



(11)

EP 4 817 857 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
07.10.2026 Bulletin 2026/41

(21) Application number: **24909672.8**

(22) Date of filing: **12.07.2024**

(51) International Patent Classification (IPC):
B31B 50/00 ^(2017.01) **B31B 50/04** ^(2017.01)
B31B 50/07 ^(2017.01) **B31B 50/74** ^(2017.01)

(52) Cooperative Patent Classification (CPC):
B31B 50/00; B31B 50/04; B31B 50/07; B31B 50/74

(86) International application number:
PCT/CN2024/105229

(87) International publication number:
WO 2025/138717 (03.07.2025 Gazette 2025/27)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **25.12.2023 CN 202311792759**

(71) Applicant: **Zhejiang New Debao Machinery Co., Ltd**
Wenzhou, Zhejiang 325000 (CN)

(72) Inventors:
• **PENG, Ziliang**
Wenzhou, Zhejiang 325000 (CN)
• **ZHOU, Jianxiu**
Wenzhou, Zhejiang 325000 (CN)
• **ZHANG, Hui**
Wenzhou, Zhejiang 325000 (CN)

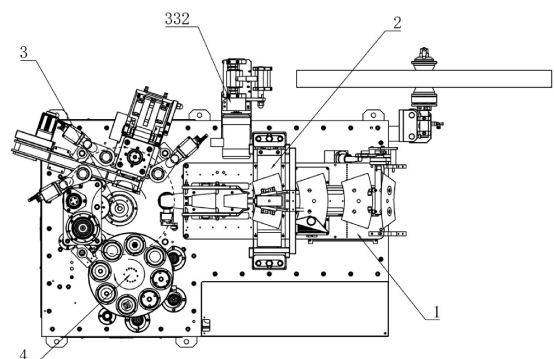
(74) Representative: **Bayramoglu et al.**
Mira Office
Kanuni Sultan Süleyman Boulevard 5387
Street Beytepe, floor 12, no:50
06800 Cankaya, Ankara (TR)

(54) **HIGH-SPEED SERVO PAPER CUP MAKING MACHINE**

(57) A high-speed servo paper cup forming machine includes a paper suction and feeding mechanism (1), a paper tube forming mechanism (2), a cup bottom forming turntable (3), and a cup rim forming turntable (4), where the paper suction and feeding mechanism (1), the paper tube forming mechanism (2), the cup bottom forming turntable (3), and the cup rim forming turntable (4) are sequentially connected for conveyance; a circumferential direction of the cup bottom forming turntable (3) is sequentially provided with a paper tube loading station (31), a paper tube bottom preheating station (32), a cup bottom forming station (33), a bottom crimping station (34), a knurling station (35), and a mold changing station (36) along a conveying direction; and the cup bottom forming turntable (3) is linked to the cup rim forming turntable (4) via the mold changing station (36). With a process of loading the paper tube, preheating a bottom of the paper tube, and connecting the cup bottom and the paper tube, the present disclosure eliminates the preheating waiting procedure after bottom forming, can simplify molds on the turntable, and can make materials of the molds lighter. Therefore, the present disclosure reduces the overall weight of the cup bottom forming turntable (3), increases the power torque of the cup bottom

forming turntable (3), and lowers the equipment cost.

[FIG. 1]



EP 4 817 857 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of paper cup forming machines, and in particular, to a high-speed servo paper cup forming machine.

BACKGROUND TECHNOLOGY

[0002] Paper cup forming machines are generally used to form paper cups, paper bowls, and other paper containers. After the cup wall is preliminarily formed, it is fed to a male mold for processing, and then to a female mold for forming and subsequent demolding. A plurality of forming stations are disposed on both the male mold and the female mold. The paper cup is transferred among stations through rotation of a male mold turntable and a female mold turntable. Upper molds (e.g., in a vertical state) of the male mold are distributed on the male mold turntable and rotate with the male mold turntable. A cup body of the paper cup is sleeved on each upper mold. As the upper molds rotate with the turntable, the cup body is carried to each station for processing, so that the cup body is connected to a cup bottom to realize bottom forming. In the prior art, both the male mold turntable and the female mold turntable are in transmission connection with a main power source of the main unit via a mechanical structure. For instance, the Chinese Patent Application No. CN100577404C provides a paper cup forming machine, having a T-shaped machine frame. The paper cup forming machine includes a paper feeding and cutting mechanism, a cup body forming and demolding mechanism, a cup feeding mechanism, and a multi-station indexing turntable, and a transmission mechanism. The multi-station indexing turntable includes a bottom feeding station, a bottom crimping station, a cup bottom knurling station, a cup rim crimping station, and a cup ejection station. The multi-station indexing turntable includes a main indexing turntable and an auxiliary indexing turntable. The bottom feeding station, the bottom crimping station, and the cup bottom knurling station are disposed on the main indexing turntable.

