HU000035766T2

(19) **HU** (11) Lajstromszám: **E 035 766** (13) **T2**

MAGYARORSZÁG
Szellemi Tulajdon Nemzeti Hivatala

EURÓPAI SZABADALOM
SZÖVEGÉNEK FORDÍTÁSA

(21) Magyar ügyszám: **E 11 157721**
(22) A bejelentés napja: **2011. 03. 10.**

(51) Int. Cl.: ***C21D 1/673*** *(2006.01)*
C21D 9/00 *(2006.01)*

(96) Az európai bejelentés bejelentési száma:
EP 20110157721
(97) Az európai bejelentés közzétételi adatai:
EP 2497840 A1 **2012. 09. 12.**
(97) Az európai szabadalom megadásának meghirdetési adatai:
EP 2497840 B1 **2017. 05. 03.**

(72) Feltaláló(k):
Schwartz, Rolf-Josef, 52152 Simmerath (DE)

(73) Jogosult(ak):
Schwartz GmbH, 52152 Simmerath (DE)

(74) Képviselő:
Danubia Szabadalmi és Jogi Iroda Kft.,
Budapest

(54) **Kemencerendszer és eljárás acéllemezrészek részleges felhevítésére**

Oven system and process for partially heating steel blanks

Description

The invention relates to a furnace system and to a method for the controlled heat treatment of sheet metal parts.

In the technical realm, many applications in a wide array of sectors call for high-strength sheet metal parts that are lightweight. For instance, the automotive industry is striving to reduce the fuel consumption of motor vehicles so as to lower the CO_2 emissions while, at the same time, improving passenger safety. For this reason, there is an ever-growing demand for autobody parts that have a favorable strength-to-weight ratio. These parts especially include A and B pillars, side-impact bars in doors, rocker panels, frame parts, bumpers, crossbeams for the floor and roof as well as front and rear longitudinal beams. In modem motor vehicles, the bodyshell with a safety cage is usually made of hardened sheet steel with a strength of about 1500' MPa. Al-Si-coated steel sheets are often used for this. The process of so-called press hardening has been developed for purposes of manufacturing parts made of hardened sheet steel. Here, steel sheets are first heated up to the austenitic temperature between 850°C. and 950°C [1562°F and 1742°F], then placed into a pressing die, quickly formed and rapidly quenched by the water-cooled die to the martensitic temperature of approximately 250°C [482°F]. This gives rise to a hard, strong martensitic structure with a strength of about 1500 MPa. A steel sheet hardened in this manner, however, only has an elongation at break of about 6% to 8%, which is a drawback in certain areas if two vehicles collide, especially in the case of a side impact The kinetic energy of the impacting vehicle cannot be converted into deformation heat. Rather, in this case, the part will undergo brittle fracture, additionally posing a risk of injury to the

passengers.

For this reason, the automotive industry is striving to develop autobody parts that have several, different elongation and strength zones so that one single part can have very strong areas on the one hand and very extensible areas on the other hand. In this context, the general requirements made of a production installation should also be taken into account: for instance, the cycle time of the press hardening installation should not be detrimentally affected, it should be possible to use the entire installation universally without restrictions and to quickly retool it according to customer specifications. The process should be robust and cost-efficient, and the production installation should only take up a minimal amount of space. The shape and the edge precision of the part should be so high that the need for hard-trimming the hardened part is virtually eliminated, thus saving material and work.

The state of the art describes such methods and devices. In this context, these methods make use of partially heated dies, whereby one area of the part is cooled off above the martensite-forming quenching velocity. The rest of the part is cooled off abruptly as is normally done, thereby forming martensite. European publication EP 2 012 948, for example; describes a forming die for press-hardening and for the temperature-controlled forming of a blank consisting of high-strength and/or ultra-high strength steel grades; this die that has means for controlling the temperature of the forming die and this publication also describes a method for press-hardening and for temperature-controlled forming of a blank consisting of high-strength and/or ultra-high strength steel grades in which the blank is heated prior to the forming process and subsequently formed in a forming die while it is hot or warm, whereby the forming die has means for controlling the temperature. Here, several temperature-control means are provided in the forming die, as a result of which a plurality of temperature zones can be defined, whereby at least the contact surfaces of the die elements used for the forming process are associated with individual temperature zones.

