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(54) **HIGH FLEXIBILITY TABLE-STYLE HEMMING MACHINE BASED ON PRINCIPLE OF SEGMENTED CONTROL AND HEMMING METHOD**

(57) Disclosed is a highly flexible table-type hemming machine based on segmented control principle, including a base, a tire mold mounting seat, a jacking mechanism, a tire mold, a plurality of pressing knife mechanisms, a pressing mold mechanism above the tire mold, and an overturning mechanism; the jacking mechanism drives the tire mold and door cover to move, the pressing knife mechanism drives horizontal movement of pressing knife to hem the door cover; the pressing knife mechanisms are spliced into contour shape of automobile door cover to hem the automobile door cover. Further disclosed is a highly flexible hemming method based on segmented control principle, including pre-hemming and final hemming. The hemming machine has advantages of high quality and high stability of hemming, meets the flexibility and high takt required by the market for different models, has advantages of compact and reasonable structure, low cost, small footprint, easy to find problems and simple maintenance and debugging, fully meeting the current market demand, has a broad market space.

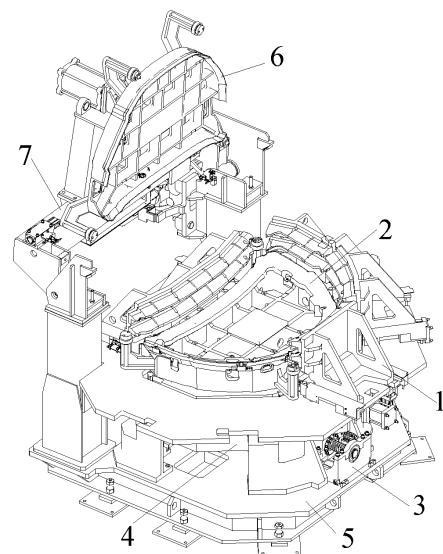


FIG. 1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of sheet metal processing equipment, in particular to a highly flexible table-type hemming machine and a hemming method based on a segmented control principle.

BACKGROUND

[0002] The four doors and two covers of a car are an important part of the car body assembly. Due to the characteristics of opening and closing, the edges of the four doors and two covers need to be beautiful and smooth. Therefore, the hemming process is irreplaceable for four doors and two covers compared to welding, riveting and other connection processes.

[0003] Recently, with the increasing diversification and personalization of modern automobile models, the quality requirements and complexity of the hemming process are also increasing. Besides, in addition to the quality and appearance requirements of the "mass production" models launched by major OEMs, the extremely high production takt also challenges the current hemming process.

[0004] At present, hemming methods for car door covers include press hemming and robot trimming. Robot trimming system is mainly composed of trimming fixture, trimming tool, robot and its control system. The principle is to use rollers to roll the flanging of the door cover for many times, so as to achieve the purpose of wrapping the inner plate by the outer plate. The advantages are high flexibility and flexible debugging. The disadvantages are that the trimming speed is slow, the takt is generally not more than 50JPH, and the long-term quality stability is not high, requiring more maintenance and correction.

[0005] The press hemming is mainly composed of a pressure body and a switchable hemming mold. The principle is to use the buckle of the upper mold and the lower mold to complete the pre-flanging and final wrapping, so as to achieve the purpose of wrapping the inner plate by the outer plate. The advantages are fast hemming speed and stable hemming quality. The disadvantages are large footprint, poor flexibility, and high cost. Especially in the multi-model collinear project, it is necessary to increase the mold switching track, which increases the model switching time and the investment cost is extremely high. Old-fashioned hydraulic presses also have defects such as loud noise and oil pollution, which cannot comply with the current trend of energy conservation and emission reduction.

[0006] US20080302161A1 discloses a hemming device and method. The lifting mechanism mainly adopts the cylinder, connecting rod and cam mechanism to realize the reciprocating lifting function, and cooperates with the pressing mechanism and the plate fixing mechanism

to realize the hemming. The lifting structure is relatively complex, the load that can be endured is relatively small, the control of the lifting stroke is difficult, and the stability is poor. In addition, the structure of the pressing mechanism is simple, and it is difficult to match different plates of multiple models, and the compatibility is relatively poor.

[0007] CN203265351U discloses a hemming machine for automobile doors. The output torque of the motor is converted into the forward thrust of the nut seat through the ball screw. The nut seat drives the connecting rod 2 and the connecting rod 3 to rotate around their respective other fulcrums. Connecting rod 2 and connecting rod 3 rotate around the fulcrum at the same time, respectively push the connecting rod 1 and connecting rod 5 to rotate around their fulcrum on the main frame. The force-increasing process is completed through the force-increasing hinge composed of connecting rod 2 and connecting rod 3. That is, the ball screw and the multi-link mechanism are used to realize the thrust of the hemming, which acts on the pressing mechanism. However, the above structure can bear a small load range, has poor stability, and the pressing mechanism is small, which is mainly suitable for the hemming of some narrow space, and the hemming consistency of the entire door cover is relatively poor.

SUMMARY

[0008] In order to overcome the defects of the related art, the purpose of the present disclosure is to provide a highly flexible table-type hemming machine based on a segmented control principle, so as to realize fast and stable hemming of automobile door covers.

[0009] For this purpose, the present disclosure provides a highly flexible table-type hemming machine based on a segmented control principle, including a base, a tire mold mounting seat, a jacking mechanism, a tire mold provided on the tire mold mounting seat, a plurality of pressing knife mechanisms located around the tire mold, a pressing mold mechanism located above the tire mold, and an overturning mechanism that drives the pressing mold mechanism to rotate; the jacking mechanism is configured to drive the tire mold and a door cover to move up and down, and the pressing knife mechanism is configured to drive a horizontal movement of a pressing knife to hem the door cover; and the plurality of the pressing knife mechanisms are spliced into contour shape of an automobile door cover to hem the automobile door cover. That is, multiple sets of pressing knives are provided in a ring shape according to the contour shape of the processed door cover, so as to realize the one-time full-circle hemming of the door cover. The design has the advantages of improving production takt and good process consistency.

[0010] Further, the pressing knife mechanism includes a bottom plate, a pressing knife base, a linear driving unit, a pre-hemming pressing knife provided on an upper layer of the pressing knife base and a final hemming

pressing knife provided on a lower layer of the pressing knife base.

[0011] Further, both the pre-hemming pressing knife and the final hemming pressing knife are formed by splicing several segments of pressing knife blades.

[0012] Further, the pressing knife mechanism further includes a self-locking mechanism for restricting the bottom plate to move.

[0013] Further, the jacking mechanism includes a drive base, a servo motor, a ball screw, a jacking block, and a left wedge block and a right wedge block symmetrical to the left wedge block.

[0014] Further, rollers are respectively provided on the left wedge block and the right wedge block, the jacking block has bottom inclined surfaces matched with the left wedge block and the right wedge block respectively, the bottom inclined surface includes a pre-hemming surface and a final hemming surface at both ends, and a rapid stroke surface in a middle, an inclination of the rapid stroke surface is greater than inclinations of the pre-hemming surface and the final hemming surface;

a guide rail plate is provided on a front side of the bottom inclined surface of the jacking block, the guide rail plate is a three-segment guide rail, the three-segment guide rail includes a pre-hemming guide rail, a rapid stroke guide rail and a final hemming guide rail, an inclination of the pre-hemming guide rail is equal to an inclination of the pre-hemming surface, and an inclination of the final hemming guide rail is equal to an inclination of the final hemming surface.

[0015] Further, the pressing mold mechanism includes an upper mold, an upper mold driving cylinder and a guide rod.

[0016] Further, the upper mold is divided into several zones, one clamping block is provided in each zone, the divided clamping blocks are annularly provided at a bottom of the upper mold along an edge of the door cover, and are respectively driven by a clamping cylinder, and a pressure sensor is provided between the clamping block and the clamping cylinder.

[0017] Further, the upper mold driving cylinder is equipped with a pressure relief valve and a proportional valve.