[0003] As disclosed in the specification of the Chinese application, at the bottom feeding station, the dedicated paper sheet of the paper cup passes between the upper cutting die and the pressure plate. The pushing rod is driven by the transmission mechanism to push the lower cutting die mounting plate upward via the connecting sleeve, thereby pushing the lower cutting die and the pressure plate upward. The pressure plate tightly presses the dedicated paper sheet of the paper cup against a lower end surface of the upper cutting die. At this time, the pushing rod continues to move upward, and the lower cutting die comes into contact with a cutting edge of the upper cutting die, thereby completing cup bottom blanking. Then, the bottom feeding rod is driven by the transmission device to move upward and push the

unformed cup bottom into a forming die, and then the cup bottom is formed in the forming die. The bottom feeding rod continues to move upward and feeds the formed cup bottom to a paper cup body. For such a station layout, base paper is fed first to form the cup bottom and then the paper tube is loaded to complete the cup bottom blanking. Afterward, the bottom feeding rod moves upward to feed the cup bottom to the paper cup body. That is, during the bottom forming process of the base paper, the paper sheet of the cup bottom needs to be adsorbed or clamped. If the paper sheet is clamped, the upper mold must be made of steel to prevent oxidation. After the paper sheet is clamped, the cup bottom further needs to be pushed out at a next station, which leads to a complex mechanical structure including a cup bottom clamping device and a bottom pushing device, and results in higher equipment cost.

[0004] The paper tube is transferred upward to the mold of the male mold turntable after being enclosed and formed. In the prior art, the upper mold mainly includes a main mold body, a steel insert, a (bottom) pushing plate 620, a return spring (which is configured to drive the pushing plate 620 to return), and a shaft end limiting ring. A recess 621 (which forms a concave bottom structure) configured to allow a movable arrangement of the pushing plate is further formed in a bottom of the main mold body. The pushing plate pushes the cup bottom downward, thereby demolding the paper cup. The upper mold has an intricate internal structure and high mounting requirements, and its various accessories are difficult to machine. Moreover, it is quite challenging to achieve airtightness if ventilation is required. In addition, since the bottom of the upper mold is recessed (i.e., the concave bottom) for entry of the preformed cup bottom paper sheet, a side wall 622 (relatively thin) of the upper mold having the bottom recess 621 still exists between the cup bottom paper sheet and the cup body. Although the side wall is relatively thin, it still poses a high risk of leakage at the connection between the cup bottom paper sheet and the cup body.

[0005] Therefore, a paper cup forming machine that optimizes the station layout, can provide more stations on the machine frame of the same size or even smaller size, optimizes the production process, saves the equipment cost, and further optimizes a structure of the upper mold is desired.

CONTENT OF THE INVENTION

[0006] In view of defects in the prior art, the present disclosure provides a high-speed servo paper cup forming machine.

[0007] To solve the above technical problems, the present disclosure proposes the following technical solutions:

[0008] A high-speed servo paper cup forming machine includes a machine frame, where a paper suction and feeding mechanism, a paper tube forming mechanism, a

cup bottom forming turntable, and a cup rim forming turntable are disposed on the machine frame; the paper suction and feeding mechanism, the paper tube forming mechanism, the cup bottom forming turntable, and the cup rim forming turntable are sequentially connected for conveyance; the cup bottom forming turntable and the cup rim forming turntable are respectively connected to servo motors that are respectively configured to drive the cup bottom forming turntable and the cup rim forming turntable to rotate; a plurality of upper molds corresponding to respective stations are suspended at a bottom of the cup bottom forming turntable; a plurality of lower molds corresponding to respective stations are disposed on the cup rim forming turntable; a circumferential direction of the cup bottom forming turntable is sequentially provided with a paper tube loading station, a paper tube bottom preheating station, a cup bottom forming station, a bottom crimping station, a knurling station, and a mold changing station along a conveying direction; a paper tube on the upper mold is preheated by the paper tube bottom preheating station, and then enters the cup bottom forming station to be connected to a cup bottom; and the cup bottom forming turntable is linked to the cup rim forming turntable via the mold changing station.