German patent document DE 10 2005 032 113 discloses a device and a method for hot-working and partially hardening a part positioned between two die halves in a press. The die halves are each divided into at least two segments that are separated from each other by thermal insulation. The two segments can be heated or cooled by means of a temperature-control unit, so that different temperatures and thus different cooling curves can be established in different areas of the part. This makes it possible to manufacture a part with areas of different hardness and ductility.

International patent document WO 2009/113 938 describes a press-hardening process with which soft areas can be created in the finished product by reducing the cooling rate of these material sections. This diminishes the martensite fraction in these areas and consequently increases the elongation at break of these areas.

In this context, all of the methods that use a partially heated die entail the drawback that the part becomes warped since the part is removed from the die with partially different temperatures ranging from about 300°C to 500°C [572°F to 932°F] in the soft area, and of about 100°C [212°F] in the martensitic areas, after which it is further cooled away from the fixed shape of the die. Moreover, the cycle time of the process is lengthened since the fast cooling is slowed down in order to promote pearlite-ferrite formation, as a result of which the cost-effectiveness is likewise reduced. In addition, such dies are very complex and therefore expensive and malfunction-prone.

In another method known from the state of the art, for example, German patent documents DE 10 350 885, DE 10 240 675, DE 10 2005 051 403 or DE 10 2007 012 180, in a dual-zone furnace, the soft area of the part is heated up to a temperature below the material-dependent Ac3 temperature, whereas the area that is to be hardened, in contrast, is heated up to a temperature above the Ac3 temperature. In this process, an extensible soft pearlite-ferrite is formed in one area of the part and a hard martensite is formed in another area of the part. The disadvantage of this process is that the furnace can only be employed with certain limitations and can no longer serve as a universal furnace. This translates into a loss of cost-effectiveness for this method. Another disadvantage is that the separation of the areas usually cannot be accomplished with sufficient precision over the long run. Moreover, it is not feasible to implement more than two different zones. Furthermore, when Al-Si-coated parts are used, the temperature has to be kept at approximately 950°C [1742°F] for about 300 seconds so that the coating can diffuse into the base material. This process takes considerably longer at lower temperatures, thus reducing the cost-effectivenes of the entire installation.

Moreover, another method is known in actual practice in which the soft areas are partially cooled slowly. In this process, the entire part is heated up above the austenitic temperature beyond the diffusion time and diffusion temperature, and subsequently, either in a separate furnace or in the same furnace, it is cooled down again slowly to below the austenitic temperature in that it is partially exposed to air. When the press-hardening process is subsequently carried out in the die, the drawbacks in terms of the insufficient dimensional precision and the cost-effectiveness of the production furnace are eliminated. A disadvantage of this method is the slower cycle time caused by the additional work step. Yet another disadvantage is the undefined cooling rate that occasionally leads to martensite formation in parts that are less than 1,2 mm-thick.

The cooling rate is undefined because the cooling takes place at an ambient temperature that cannot be precisely defined. For this reason, the process cannot be said to be robust. Moreover, this process can only be carried out with two zones of different hardness.

European patent application EP 2 143 808 A1 discloses a method for the production of a shaped part having at least two structural areas of different ductility from a blank made of hardenable steel, different regions of which are heated differently and subsequently shaped in a heat-forming and hardening die and hardened in certain regionsSubsequently, by use of an infrared lamp array is used to bring first regions of the blank to a temperature above the Ac3 temperature, to be subsequently hardened in a heat-forming and hardening die in the first regions. For solving the problem of the temperature distribution in the shaped part and the precise adjustment of the hardness values in the finally shaped part coupled therewith compartments are proposed for separating the temperature zones. Due to the very good heat conduction of the material steel it cannot be avoided by the proposed method to have transition areas of the temperature in which a temperature around the Ac3 temperature is reached without being able to define precisely where in the part a temperature below said temperature or already above this temperature is present.

