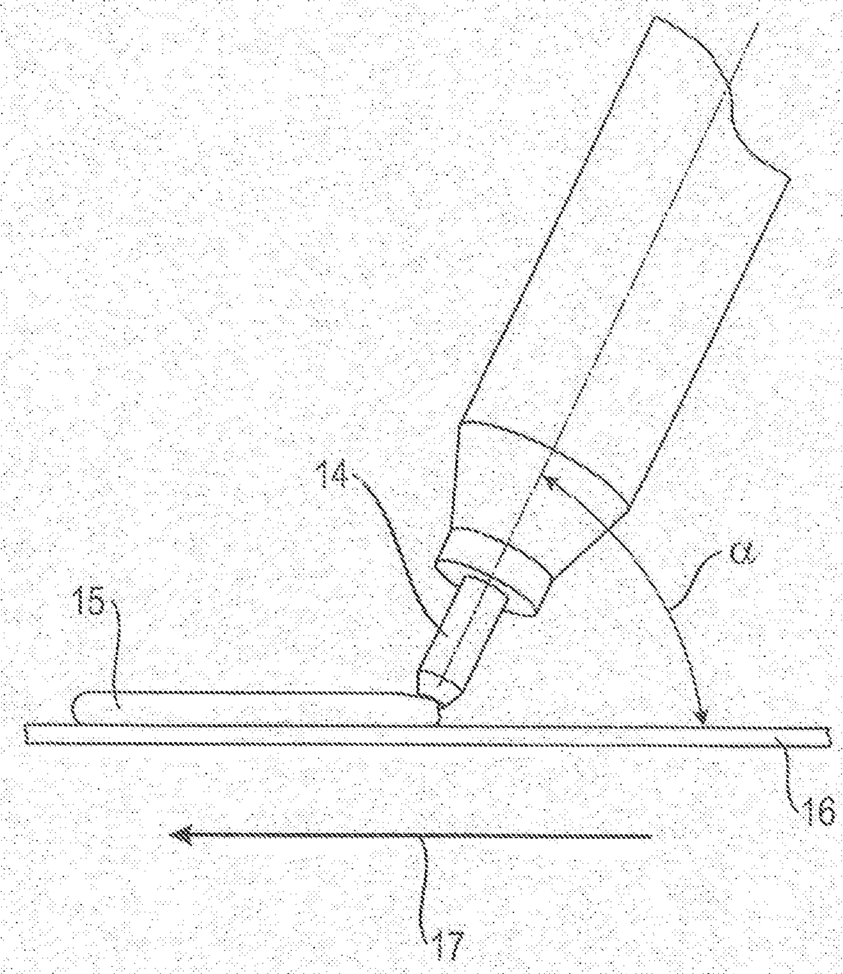

Fig. 3