[0009] Preferably, the upper molds each include an integrally formed main mold body; a bottom of the main mold body is a flat bottom surface; a circumferential side of the main mold body is a cup body sleeving surface; a demolding gas outlet is formed in the main mold body; the demolding gas outlet is formed in the cup body sleeving surface; a demolding gas passage is disposed in the main mold body; the demolding gas passage communicates with the demolding gas outlet; a demolding gas inlet is further formed in the main mold body; and the demolding gas inlet communicates with the demolding gas passage.

[0010] An annular recess is further formed in the cup body sleeving surface of the main mold body; at least two annular recesses are formed in the main mold body; the annular recesses are vertically parallel to each other; a vertically penetrating exhaust passage is further formed in the main mold body; one end of the exhaust passage is located on the flat bottom surface of the main mold body; and another end of the exhaust passage is located on a top of the main mold body.

[0011] Preferably, the mold changing station is disposed on each of the cup bottom forming turntable and the cup rim forming turntable; and a circumferential direction of the cup rim forming turntable is provided with the mold changing station, a cup rim lubricating station, a cup rim pre-crimping station, a cup rim forming station, a cup interior detecting station or a three-step rim crimping station, a defective cup ejection station, and a finished cup ejection station.

[0012] Preferably, a first cup bottom heating station and a second cup bottom heating station are disposed between the cup bottom forming station and the bottom crimping station; a cup body detecting station is disposed

between the knurling station and the mold changing station; nine working stations and a reserved station are disposed on the cup bottom forming turntable; and a circumferential direction of the cup rim forming turntable is provided with eight stations.

[0013] Preferably, a bottom of the cup bottom forming station is provided with a cup bottom forming device; the cup bottom forming device is connected to a base paper conveying device and a waste paper discharging device; and the waste paper discharging device extends out between the first cup bottom heating station and the second cup bottom heating station.

[0014] Preferably, the paper suction and feeding mechanism includes a suction device configured to suck out a paper sheet and a pushing device configured to push out the paper sheet; a side of the pushing device is provided with a paper sheet heating device; the paper tube forming mechanism includes a clamping device, an ultrasonic welding device, and a paper tube transfer device configured to pick up the paper tube; and the paper tube transfer device is connected to the paper tube loading station via a paper tube loading manipulator.

[0015] Preferably, the servo motors are respectively disposed on the cup bottom forming turntable and the cup rim forming turntable; a main power source and three parallel transmission shafts connected to the main power source are disposed below the machine frame; and each of the paper suction and feeding mechanism, the paper tube forming mechanism, the cup bottom forming turntable, and the cup rim forming turntable includes a device in transmission connection with the transmission shafts.

[0016] Preferably, each of the paper tube bottom preheating station, the first cup bottom heating station, and the second cup bottom heating station is provided with a cup bottom hot-air device; the cup bottom hot-air device includes a heating mantle and a hot air generating device; a cavity for allowing a cup bottom to enter is formed in the heating mantle; a bottom of the cavity is provided with a hot air head; a bottom of the hot air head is fixedly connected to a hot air guide tube; the hot air generating device includes an air outlet tube; an outlet end of the air outlet tube communicates with the hot air guide tube; and the hot air guide tube can move up and down relative to the hot air generating device, so as to adjust a size of an air passage communicating between the air outlet tube and the hot air guide tube.

[0017] Preferably, an adjustment seat is fixedly mounted on an outlet end of the hot air generating device; the hot air guide tube is slidably disposed in the adjustment seat; a sealed chamber is formed in the adjustment seat; the chamber communicates with the hot air guide tube and the hot air generating device; an adjusting valve is disposed at the air outlet tube of the hot air generating device; the hot air guide tube is connected to the adjusting valve; and the hot air guide tube moves up and down to drive the adjusting valve to move, thereby changing an opening degree of the adjusting valve.