Finally, it is also possible to weld different grades of steel together, so that unhardenable steel is present in the soft zones while hardenable steel is found in the hard zones. During the subsequent hardening process, the desired hardness profile is achieved over the entire part. The drawbacks of this process are the occasionally unreliable weld seam of the approximately 0.8 to 1.5 mm-thick Al- Si-coated sheet metal normally used for chassis parts, the abrupt hardness transition there as well as the increased costs of the sheet metal due to the additional production step of welding. During testing, failures occasionally occurred due to breakage in the vicinity of the weld seam, so that the process cannot be considered to be robust.

Before this backdrop, it is the objective of the invention to put forward a furnace system and a method for the controlled heat treatment of sheet metal parts which avoids the above-mentioned disadvantages.

According to the invention, this objective is achieved by a furnace system having the features of the independent claim 1. Advantageous refinements of the furnace system ensue from the subordinate claims 2 to9.

Furthermore, the objective is achieved by a method according to claim10. Advantageous refinements of the method ensue from the subordinate claims 11 to13.

The furnace system according to the invention is adapted for heating shaped parts made from steel sheets partially to a temperature above the Ac3 temperature. The furnace system has a conventional, universal production furnace for heating up the sheet steel parts to a temperature that is close to but below the Ac3 temperature,

whereby the furnace system has further a profiling furnace with at least one level. The at least one level has an upper section and a lower section as well as a product-specific intermediate flange implemented in a respective receptacle whereas the product-specific intermediate flange is formed to imprint the part with a prescribed temperature profile at temperatures above the Ac3 temperature for areas that are to be hardened, and at temperatures below the Ac3 temperature for less hard parts.

In a preferred embodiment, the furnace system also has a positioning system on which the part can be placed in a defined position after it has been heated in the production furnace and/or in the profiling furnace.

This ensures that the part is in a predefined position after it has been heated up in the production furnace or after it has been partially heated up in the profiling furnace. Then the part can be subsequently placed in a predefined position into the profiling furnace or into a press for the subsequent press-hardening process. The more precisely the placement position of the part can be adhered to, the less trimming work is needed for the finished, hard sheet metal part. The product-specific intermediate flange has means for actively cooling individual areas. In an advantageous embodiment, the cooling is effectuated by means of water cooling.

In another particularly advantageous embodiment, the product-specific intermediate flange has means for heating individual areas, whereby, in a special embodiment, these means are in the form of electric heaters. This makes it possible to systematically heat and/or cool individual, product-specific areas, so that the temperatures of these areas can be kept within narrow tolerance ranges. If individual areas are heated above the Ac3 temperature, these areas become extremely hard in the subsequent press-hardening process. The other areas that are ystematically heated with a temperature not above the Ac3 temperature will become in the subsequent press-hardening process considerably less hard and instead, they have a higher elongation at break. Electric heaters allow very precise temperature regulation.

It has been found to be advantageous for the production furnace to be heated by means of gas burners. This allows an especially economical heating of the parts. Since the method according to the invention provides for the parts to be heated up in the production furnace only to a temperature below the Ac3 temperature and for the heat needed for heating defined areas to a temperature above the Ac3 temperature to be fed into the profiling furnace during a later process step, it is not necessary to have a very precise temperature regulation in the production furnace, so that the disadvantage of the less accurate regulation of gas burners in comparison to electric heaters is offset by the greater cost efficiency of gas as a cheaper energy carrier.

In another advantageous embodiment, the furnace system has a production furnace which, as a continuous furnace, has a transport system to convey the parts through the production furnace. The cycle time for heating up the parts can thus be kept at the level of conventional heating furnaces used for the press-hardening process. If the subsequent process step of imparting the part with a temperature profile affects the cycle time so that the cycle time for the entire process is at risk of becoming prolonged, a profiling furnace with several levels can be employed in which the parts are partially further heated in parallel or partially in parallel. The parallel use of several profiling furnaces is also conceivable.