[0018] The present disclosure further provides a highly flexible hemming method based on a segmented control principle, including the following operations:

S1, driving a tire mold to a loading station a through a jacking mechanism, placing an automobile door cover into the tire mold, fixing an outer plate of the automobile door cover through the tire mold, and fixing an inner plate of the automobile door cover through a pressing mold mechanism;

S2, driving a tire mold mounting seat, the tire mold, the pressing mold mechanism and the automobile door cover to move to a pre-hemming waiting station c simultaneously through the jacking mechanism

such that edges around the automobile door cover are located on a lower side of a pre-hemming pressing knife; all pressing knife mechanisms are moved to a side of the tire mold under a driving of a linear driving unit, and all the pre-hemming pressing knives are seamlessly spliced into a contour shape of the automobile door cover;

S3, lifting the tire mold up to a pre-hemming station b through the jacking mechanism, bending an edge of the outer plate of the automobile door cover to complete pre-hemming through the pre-hemming pressing knife; driving the tire mold to descend to the pre-hemming waiting station c through the jacking mechanism, to make the pressing knife mechanism all return to the waiting station;

S4, driving the tire mold to descend to a final hemming waiting station e through the jacking mechanism, pushing the pressing knife mechanism forward to a working station again, and seamlessly splicing a final hemming pressing knife into a complete circle;

S5, driving the tire mold to up to a final hemming station d through the jacking mechanism, and flattening edges around the automobile door cover under extrusion of the final hemming pressing knife; driving the tire mold to return to the final hemming waiting station e through the jacking mechanism, to make the pressing knife mechanism return to the waiting station again; and

S6, lifting the tire mold back to the loading station a through the jacking mechanism, returning the pressing mold mechanism simultaneously, and finally retrieving the hemmed automobile cover to complete an entire hemming process.

[0019] Compared with the related art, the beneficial effects of the present disclosure are as follows.

1. The present disclosure provides a highly flexible table-type hemming machine based on a segmented control principle. The high quality and high stability of the hemming can be achieved by setting up a pressing knife mechanism with a pre-hemming pressing knife, a final hemming pressing knife, and a tire mold that can move up and down. By setting the replaceable tire mold, the pressing mold mechanism and the pressing knife mechanism, it can be individually designed according to different door covers, and the other mechanisms can be used as standard parts or semi-standard parts. The mechanism has a high reuse rate, and the pressing knife mechanism can be adjusted according to the size of the door cover and the shape of the edge contour, which has the advantage of high flexibility. In addition, the automobile door cover can complete the

whole circle of hemming at one time, thus the hemming takt is greatly accelerated, and the quality, stability and consistency of the hemming are greatly improved.

2. The highly flexible table-type hemming machine based on a segmented control principle of the present disclosure not only has the advantages of high quality and high stability of hemming, but also meets the flexibility and high takt required by the market for different models, and has the advantages of compact and reasonable structure, low cost, small footprint, easy to find problems and simple maintenance and debugging, fully meeting the current market demand, and has a broad market space.

[0020] In addition to the objects, features and advantages described above, the present disclosure has other objects, features and advantages. The present disclosure will be described in further detail below with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The accompanying drawings forming a part of the present disclosure are used to provide further understanding of the present disclosure, and the exemplary embodiments of the present disclosure and their descriptions are used to explain the present disclosure and do not constitute an improper limitation of the present disclosure.

FIG. 1 is a structural schematic view of a highly flexible table-type hemming machine based on a segmented control principle according to the present disclosure.

FIG. 2 is a schematic diagram of a position of a tire mold during the hemming process in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 3 is a structural schematic view of a pressing knife mechanism in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 4 is a cross-sectional structural schematic view of a tire mold mounting seat in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 5 is a structural schematic diagram of a jacking mechanism in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 6 is a structural schematic view of a pressing

mold mechanism in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 7 is a structural schematic view of an overturning mechanism in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 8 is a schematic structural view of the cooperation between the pressing knife mechanism and the tire mold in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 9 is a schematic diagram 1 of the pre-hemming of the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 10 is a schematic diagram 2 of the pre-hemming of the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 11 is a schematic diagram 1 of the final hemming of the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 12 is a schematic diagram 2 of the final hemming of the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 13 is a partial cross-sectional view of the pressing mold mechanism in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 14 is a structural schematic view of a clamping cylinder in the highly flexible

table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 15 is a schematic diagram of dividing the upper pressing mold into several clamping blocks in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 16 is a structural schematic view of a self-locking mechanism in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 17 is a structural schematic view of a guide rail

plate in a highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

FIG. 18 is a cross-sectional view of a cooperation between a left wedge block and a ball screw in the highly flexible table-type hemming machine based on the segmented control principle of the present disclosure.

Description of reference signs

[0022] 1 pressing knife mechanism; 2 tire mold; 3 jacking mechanism; 4 tire mold mounting seat; 5 base; 6 pressing mold mechanism; 7 overturning mechanism; 8 pre-hemming pressing knife; 9 final hemming pressing knife; 10 adjustable spacer; 11 pressing knife base; 12 bottom plate; 13 front side pressing plate; 14 two side pressing plates; 15 self-locking mechanism; 16 linear driving unit; 17 limiting screw; 18 position sensor; 21 guide rail; 22 base; 23 jacking block; 24 ball screw; 25 left wedge block; 26 right wedge block; 27 guide rail plate; 28 pressure sensor; 29 servo motor; 30 roller; 31 lifting guide plate; 32 oil pump; 33 drag chain; 34 upper mold driving cylinder; 35 guide rod; 36 upper mold; 37 servo motor; 38 link mechanism; 39 clamping cylinder; 40 pressure sensor; 41 pressing knife blade; 151 shaft sleeve; 152 self-locking shaft; 231 pre-hemming surface; 232 rapid stroke surface; 233 final hemming surface; 271 pre-hemming guide rail; 272 rapid stroke guide rail; 273 final hemming guide rail; 361 clamping block

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0023] It should be noted that the embodiments in the present disclosure and the features of the embodiments may be combined with each other in the case of no conflict. The present disclosure will be described in detail below with reference to the accompanying drawings and in conjunction with the embodiments.

[0024] FIG. 1 to FIG. 18 shows some embodiments of the present disclosure.

[0025] As shown in FIG. 1, a highly flexible table-type hemming machine based on a segmented control principle includes a base 5, a tire mold mounting seat 4, a jacking mechanism 3, a tire mold 2 provided on the tire mold mounting seat 4, a plurality of pressing knife mechanisms 1 located around the tire mold 2, a pressing mold mechanism 6 located above the tire mold 2, and an overturning mechanism 7 that drives the pressing mold mechanism 6 to rotate. The jacking mechanism 3 is configured to drive the tire mold mounting seat 4 and the tire mold 2 to slide along the vertical direction in the base 5.

[0026] Both the outer plate and the inner plate of the automobile door cover are placed on the tire mold 2. The outer plate is fixed by the outer plate positioning mechanism on the tire mold 2. The pressing mold mechanism 6 is driven to turn over to the working position by the

overturning mechanism 7. The pressing mold mechanism 6 is pressed to the inner plate by the cylinder, so far the inner plate and the outer plate are both positioned and clamped. Through the horizontal movement of the pressing knife mechanism 1, the pressing knife mechanism 1 cooperates with the tire mold 2 to complete the pre-pressing and final pressing of the outer plate, to realize the hemming of the door cover.

[0027] As shown in FIG. 3, the pressing knife mechanism 1 has a pressing knife on the upper layer and a pressing knife on the lower layer, which are respectively the pre-hemming pressing knife 8 of the upper layer and the final hemming pressing knife 9 of the lower layer. Both the pre-hemming pressing knife 8 and the final hemming pressing knife 9 are mounted on the triangular pressing knife base 11, and the pressing knife base 11 is integrally cast.

[0028] As shown in FIG. 3 and FIG. 8, both the pre-hemming pressing knife 8 and the final hemming pressing knife 9 are formed by splicing several segments of pressing knife blades 41. An adjustable spacer 10 is installed above each segment of the pressing knife blade 41. The adjustable spacer 10 is used to adjust the position of the pressing knife blade 41 in the height direction. The shape of the cutter head of each segment of the pressing knife blade 41 is not exactly the same. After splicing several segments of the pressing knife blades 41, they can be matched with the outer contour of the door cover at the corresponding position. All the pre-hemming pressing knives 8 and the final hemming pressing knives 9 can form a circle after splicing, and their shape matches the outer contour of the entire door cover. Through the movement of the pre-hemming pressing knife 8 or the final hemming pressing knife 9, the automobile door cover can be hemmed in a whole circle at one time. The takt of hemming is greatly accelerated, and the quality, stability and consistency of hemming are greatly improved.

[0029] As shown in FIG. 8, in the present disclosure, a single pressing knife mechanism is equipped with a plurality of segmented pressing knife blades 41. Although there may be an angular deviation of each pressing knife blade in the front and rear directions due to the shape of the door cover, the installation height of the pressing knife blade mounting surface in the vertical direction is the same. But there are other situations. When the height deviation of a certain position of the door cover is larger than that of other positions, that is, a certain position of the door cover is upturned. The relative position of the pressing knife blade 41 corresponding to the upturned position needs to be adjusted. As a result, the installation surfaces of the vertical direction of a single pressing knife mechanism on the same layer are not at the same height, and there is a situation of mutual staggering or angular deviation, so as to adapt to the shape of the door cover.