[0018] The present disclosure has significant technical

effects due to adoption of the above technical solutions: A new station layout is used. The paper tube is loaded first and fed from another direction for preheating. A portion of the paper tube to be connected to the cup bottom is heated first to facilitate subsequent fixation. Afterwards, the base paper is fed to form the cup bottom, followed by two heating processes, bottom crimping, knurling, and forming. This can eliminate a tapered inner wall structure of the mold for clamping the cup bottom in the paper tube for forming. The stainless steel can also be replaced by other lightweight materials, such that the mold can be made lighter. Consequently, the torque of the cup bottom forming turntable is reduced, the turntable can operate more rapidly, and the area of the support plate is reduced. With improved strength, the overall processing speed of the machine can be accelerated, realizing matching between the strength and the speed.

[0019] A new process layout is used. The three-step hot-air bottom forming process is used when the cup bottom is formed, improving the quality of cup bottom forming. The optional cup interior detecting function better ensures the quality of the paper cup. The defective product is discharged via the cup ejection device at the defective cup ejection station. With the process layout, the present disclosure can utilize the molds to form different paper cups. With the modular design, each mechanism has better space utilization, and the machine frame is structurally compact, which can greatly shorten the length of the machine body.

[0020] The bottom of the upper mold is the flat bottom surface, without being additionally recessed inward (without the concave bottom structure). During demolding, the demolding gas outlet is also used for gas blowing, and the paper cup is blown for demolding (separation), so the bottom pushing plate on the bottom of the main mold body turns out to be unnecessary. The demolding gas inlet, the demolding gas passage, and the demolding gas outlet cooperate to form a gas path structure, which is relatively simple. Without the concave bottom structure and the bottom pushing plate for demolding, the structure is more concise, the manufacturing is more convenient, the paper cup forming requirements are met when the paper cup is formed, and the mounting and debugging are relatively convenient.

DESCRIPTION OF THE DRAWINGS

[0021] FIG. 1 is a top view according to the present disclosure. FIG. 2 is a top view of a cup bottom forming turntable and a cup rim forming turntable according to the present disclosure. FIG. 3 is a top view of a paper suction and feeding mechanism, and a paper tube forming mechanism according to the present disclosure. FIG. 4 is a schematic structural view of an upper mold and a lower mold. FIG. 5 is a schematic top view of an upper mold. FIG. 6 is a cross-sectional view along F-F shown in FIG. 5. FIG. 7 is a cross-sectional view along G-G shown in FIG. 5. FIG. 8 is a perspective view of FIG. 5. FIG. 9

shows an upper mold of a paper cup forming machine in a background art. FIG. 10 is a schematic structural view of a cup bottom hot-air device. FIG. 11 is a longitudinal cross-sectional view of a cup bottom hot-air device. FIG. 12 is a schematic structural view of a cup bottom hot-air device from another angle. FIG. 13 is a manufacturing flowchart according to the present disclosure.

SPECIFIC IMPLEMENTATIONS

[0022] The present disclosure will be further described below in conjunction with the drawings and embodiments.

Embodiments

[0023] As shown in FIGS. 1 to 4, a high-speed servo paper cup forming machine includes a machine frame. Paper suction and feeding mechanism 1, paper tube forming mechanism 2, cup bottom forming turntable 3, and cup rim forming turntable 4 are disposed on the machine frame. The paper suction and feeding mechanism 1, the paper tube forming mechanism 2, the cup bottom forming turntable 3, and the cup rim forming turntable 4 are sequentially connected for conveyance. The cup bottom forming turntable 3 and the cup rim forming turntable 4 are respectively connected to servo motors 8 that are respectively configured to drive the cup bottom forming turntable 3 and the cup rim forming turntable 4 to rotate. A plurality of upper molds 6 corresponding to respective stations are suspended at a bottom of the cup bottom forming turntable 3. A plurality of lower molds 7 corresponding to respective stations are disposed on the cup rim forming turntable 4. A circumferential direction of the cup bottom forming turntable 3 is sequentially provided with paper tube loading station 31, paper tube bottom preheating station 32, cup bottom forming station 33, bottom crimping station 34, knurling station 35, and mold changing station 36 along a conveying direction. A paper tube on the upper mold 6 is preheated by the paper tube bottom preheating station 32, and then enters the cup bottom forming station 33 to be connected to a cup bottom. The cup bottom forming turntable 3 is linked to the cup rim forming turntable 4 via the mold changing station 36.