In order to keep the temperature tolerances on the part especially narrow during the controlled heating of individual areas, it has proven to be advantageous to regulate the temperature in a closed control circuit. For this purpose, in an advantageous embodiment, the profiling furnace has means for temperature regulation in a closed control circuit. Here, it is advantageously possible to also provide more than one control circuit.

It has proven to be particularly advantageous for the furnace system to also have a handling system for handling the parts. The handling system can place the parts quickly and systematically into the positioning system, can then remove them from the positioning system and can put them into the product-specific intermediate flange in the profiling furnace and take them out again. Moreover, the handling system can subsequently place the parts into a press die for the subsequent press-hardening. The use of a handling system minimizes the risk of injury to the operating personnel due to hot parts. A handling system executes the movements in defined and reproducible times, so that the parts can be placed with minimum temperature tolerances into the pressing die for the press-hardening, which has a positive effect on the quality of the part.

The method according to the invention is characterized by the following process steps:

* heating a part in the production furnace close to its Ac3 temperature;
* positioning the heated part by means of a positioning system;
* placing the positioned part in a defined position into the profiling furnace; .
* imparting a temperature profile to the part in the profiling furnace through heating selected areas to a temperature above the Ac3 temperature, while another areas are kept at a temperature below the Ac3 temperature;
* removing from the profiling furnace the part that has been imparted with a temperature profile.

It has proven to be advantageous tor the part to be heated up ill the production furnace by means of gas burners, whereby natural gas, for example, can be employed as the energy carrier.

In another advantageous embodiment, the positioned part is brought in a defined position into the profiling furnace by means of a handling system The advantages of this are that the risk of injury to the operating personnel is minimized and that the process is rendered more robust due to the constant handling times. An advantage here is that such a system can be retrofitted into existent installations.

Advantageously, imparting a temperature profile to the part in the profiling furnace is regulated by means of a closed control circuit. This makes it possible to achieve very narrow temperature tolerances for the part, which has a positive impact on the quality of the press-hardened part. In order to impart the temperature profile, areas of the part that are to be hardened are systematically heated up via a product-specific intermediate flange to a temperature above the Ac3 temperature, while other areas that are supposed to display a higher extensibility in the finished part are kept at a temperature below the Ac3 temperature.

Other advantages, special features and practical refinements of tile invention ensue from the subordinate claims as well as from the presentation below of preferred embodiments with reference to the figure.

The following is shown:

Figure 1 a top view of the furnace system according to the invention;

Figure 2 a detailed view of the profiling furnace;

Figure 3 section A-A from Figure 2

Figure 1 shows a top view of the furnace system according to the invention. A first robot 61 positions a part 5 onto a roller conveyor that transports the part 5 through the production furnace 10. The production furnace 10 is a conventional universal furnace that is heated up by natural gas burners 9 to a temperature below the Ac3 temperature of the material in question, The conveying speed for the parts 5 through the production furnace 10 is selected in such a way that the parts 5 almost reach the temperature that prevails in the production furnace 10. Downstream from the production furnace 10 in the transport direction, there is a positioning system 20 that places each part 5 in a defined flat position. A handling system 22 picks up the part 5 and places it in a defined position into the profiling furnace 40. Inside the profiling furnace 40, there is an upper section 41 and a lower section 42 as well as a receptacle 44 for a product-specific intermediate flange 45 as well asthe product-specific intermediate flange 45 itself. The intermediate flange 45 has areas with heaters 46 on one side and areas 48 that can be cooled on the other side. in addition, it is also possible to provide the profiling furnace 40 only with means 46 for controlled heating or else only areas 48 that can be systematically cooled. In this context, such areas 48 can have cooling openings through which a cooling medium such as water or oil flows. However, it is likewise possible to employ familiar means such as heat pipes or inserts made of highly heat-conductive materials such as, for example, copper alloys, for purposes of very systematic cooling. Examples of heaters 46 that can be used are all known types of heaters such as electric heating cartridges or electric heating radiators. Electric heaters have the advantage that they can be regulated very quickly and precisely. The areas 30, which are supposed to be very hard after undergoing a subsequent press-hardening process, are heated up to a temperature above the Ac3 temperature by means of the heaters 46. Other areas 50, which are supposed to have a higher elongation at break after the subsequent press-hardening process, are kept at a temperature below the Ac3 temperature by means of the systematic cooling 48 of this areas. The temperature is regulated in at least one dosed control circuit. At the end of the holding time needed to heat up the areas 30 to the desired temperature above the Ac3 temperature, the part 5, which has now been imparted with a temperature profile, is removed from the profiling furnace 40 by means of the handling system 22. In the embodiment shown, the handling system 22 is configured as a rake. However, any other suitable handling systems can likewise be used. The handling system 22 once again places the part 5 onto the positioning system 20. However, it is likewise conceivable to place the part 5 onto another transfer station after it has been imparted with a temperature profile. A second robot 60 then takes over the part 5 in order to place it into the die 70 of a press so that it can be press-hardened. Normally, however, the part 5 can be placed directly into the pressing die 70 without being repositioned, since there is no longer any relative to movement in the profiling furnace 40 and thus no reorientation of the part 5.