[0030] A linear driving unit 16 is provided on the lower side of the bottom plate 12, the piston rod of the linear driving unit 16 is fixedly connected with the bottom plate 12, the cylinder of the linear driving unit 16 is fixedly con-

nected with the frame, and the linear driving unit 16 drives the bottom plate 12 and the upper mechanism to reciprocate back and forth along the two side pressing plates 14. The front of the bottom plate 12 is provided with a front side pressing plate 13, and the front side pressing plate 13 is pressed on the bottom plate 12, which further reduces the overall force deformation of the pressing knife base 11 during hemming. The lower surface of the protruding portion of the bottom plate 12 is in contact with the jacking mechanism during hemming, and acts as a limiting surface.

[0031] Specifically, a self-locking mechanism 15 is also fixedly installed on the frame. The self-locking mechanism 15 is located on the lower side of the bottom plate 12, the self-locking mechanism 15 has a self-locking shaft, and the self-locking shaft can be inserted and matched with the bottom plate 12 to limit the movement of the bottom plate 12. When the pre-hemming pressing knife 8 or the final hemming pressing knife 9 moves to the hemming station, the self-locking mechanism 15 will start immediately, the pressing knife mechanism 1 will be locked and fixed to prevent the pressing knife from moving back and forth and cause the quality problem of the hemming.

[0032] As shown in FIG. 16, the self-locking mechanism 15 includes a cylinder, a self-locking shaft 152, and a shaft sleeve 151. The cylinder and the shaft sleeve 151 are fixed on the frame of the hemming equipment, and the self-locking shaft 152 is driven by the cylinder to reciprocate up and down in the shaft sleeve 151. The rear end of the bottom plate 12 has an inclined surface, and the upper end of the self-locking shaft 152 also has an inclined surface. The self-locking shaft 152 and the bottom plate 12 cooperate with each other through the inclined surface, and the angle of the inclined surface satisfies the principle of mechanical self-locking angle. If the working position of the pressing knife mechanism 1 changes, the self-locking function can also be realized by adjusting the displacement of the cylinder. That is to say, the same self-locking mechanism 15 can satisfy the self-locking of the knife pressing mechanism 1 at multiple different working positions.

[0033] In this embodiment, not all pressing knife mechanisms 1 need to be equipped with self-locking mechanisms 15. Under some specific conditions, such as when the angle of the pre-pressing knife surface is horizontal or obliquely downward, the pressing knife mechanism will not be subjected to the backward component force along the driving direction. In this case, the self-locking mechanism 15 is definitely not required. The size of the component force is determined by the angle of the working surface of the pre-pressing knife and the length of the working surface. If the component force is smaller than the cylinder thrust, the self-locking device is not required in this case. Since the working surface of the pressing knife is quite complex, the component force is difficult to calculate clearly, so in many cases it is impossible to determine the relationship between the compo-

nent force and the cylinder thrust. At this time, it is necessary to reserve the installation position of the self-locking mechanism 15 on the pressing knife mechanism 1 in case of emergency.

[0034] As shown in FIG. 3, the pressing knife base 11 is fixedly installed on the bottom plate 12. The upper, lower and left and right sides of the bottom plate 12 are provided with self-lubricating plates with graphite. Both sides of the rear of the bottom plate 12 are provided with two pressing plates 14. The two pressing plates 14 are fixedly connected with the frame of the whole hemming equipment, and the two pressing plates 14 are used to limit the movement direction of the pressing knife base 11.

[0035] A limiting screw 17 is installed between the pressing knife base 11 and the front side pressing plate 13, and an adjusting washer is also provided, so that the front and rear positions of the pressing knife base 11 can be finely adjusted. A position sensor 18 is provided at the bottom of the pressing knife base 11, and the position sensor 18 can sense the position of the pressing knife mechanism 1.

[0036] As shown in FIG. 4, the base 5 is provided with a through hole that facilitates the tire mold mounting seat 4 to move in the vertical direction. The four diagonal corners of the through hole are provided with vertical grooves. The guide rails 21 made of brass and solid lubricant graphite are installed in the four grooves of the base 5. The corresponding positions of the four diagonal corners of the tire mold mounting seat 4 are also provided with grooves, the width of which is the same as that of the guide rail 21. When the jacking mechanism 3 drives the tire mold mounting seat 4 to move up and down, the four grooves of the tire mold mounting seat 4 slide up and down along the guide rail 21, and the solid lubricant graphite in it ensures uninterrupted lubrication without the need for regular lubrication maintenance.

[0037] As shown in FIG. 5, FIG. 17 and FIG. 18, the jacking mechanism 3 includes a drive base 22, a servo motor 29, a ball screw 24, a left wedge block 25, a right wedge block 26, and a jacking block 23. The drive base 22 is a casting with a certain rigidity, and has bearing holes at both ends for installing the ball screw 24. The ball screw is driven by the servo motor 29. The servo motor 29 is connected to the drive base 22 through a flange. The ball screw 24 is connected to the servo motor 29 through the hollow shaft of the servo motor 29, and the servo motor 29 is equipped with a servo driver, which can precisely control its parameters such as rotation speed and output torque.

[0038] The ball screw 24 has left-hand and right-hand threads, and is also equipped with left-hand and right-hand nuts. The left-hand nut is installed in the left wedge block 25, and the right-hand nut is installed in the right wedge block 26. The left wedge block 25 and the right wedge block 26 are both wedge sliding blocks with an inclined surface on the upper part, both of which are inclined downward along the inner side, and the inclined

directions of the two are symmetrically arranged. The jacking block 23 is provided on the upper side of the left wedge block 25 and the right wedge block 26. The lower part of the jacking block 23 has two symmetrically arranged bottom inclined surfaces, and the slope angle of the bottom inclined surface is the same as that of the left wedge block 25 and the right wedge block 26. When the jacking block 23 falls on the left wedge block 25 and the right wedge block 26, the bottom of the jacking block 23 can completely fit with the inclined surfaces of the left wedge block 25 and the right wedge block 26.

[0039] When the ball screw 24 rotates under the drive of the servo motor 29, the left and right nuts drive the left wedge block 25 and the right wedge block 26 to move in the opposite direction. Thus, the jacking block 23 is driven to move vertically up and down, and then the tire mold 2 on the upper side of the jacking mechanism is pushed up and down to complete the hemming process.

[0040] A pressure sensor 28 is provided between the jacking block 23 and the tire mold mounting seat 4, which can timely feedback the force provided by the jacking mechanism 3 to the tire mold 2. Therefore, an appropriate force can be selected to meet the requirements of hemming and improve the quality of hemming.

[0041] As shown in FIG. 6, the pressing mold mechanism 6 includes an upper mold 36, an upper mold driving cylinder 34 and a guide rod 35. The upper mold 36 is driven by the upper mold driving cylinder 34 to move vertically up and down along the guide rod 35. The upper mold 36 cooperates with the tire mold 2 to compress the door cover.

[0042] The upper mold driving cylinder 34 is equipped with a pressure relief valve. During the entire hemming process, the upper mold 36 will move with the movement of the tire mold 2, and the pressure between the two will always remain unchanged. The mold pressing mechanism 6 is equipped with a proportional valve, and the output pressure of the upper mold driving cylinder 34 can be controlled by adjusting the proportional valve.

[0043] As shown in FIG. 14 and FIG. 15, the upper mold 36 is divided into several zones, one clamping block 361 is provided in each zone, the divided clamping blocks 361 are annularly provided at a bottom of the upper mold 36 along an edge of the door cover, and are respectively driven by a clamping cylinder 39, and a pressure sensor 40 is provided between the clamping block 361 and the clamping cylinder 39, such that the clamping blocks 361 in each zone have their own suitable clamping pressure.

[0044] The pressure sensor 40 is installed between the clamping block 361 and the clamping cylinder 39, and is used to measure the actual pressure on the body panel in each zone. It is possible to adjust the output pressure of the clamping cylinder 39 according to the difficulty of hemming the body panels in different regions and positions, so as to avoid problems such as overpressure or insufficient compression of the body panels.

[0045] As shown in FIG. 7, the overturning mechanism 7 is composed of a servo motor 37 and a link mechanism

38. The servo motor 37 drives the link mechanism 38 to drive the pressing mold mechanism 6 to turn over. When the pressing mold mechanism 6 moves to a horizontal state, the link mechanism is exactly three points and one line, forming a dead point mechanism.

[0046] In an embodiment, as shown in FIG. 5, lifting guide plates 31 are provided on both sides of the lifting block 23, and the lifting guide plate 31 is provided with a V-shaped groove, and the lifting block 23 is correspondingly provided with a V-shaped convex block. Under the cooperation of the V-shaped convex block and the V-shaped groove, the lifting block 23 can play a guiding role when the lifting block 23 moves up and down, such that when the left wedge block 25 and the right wedge block 26 move out of synchronization, the lifting block 23 is prevented from deviating to one side.

[0047] In an embodiment, as shown in FIG. 5, FIG. 17 and FIG. 18, the jacking mechanism also has a rapid stroke design. The bottom inclined surface of the jacking block 23 is designed as three-segment type. The bottom inclined surface includes a pre-hemming surface 231, a rapid stroke surface 232, and a final hemming surface 233. The pre-hemming surface 231 and the final hemming surface 233 are the inclined surfaces of the two key forces (pre-hemming and final hemming). The inclination of the rapid stroke surface 232 is greater than the inclination of the pre-hemming surface 231 and the final hemming surface 233.

[0048] A guide rail plate 27 is provided on a front side of the jacking block 23, the guide rail plate 27 is a three-segment guide rail, the three-segment guide rail includes a pre-hemming guide rail 271, a rapid stroke guide rail 272 and a final hemming guide rail 273, the inclination of the rapid stroke guide rail 272 in the middle of the guide rail plate 27 is greater than the inclination of the pre-hemming guide rail 271 and the inclination of the final hemming guide rail 273 at both ends of the guide rail plate 27, an inclination of the pre-hemming guide rail 271 is equal to the inclination of the pre-hemming surface 231, and an inclination of the final hemming guide rail 273 is equal to the inclination of the final hemming surface 233.

[0049] As shown in FIG. 2, the roller 30 is installed on the left wedge block 25 and the right wedge block 26. When the rollers 30 follow the left and right wedge blocks to move to the rapid stroke guide rail 272, the jacking block 23 can be quickly jacked up to complete the fast movement of the idle travel. When the roller 30 is separated from the rapid stroke guide rail 272, the bottom surface of the jacking block 23 contacts with the wedge block and receives force, and returns to a state that can bear a large load.

[0050] When the load of the idle travel system is small, the roller 30 contacts with the rapid stroke guide rail to realize the rapid lifting and lowering of the jacking block. During pre-hemming and final hemming, the bottom of the jacking block and the wedge block are contacted and subjected to force to withstand a large load pressure and

realize the lifting and lowering motion of the jacking block. Through the design of the rapid stroke structure, the hemming takt can be improved.

[0051] In an embodiment, as shown in FIG. 5, the driving base 22 is provided with an oil pump 32 and a drag chain 33, the oil pump 32 is located at one end of the ball screw 24, and the oil pipe is connected to the left and right nuts through the drag chain 33. The oil pump 32 can periodically supply oil to the ball screw 24 and the nut through the oil pipe, so as to improve the lubrication condition and prolong the service life.

[0052] The present disclosure further provides a highly flexible hemming method based on a segmented control principle, including the following operations:

S1, driving a tire mold 2 to a loading station a through a jacking mechanism 3, placing an automobile door cover into the tire mold 2, fixing an outer plate of the automobile door cover through the tire mold 2, and fixing an inner plate of the automobile door cover through a pressing mold mechanism 6;

S2, driving a tire mold mounting seat 4, the tire mold 2, the pressing mold mechanism 6 and the automobile door cover to move to a pre-hemming waiting station c simultaneously through the jacking mechanism 3 such that edges around the automobile door cover are located on a lower side of a pre-hemming pressing knife 8; all pressing knife mechanisms 1 are moved to a side of the tire mold 2 under a driving of a linear driving unit 16, and all the pre-hemming pressing knives 8 are seamlessly spliced into a contour shape of the automobile door cover;

S3, lifting the tire mold 2 up to a pre-hemming station b through the jacking mechanism 3, bending an edge of the outer plate of the automobile door cover to complete pre-hemming through the pre-hemming pressing knife 8; driving the tire mold 2 to descend to the pre-hemming waiting station c through the jacking mechanism 3, to make the pressing knife mechanism 1 all return to the waiting station;

S4, driving the tire mold 2 to descend to a final hemming waiting station e through the jacking mechanism 3, pushing the pressing knife mechanism 1 forward to a working station again, and seamlessly splicing a final hemming pressing knife 9 into a complete circle;

S5, driving the tire mold 2 to up to a final hemming station d through the jacking mechanism 3, and flattening edges around the automobile door cover under extrusion of the final hemming pressing knife 9; driving the tire mold 2 to return to the final hemming waiting station e through the jacking mechanism 3, to make the pressing knife mechanism 1 return to the waiting station again; and

S6, lifting the tire mold 2 back to the loading station a through the jacking mechanism 3, returning the pressing mold mechanism 6 simultaneously, and finally retrieving the hemmed automobile cover to complete an entire hemming process.

[0053] The working process of the highly flexible table-type hemming machine based on a segmented control principle of the present disclosure is as follows.

[0054] Firstly, the robot grabs the door cover to be hemmed and puts it into the tire mold 2, the tire mold 2 contains an outer plate positioning mechanism. The outer plate positioning mechanism positions and tightens the outer plate, and the overturning mechanism 7 driven by the servo motor 37 and the link mechanism 38 is turned over to the working station. The upper pressing mold mechanism 6 is pressed to the inner plate by the upper mold driving cylinder 34, so far the inner and outer plates are both positioned and clamped. After the automobile door cover is positioned and fixed in the tire mold 2, the lifting mechanism 3 composed of the ball screw 24 and the wedge slider drives the tire mold mounting seat 4 and the tire mold 2 to move.

[0055] As shown in FIG. 2, the tire mold mounting seat 4 and the tire mold 2 are lowered from the loading station a to the pre-hemming waiting station c. When the tire mold 2 reaches the pre-hemming waiting station c (as shown in FIG. 9), the pressing knife mechanism 1 is pushed forward to the hemming working station, and all the pre-hemming pressing knives 8 are seamlessly spliced together to form a full circle (as shown in FIG. 8). After all the pre-hemming pressing knives 8 reach the working station, the lifting mechanism 3 lifts the tire mold 2 to the pre-hemming station b, the pre-hemming pressing knife 8 bends the edge of the automobile door cover (as shown in FIG. 10) to complete the pre-hemming process.

[0056] After completing the pre-hemming, the jacking mechanism 3 drives the tire mold 2 to return to the pre-hemming waiting station c, and then the pressing knife mechanism 1 all returns to the waiting station. The jacking mechanism 3 drives the tire mold 2 to descend to the final hemming waiting station e (as shown in FIG. 11), and the pressing knife mechanism 1 pushes forward again to the working station. The final hemming pressing knife 9 is seamlessly spliced into a full circle. The jacking mechanism 3 drives the tire mold 2 to lift to the final hemming station d, and the edge of the door cover is flattened under the pressing of the final hemming press knife 9 (as shown in FIG. 12).

[0057] After completing the final hemming, the jacking mechanism 3 drives the tire mold 2 to return to the final hemming waiting station e, the pressing knife mechanism 1 returns to the waiting station again, and the jacking mechanism 3 lifts the tire mold 2 back to the loading station a. At the same time, the pressing mechanism 6 is retracted, and the overturning mechanism 7 is driven by the motor to move to the waiting station, the robot enters

the equipment again, grabs the door cover after the hemming, and leaves the station. At this point, a complete hemming cycle is completed.

[0058] The above descriptions are only preferred embodiments of the present disclosure, and are not intended to limit the present disclosure. For those skilled in the art, the present disclosure may have various modifications and changes. Any modification, equivalent replacement, improvement, etc. made within the spirit and principle of the present disclosure shall be included within the protection scope of the present disclosure.