Figure 2 shows a top view of the profiling furnace 40 in a detailed view. It is possible to see a part 5 that is located on the positioning system 20 in front of the profiling furnace 40. Another part 5 is inside the profiling furnace 40. Areas 30 of the part 5 that are supposed to be very hard after the press-hardening process are in the places of the product-specific intermediate flange 45 that can be heated by the heaters 46. This heater is an electric heating element that is supplied via connectors 47 with electricity made available by a regulator (not shown here). Another area 50 of the part 5 that, after the press-hardening process, is supposed to have a higher elongation at break than the hard area 30, is located in an area 48 of the product-specific intermediate flange 45 that can be systematically cooled. For this purpose, cooling medium is fed in via the connections 49 in the area 47.

Figure 3 shows the section A-A from Figure 2 through the profiling furnace 40. The profiling furnace 40 has an upper section 41 and a lower section 42 as well as a receptacle 44 for a product-specific intermediate flange 45 and the product-specific intermediate flange 45 itself. Heaters 46 that are supplied with power via connectors 47 can be seen in the product-specific intermediate flange 45. In this manner, the part 5 in the area 30 can be systematically heated up to a temperature above the Ac3 temperature. Likewise visible is the handling system 22, which is situated in front of the profiling furnace 40. The arrows indicate that the handling system 22 can move a part 5 vertically and horizontally, so that a part 5 located on the positioning system 20 (not shown here) can be placed into the product-specific intermediate flange 45 inside the profiling furnace 40 by means of the handling system 22.

Instead of the above-mentioned robot, it is likewise possible to employ any other suitable handling system. In the embodiment shown in the figure, only a profiling furnace 40 with one level is described, However, it is likewise possible to have more than one level in the profiling furnace 40, whereby each level has an upper section and a lower section as well as a receptacle for a product-specific intermediate flange, so that several pru ls 5 can be imparted with a temperature profile in parallel or partially in parallel. By the same token, several profiling furnaces 40 can be provided in order to increase the capacity of the furnace system 1.

List of reference numerals

1	furnace system
5	sheet steel part, part
9	gas burner
10	production furnace
20	positioning system
22	handling system
30	hard area
40	profiling furnace
41	upper section
42	lower section
44	receptacle
45	product-specific intermediate flange
46	heater
47	connector
48	cooled area
49	cooling-water connection
50	extensible area
60	second robot
61	first robot
70	pressing die

KEMENCERENDSZER ÉS ELJÁRÁS ACÉLLEMEZRÉSZEK RÉSZLEGES FELHEVÍTÉSÉRE

Szabadalmi igénypontok

1. Kemencerendszer (1) acéllemezrészek (5) részleges felhevítésére egy, az Ac3 hömérséklet feletti hömérsékletre egy, az acéllemezrészeknek (5) egy, az Ac3 hömérséklethez közeli, de az alatti hömérsékletre való felhevítésére szolgáló termelö kemencével (10),