Claims

1. A highly flexible table-type hemming machine based on a segmented control principle, **characterized by** comprising: a base (5), a tire mold mounting seat (4), a jacking mechanism (3), a tire mold (2) provided on the tire mold mounting seat (4), a plurality of pressing knife mechanisms (1) located around the tire mold (2), a pressing mold mechanism (6) located above the tire mold (2), and an overturning mechanism (7) that drives the pressing mold mechanism (6) to rotate;
wherein the jacking mechanism (3) is configured to drive the tire mold (2) and a door cover to move up and down, and the pressing knife mechanism (1) is configured to drive a horizontal movement of a pressing knife to hem the door cover; and the plurality of the pressing knife mechanisms (1) are spliced into a contour shape of an automobile door cover to hem the automobile door cover.
2. The highly flexible table-type hemming machine based on the segmented control principle according to claim 1, wherein the pressing knife mechanism (1) comprises a bottom plate (12), a pressing knife base (11), a linear driving unit (16), a pre-hemming pressing knife (8) provided on an upper layer of the pressing knife base (11) and a final hemming pressing knife (9) provided on a lower layer of the pressing knife base (11).
3. The highly flexible table-type hemming machine based on the segmented control principle according to claim 2, wherein both the pre-hemming pressing knife (8) and the final hemming pressing knife (9) are formed by splicing several segments of pressing knife blades (41).
4. The highly flexible table-type hemming machine based on the segmented control principle according to claim 2, wherein the pressing knife mechanism (1) further comprises a self-locking mechanism (15) for restricting the bottom plate (12) to move.
5. The highly flexible table-type hemming machine

based on the segmented control principle according to claim 1, wherein the jacking mechanism (3) comprises a drive base (22), a servo motor (29), a ball screw (24), a jacking block (23), and a left wedge block (25) and a right wedge block (26) symmetrical to the left wedge block (25).

6. The highly flexible table-type hemming machine based on the segmented control principle according to claim 5, wherein rollers (30) are respectively provided on the left wedge block (25) and the right wedge block (26), the jacking block (23) has bottom inclined surfaces matched with the left wedge block (25) and the right wedge block (26) respectively, the bottom inclined surface comprises a pre-hemming surface (231) and a final hemming surface (233) at both ends, and a rapid stroke surface (232) in a middle, an inclination of the rapid stroke surface (232) is greater than inclinations of the pre-hemming surface (231) and the final hemming surface (233); a guide rail plate (27) is provided on a front side of the bottom inclined surface of the jacking block (23), the guide rail plate (27) is a three-segment guide rail, the three-segment guide rail comprises a pre-hemming guide rail (271), a rapid stroke guide rail (272) and a final hemming guide rail (273), an inclination of the pre-hemming guide rail (271) is equal to an inclination of the pre-hemming surface (231), and an inclination of the final hemming guide rail (273) is equal to an inclination of the final hemming surface (233).
7. The highly flexible table-type hemming machine based on the segmented control principle according to claim 1, wherein the pressing mold mechanism (6) comprises an upper mold (36), an upper mold driving cylinder (34) and a guide rod (35).
8. The highly flexible table-type hemming machine based on the segmented control principle according to claim 7, wherein the upper mold (36) is divided into several zones, one clamping block (361) is provided in each zone, the divided clamping blocks (361) are annularly provided at a bottom of the upper mold (36) along an edge of the door cover, and are respectively driven by a clamping cylinder (39), and a pressure sensor (40) is provided between the clamping block (361) and the clamping cylinder (39).
9. The highly flexible table-type hemming machine based on the segmented control principle according to claim 7, wherein the upper mold driving cylinder (34) is equipped with a pressure relief valve and a proportional valve.
10. A highly flexible hemming method based on a segmented control principle, **characterized by** comprising the following operations:

S1, driving a tire mold (2) to a loading station a through a jacking mechanism (3), placing an automobile door cover into the tire mold (2), fixing an outer plate of the automobile door cover through the tire mold (2), and fixing an inner plate of the automobile door cover through a pressing mold mechanism (6); 5

S2, driving a tire mold mounting seat (4), the tire mold (2), the pressing mold mechanism (6) and the automobile door cover to move to a pre-hemming waiting station c simultaneously through the jacking mechanism (3) such that edges around the automobile door cover are located on a lower side of a pre-hemming pressing knife (8); all pressing knife mechanisms (1) are moved to a side of the tire mold (2) under a driving of a linear driving unit (16), and all the pre-hemming pressing knives (8) are seamlessly spliced into a contour shape of the automobile door cover; 10

S3, lifting the tire mold (2) up to a pre-hemming station b through the jacking mechanism (3), bending an edge of the outer plate of the automobile door cover to complete pre-hemming through the pre-hemming pressing knife (8); 15

driving the tire mold (2) to descend to the pre-hemming waiting station c through the jacking mechanism (3), to make the pressing knife mechanism (1) all return to the waiting station; 20

S4, driving the tire mold (2) to descend to a final hemming waiting station e through the jacking mechanism (3), pushing the pressing knife mechanism (1) forward to a working station again, and seamlessly splicing a final hemming pressing knife (9) into a complete circle; 25

S5, driving the tire mold (2) to up to a final hemming station d through the jacking mechanism (3), and flattening edges around the automobile door cover under extrusion of the final hemming pressing knife (9); driving the tire mold (2) to return to the final hemming waiting station e through the jacking mechanism (3), to make the pressing knife mechanism (1) return to the waiting station again; and 30

S6, lifting the tire mold (2) back to the loading station a through the jacking mechanism (3), returning the pressing mold mechanism (6) simultaneously, and finally retrieving the hemmed automobile cover to complete an entire hemming process. 35

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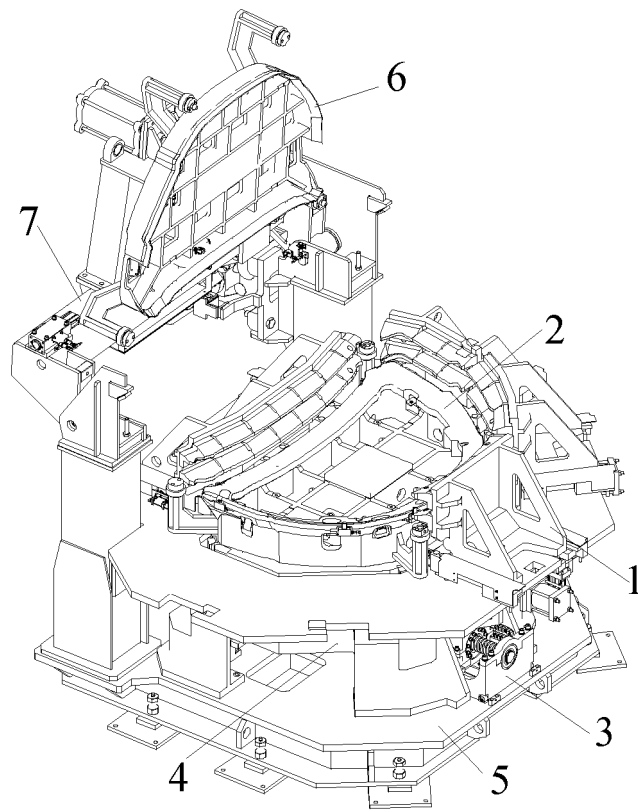


FIG. 1

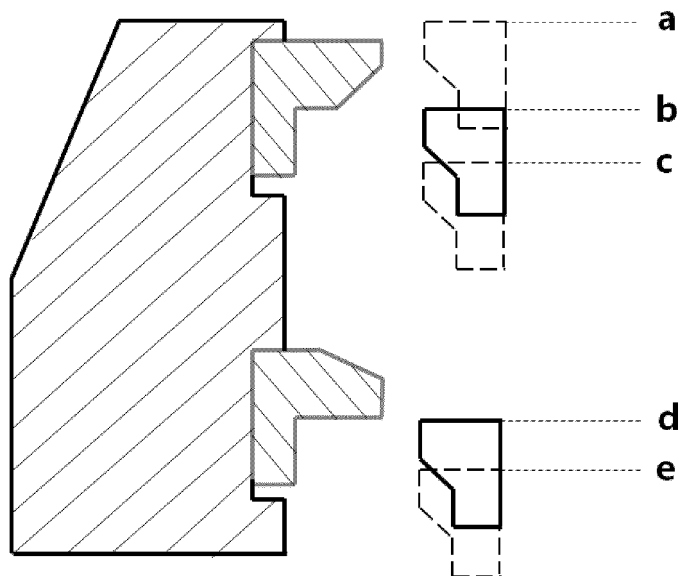


FIG. 2

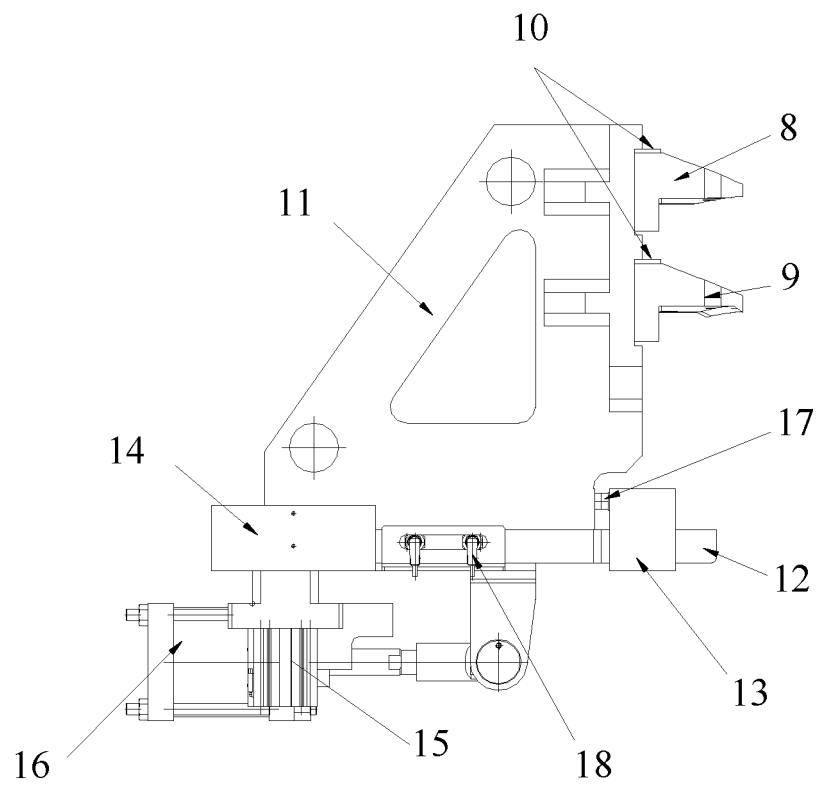


FIG. 3

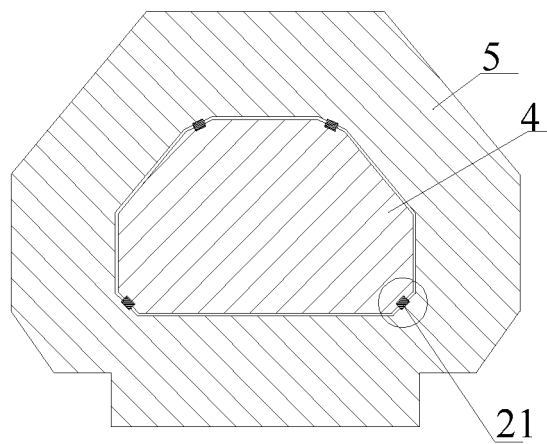


FIG. 4

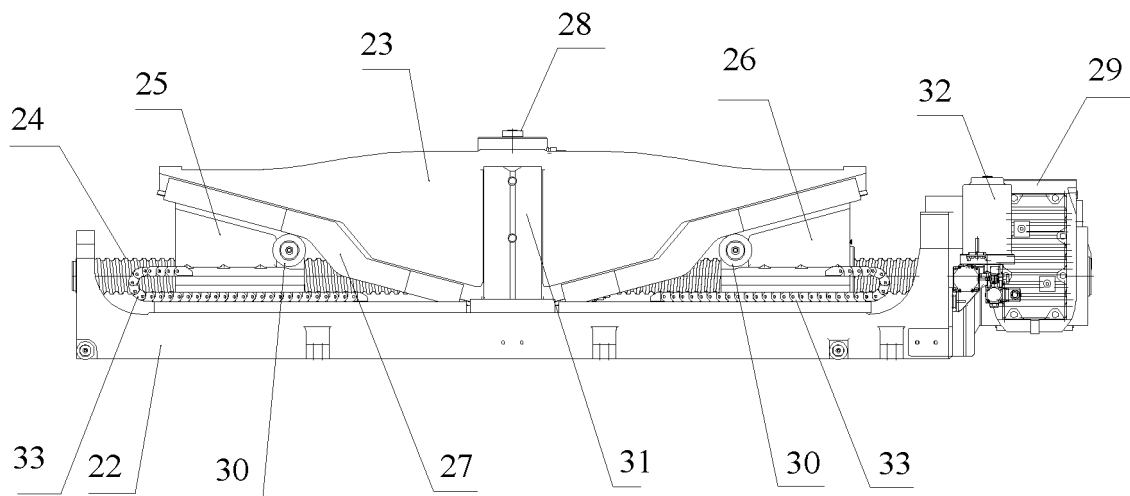


FIG. 5

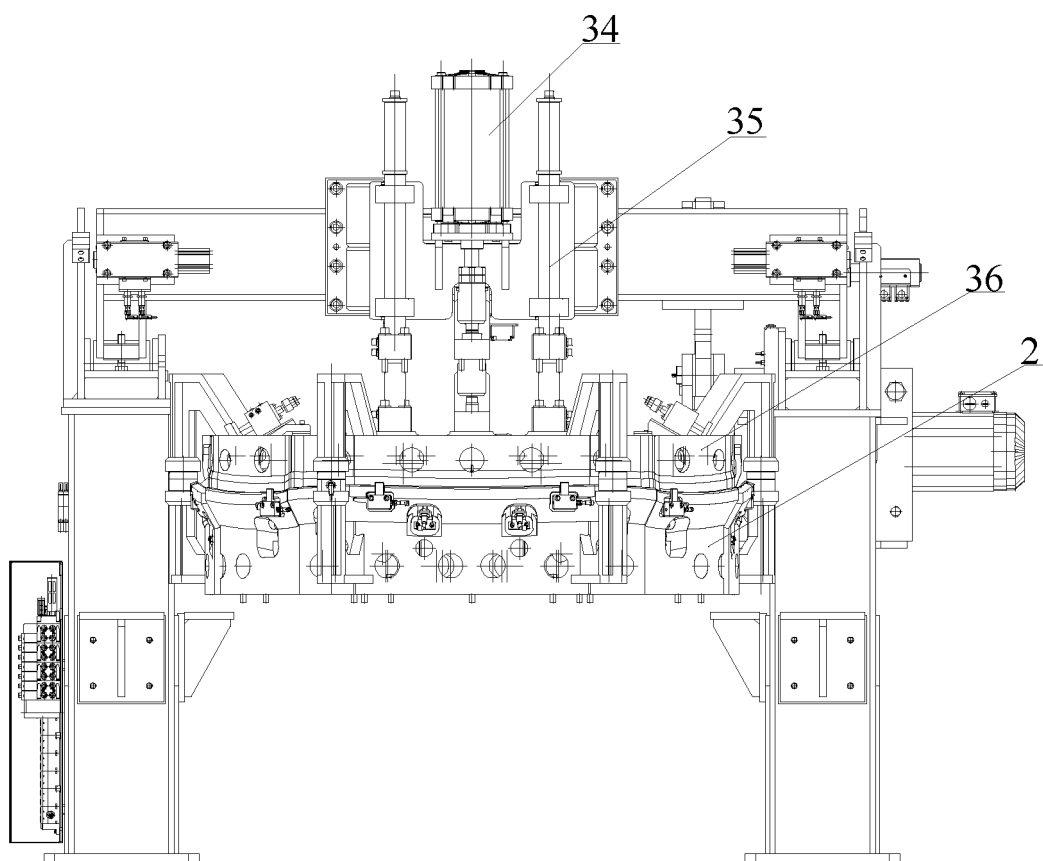


FIG. 6

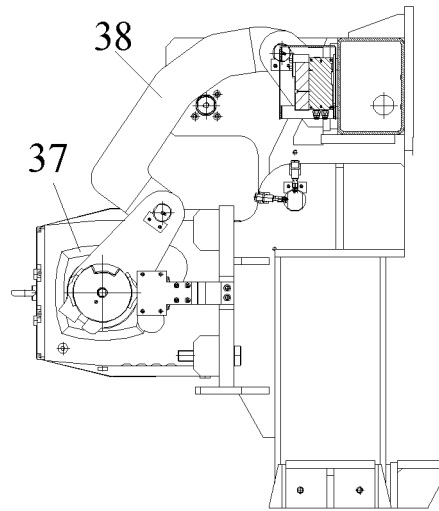


FIG. 7