azzal jellemezve, hogy

a kemencerendszer (1) továbbá egy legalább egyszintes profilozó kemencét (40) tartalmaz, ahol a legalább egy szint egy felsö résszel (41) és egy alsó résszel (42), valamint egy termékspecifikus közbensö keret (45) számára egy befogadó résszel (44) és az abba helyezett termékspecifikus közbensö kerettel (45) rendelkezik, és ahol a termékspecifikus közbensö keret (45) arra alkalmasan van kiképezve, hogy az alkatrésznek (5) egy elöre meghatározott hömérsékletprofilt adjon át, Ac3-nál magasabb hömérsékletekkel az edzeni szándékozott tartományokban (30) és Ac3-nál alacsonyabb hőmérsékletekkel a lágyabb tartományokban (50), emellett egyes tartományok (48) aktív hűtésére szolgáló eszközökkel van ellátva.

2. Az 1. igénypont szerinti kemencerendszer (1),

azzal jellemezve, hogy

a kemencerendszer (1) továbbá egy pozicionáló rendszerrel (20) van ellátva, amelyre az alkatrész (5) a termelőkemencebeli (10) felhevítést követően és/vagy a profilozókemencebeli (40) felhevítést követően egy meghatározott helyzetbe lerakható.

3. Az 1. vagy a 2. igénypont szerinti kemencerendszer (1),

azzal jellemezve, hogy

a termékspecifikus közbenső keret (45) egyes tartományokban (48) vízhűtéssel van ellátva.

4. Az előző igénypontok bármelyike szerinti kemencerendszer (1),

azzal jellemezve, hogy

a termékspecifikus közbenső keret (45) egyes tartományok fűtésére szolgáló eszközökkel (46) van ellátva.

5. A 4. igénypont szerinti kemencerendszer (1),

azzal jellemezve, hogy

a termékspecifikus közbenső keret (45) egyes tartományok fűtéséhez villamos fűtőeszközökkel (46) van ellátva.

6. Az előző igénypontok bármelyike szerinti kemencerendszer (1),

azzal jellemezve, hogy

a termelő kemence (10) gázégőkkel (9) van fűtve.

7. Az előző igénypontok bármelyike szerinti kemencerendszer (1),

azzal jellemezve, hogy

a termelő kemence (10) továbbá az alkatrészeknek (5) a termelő kemencén (10) való átvezetéséhez egy szállítórendszerrel van ellátva.

8. Az előző igénypontok bármelyike szerinti kemencerendszer (1),

azzal jellemezve, hogy

a kemencerendszer (1) továbbá az alkatrészek (5) kezeléséhez egy kezelőrendszerrel (22, 60, 61) van ellátva.

9. Az előző igénypontok bármelyike szerinti kemencerendszer (1),

azzal jellemezve, hogy

a profilozó kemence (40) zárt szabályozókörben működő hőmérséklet-befolyásoló eszközökkel van ellátva.

10. Eljárás acéllemezrészek (5) Ac3 hőmérséklet feletti hőmérsékletre történő részleges felhevítésére, amely eljárás során

az alkatrészt (5) a termelő kemencében (10) az Ac3 hőmérséklete közelébe hevítjük fel;

a felhevített alkatrészt (5) egy pozicionáló rendszerrel (20) pozicionáljuk;

a pozicionált alkatrészt (5) egy meghatározott helyzetben juttatjuk a profilozó kemencében (40);

az alkatrészre (5) a profilozó kemencében (40) egy hőmérsékletprofilt viszünk rá kiválasztott tartományoknak (30) egy termékspecifikus közbenső keret (45) általi, Ac3 hőmérsékletnél magasabb hőmérsékletre történő felhevítésével, ahol más tartományokat (50) a termékspecifikus közbenső keret (45) általi aktív hűtéssel célzottan az Ac3 hőmérséklet alatti hőmérsékleten tartunk;

a hőmérsékletprofillal ellátott alkatrészt (5) kijuttatjuk a profilozó kemencéből (40).

11. A 10. igénypont szerinti eljárás,

azzal jellemezve, hogy

az alkatrész (5) felhevítését a termelő kemencében (10) gázégőkkel (9) végezzük.