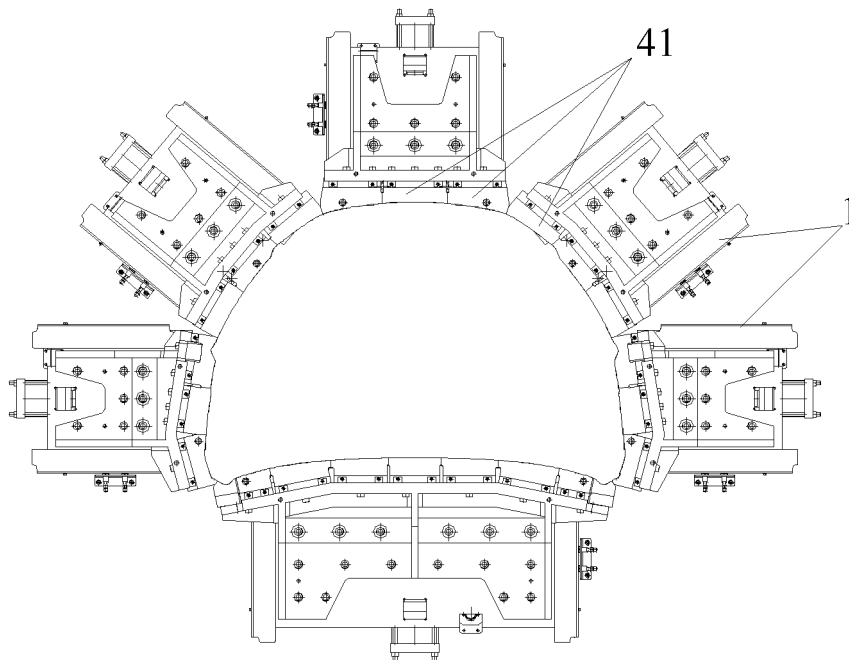


FIG. 8

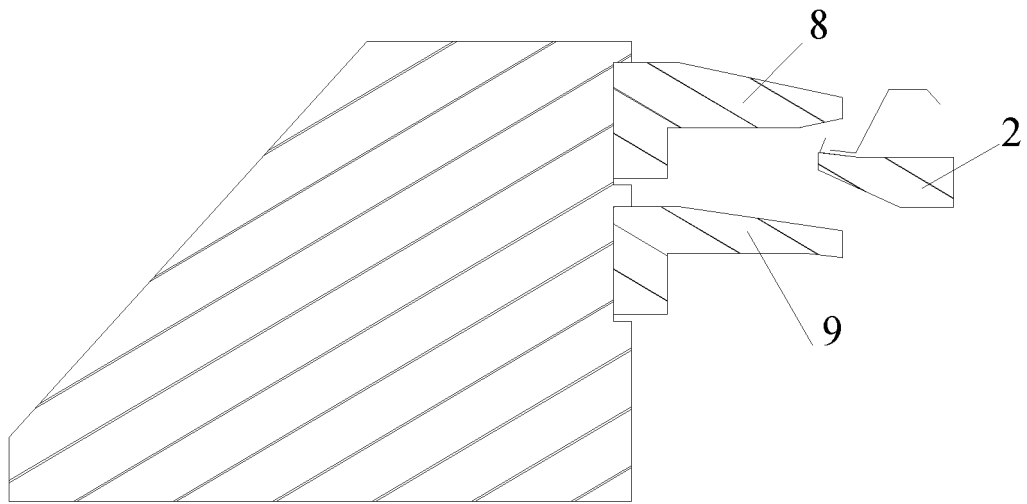


FIG. 9

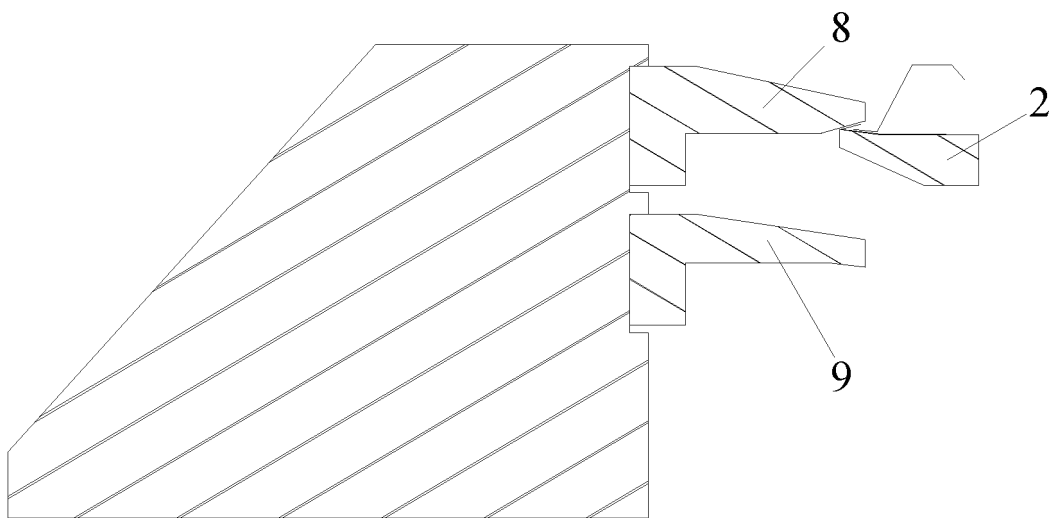


FIG. 10

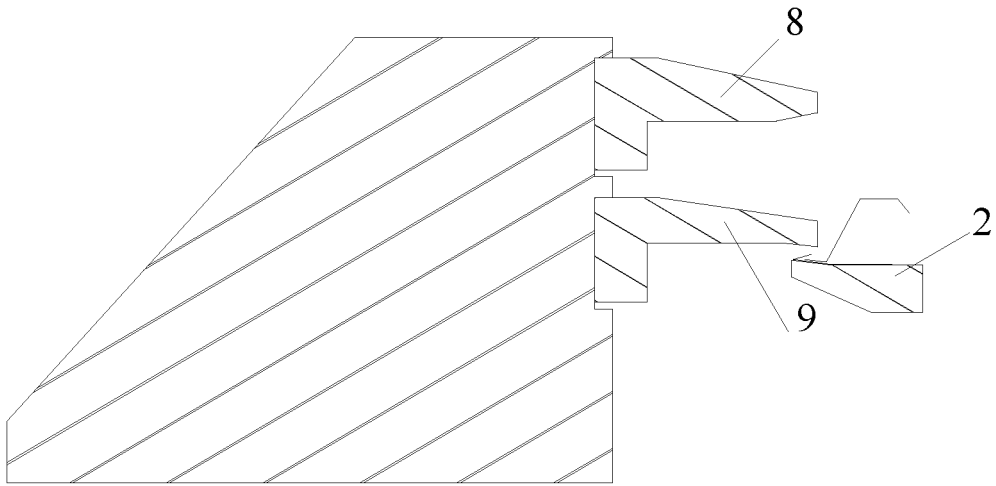


FIG. 11

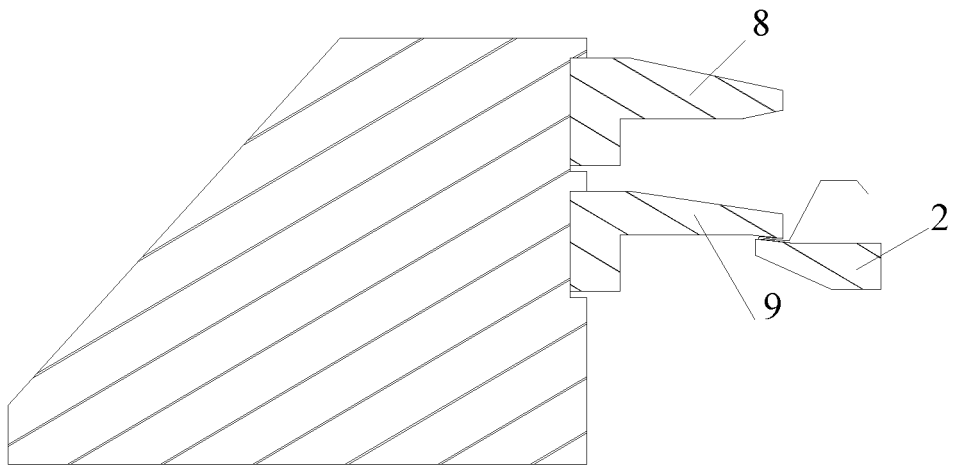


FIG. 12

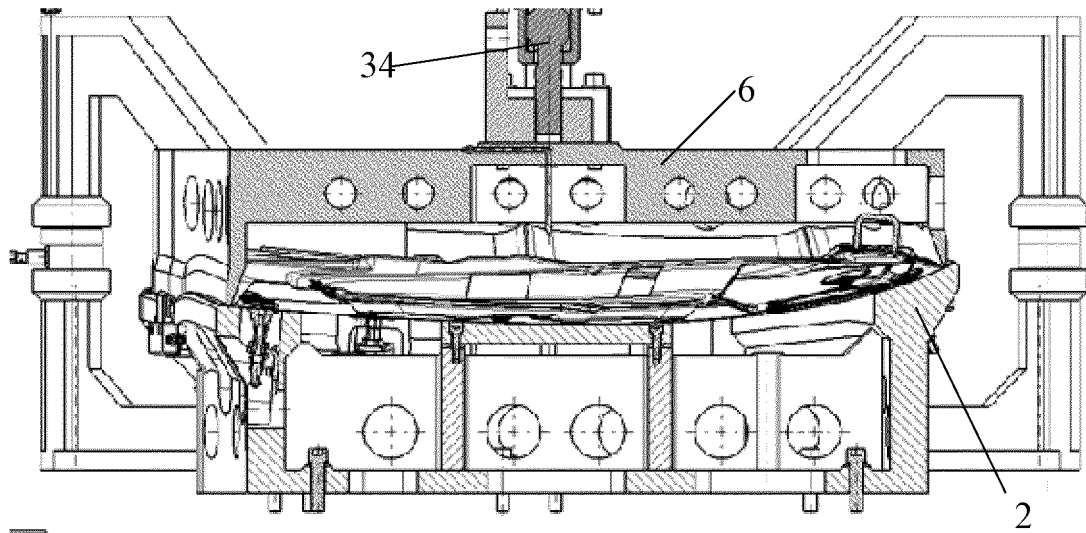


FIG. 13

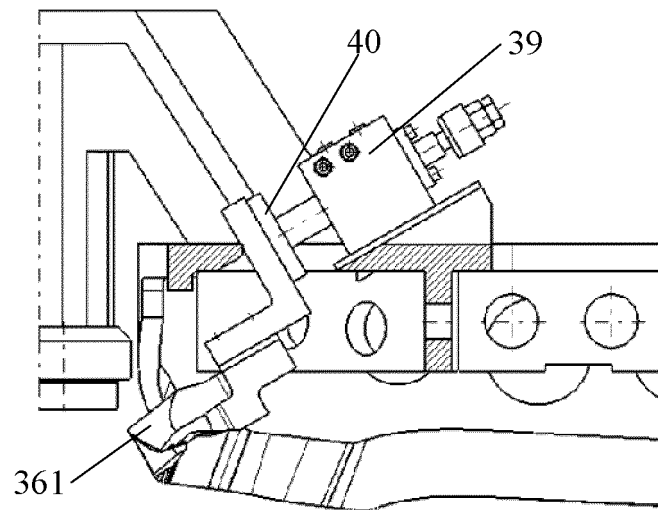


FIG. 14

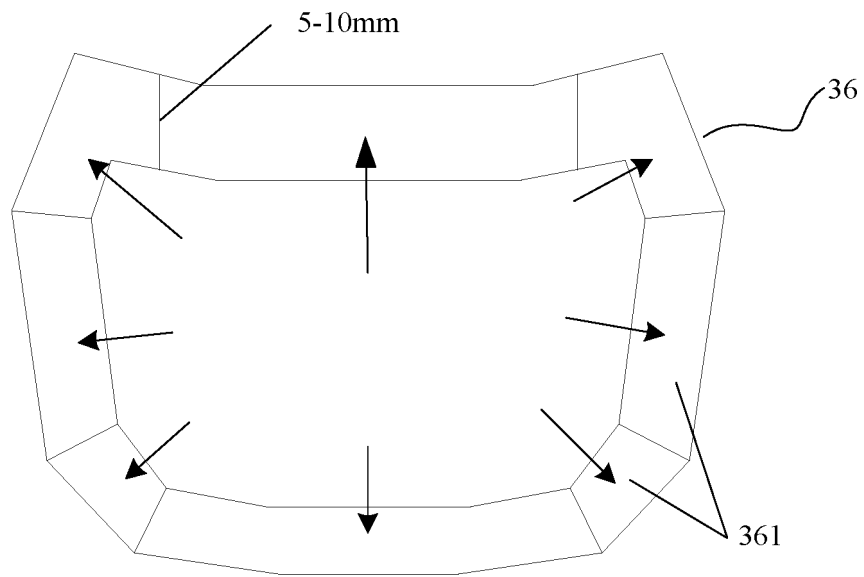


FIG. 15

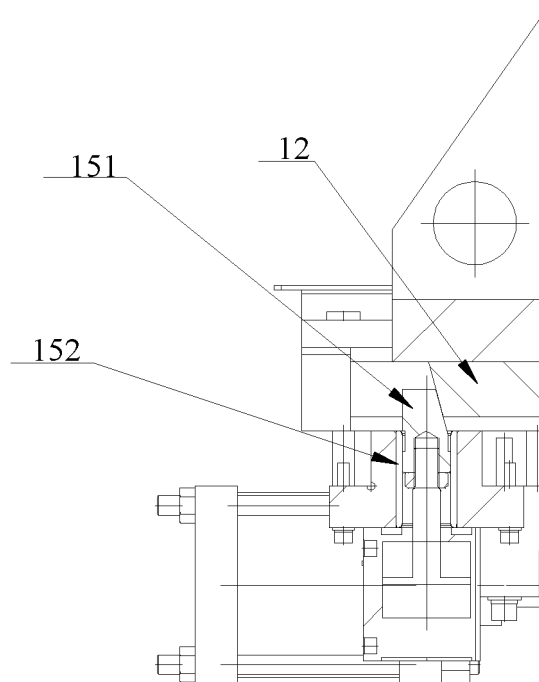


FIG. 16

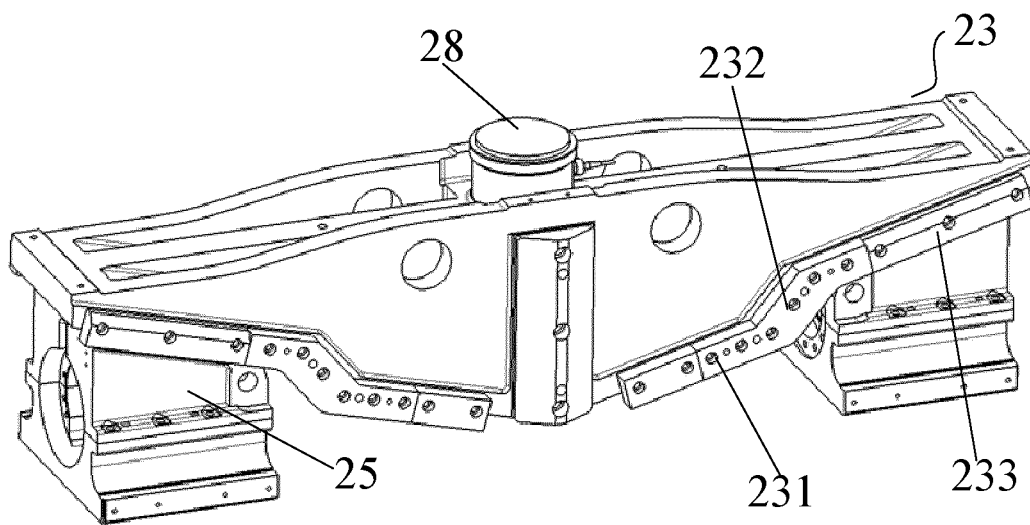


FIG. 17

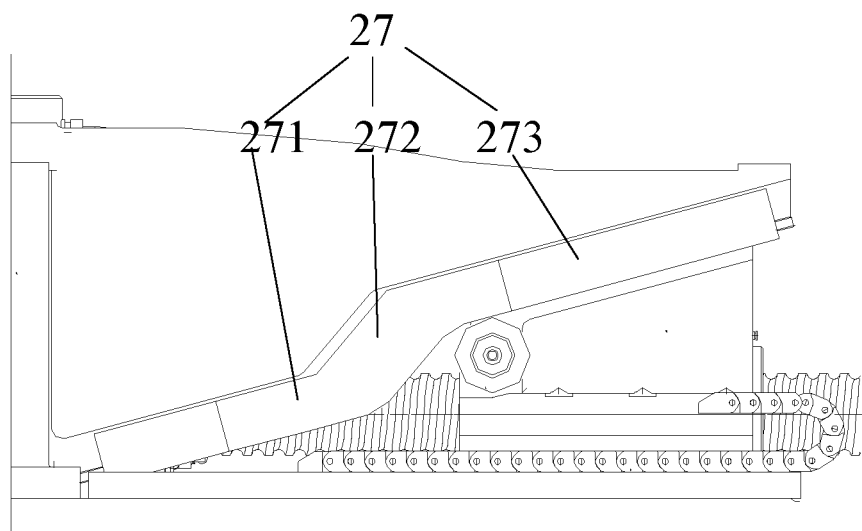


FIG. 18

REFERENCES CITED IN THE DESCRIPTION

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