12. A 10. vagy a 11. igénypont szerinti eljárás,

azzal jellemezve, hogy

a pozícionált alkatrésznek (5) egy meghatározott helyzetbe való juttatását a profilozó kemencében (40) egy kezelőrendszerrel (22) végezzük.

13. A 10-12. igénypontok bármelyike szerinti eljárás,

azzal jellemezve, hogy

egy hőmérséklet-profilnak az alkatrészen (5) való létrehozását a profilozó kemencében (40) egy zárt szabályozókörön keresztül vezéreljük.

SZTNH-100070870

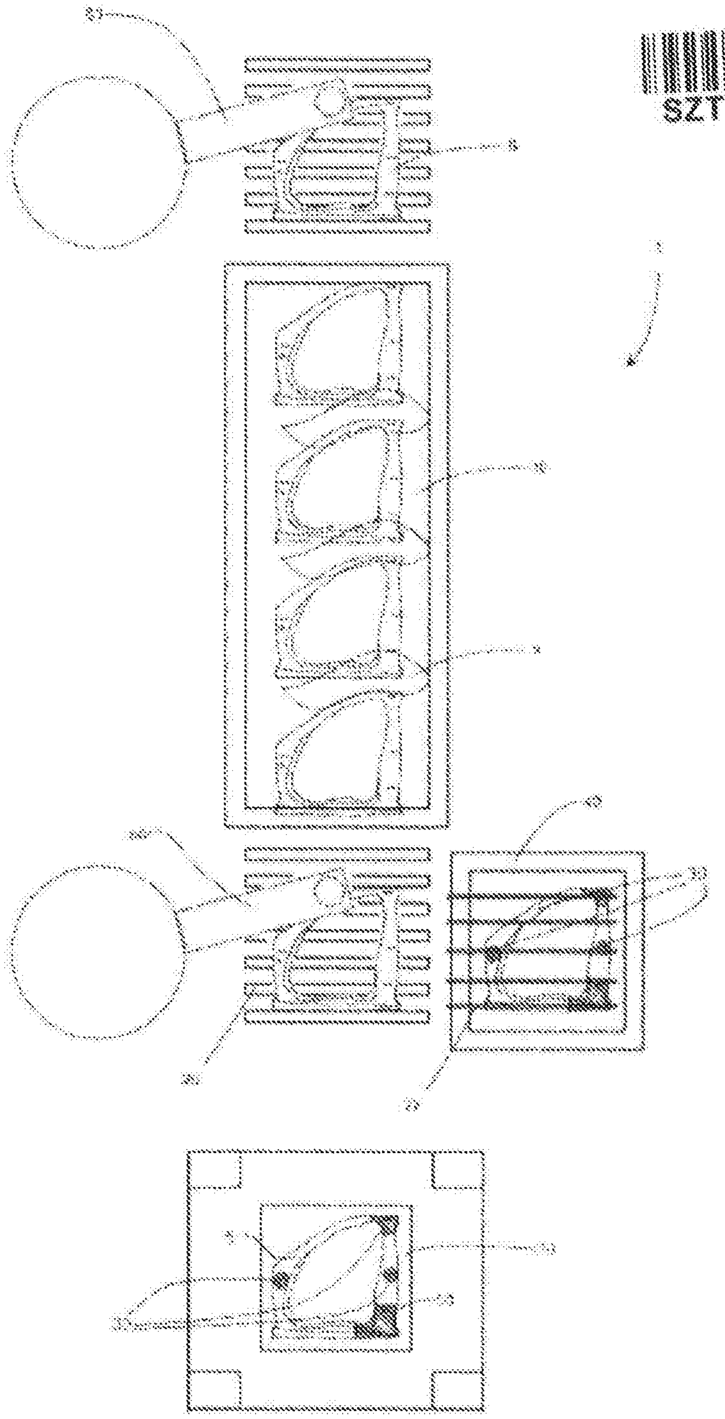

Fig. 1

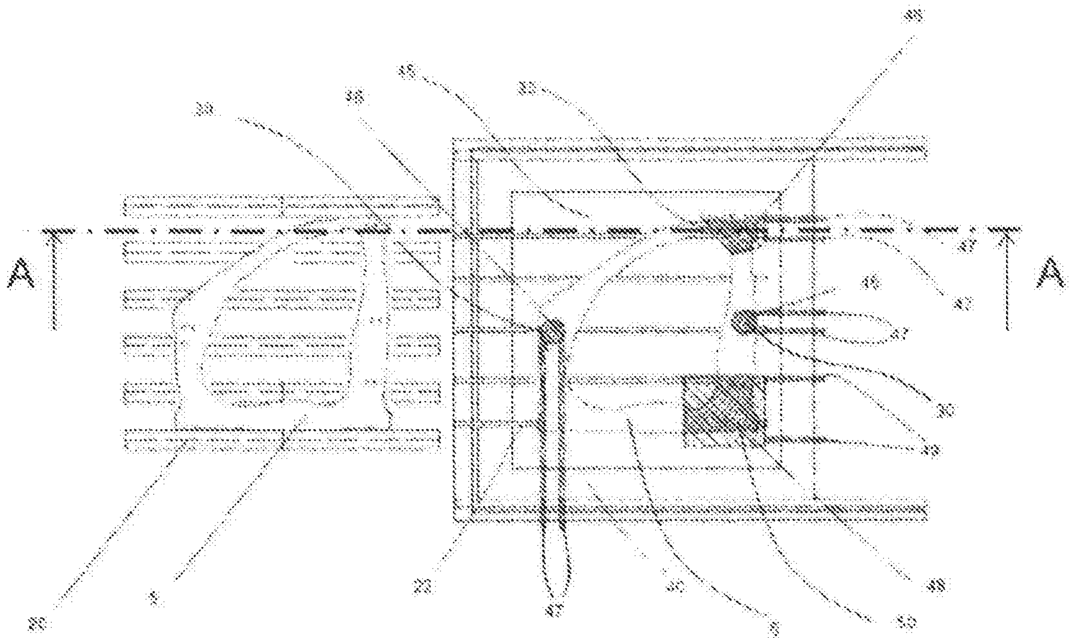

Fig. 2

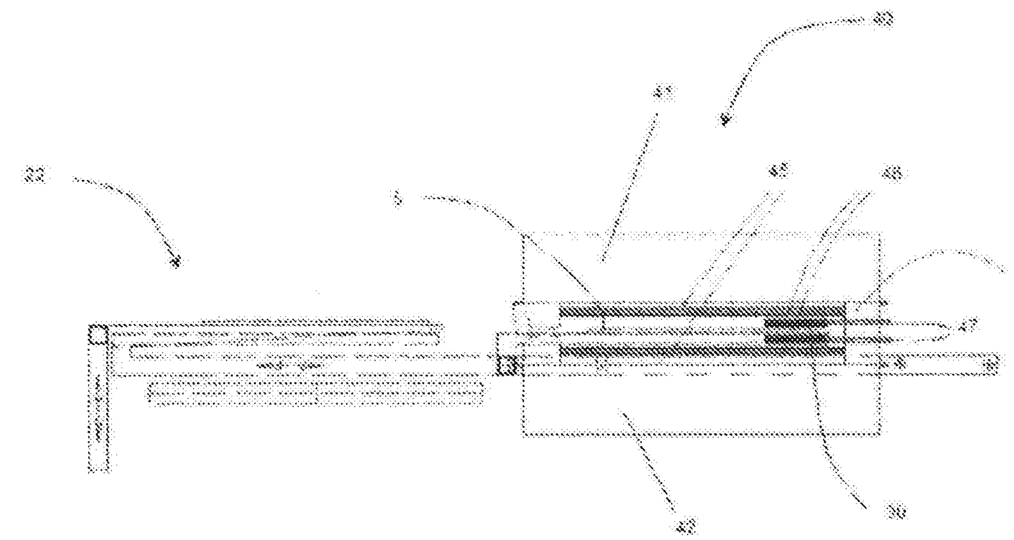

Fig. 3