[0024] The paper suction and feeding mechanism 1, the paper tube forming mechanism 2, the cup bottom forming turntable 3, and the cup rim forming turntable 4 are arranged in a "7" shape. Nine working stations and a reserved station are disposed on the cup bottom forming turntable 3. A circumferential direction of the cup rim forming turntable is provided with eight stations. The cup bottom forming turntable 3 and the cup rim forming turntable 4 rotate in opposite directions. A bottom of the cup bottom forming station 33 is provided with cup bottom forming device 331. The cup bottom forming device 331 is connected to base paper conveying device 332 and waste paper discharging device 333. The waste paper

discharging device 333 extends out between first cup bottom heating station 37 and second cup bottom heating station 38.

[0025] The mold changing station 36 is disposed on each of the cup bottom forming turntable 3 and the cup rim forming turntable 4. The circumferential direction of the cup rim forming turntable 4 is provided with the mold changing station 36, cup rim lubricating station 41, cup rim pre-crimping station 42, cup rim forming station 43, cup interior detecting station 44 or a three-step rim crimping station, defective cup ejection station 45, and finished cup ejection station 46. The first cup bottom heating station 37 and the second cup bottom heating station 38 are disposed between the cup bottom forming station 33 and the bottom crimping station 34. Cup body detecting station 39 is disposed between the knurling station 35 and the mold changing station 36.

[0026] As shown in FIG. 13, the paper suction and feeding mechanism 1 includes suction device 11 configured to suck out a paper sheet and pushing device 12 configured to push out the paper sheet. A side of the pushing device 12 is provided with paper sheet heating device 13. The paper tube forming mechanism 2 includes clamping device 21, paper tube connecting device 22, and paper tube transfer device 23 configured to pick up the paper tube. The paper tube transfer device 23 is connected to the paper tube loading station 31 via paper tube loading manipulator 311. Raw paper is subjected to single-sided or double-sided polyethylene (PE) coating by a lamination machine to obtain coated paper, such that the paper sheet achieves such properties as water resistance, oil resistance and heat sealability, and is applied to paper cup production. The paper sheet may be transferred via adsorption of a suction nozzle. The single paper sheet in a feed bin is adsorbed by the paper suction and feeding mechanism 1, transferred to a horizontal conveying frame, and pushed out by the pushing device 12 to the paper tube forming mechanism. During production, the clamping device 21 shapes the paper sheet into the paper tube according to an intermediate mold. The paper tube connecting device 22 fixes a cup wall of the paper tube in a heating or mechanical manner. The common paper tube connecting device is an ultrasonic welding device. By means of mechanical vibration generated by the ultrasonic welding device, mechanical pressure is produced between material molecules, and released heat softens and bonds a PE film in the paper sheet, thereby connecting linked portions of the paper tube. The paper tube transfer device 23 transfers the formed paper tube to the cup bottom forming turntable 3 via the paper tube loading manipulator. The paper tube is fixed on each mold of the cup bottom forming turntable 3 to gradually form the cup bottom.

[0027] Each of the paper tube loading station 31, the cup bottom forming station 33, the bottom crimping station 34, the knurling station 35, the mold changing station 36, the paper tube bottom preheating station 32, the first cup bottom heating station 37, and the second cup bot-

tom heating station 38 is provided with a heating device, which is typically a hot-air device. The paper tube is fed to the paper tube loading station 31 by the manipulator. The cup bottom forming station 33 is provided with a cup bottom cutting and forming device, which can cut the paper sheet into a desired shape, and push the paper sheet upward to connect a bottom of the paper tube. Restricted by the mold, the paper sheet is bent outward to form a skirt. At the bottom crimping station 34 and the knurling station 35, the cup bottom is folded and crimped inward. A knurling device at the knurling station rolls and fixes the cup bottom and the paper tube, while embossing a pattern thereon. Through the mold changing station 36, molds of the two turntables are linked to realize operation of transferring to another mold. Each of the cup rim lubricating station 41, the cup rim pre-crimping station 42, and the cup rim forming station 43 is provided with a cup rim lubricating device, a cup rim pre-crimping device, and a cup rim forming device. Each of the defective cup ejection station 45 and the finished cup ejection station 46 ejects a cup body via a cup ejection device thereunder. The cup body is typically conveyed by cup ejection, and may also be collected in other ways. The above processing devices are mature technologies known to those skilled in the art. The present disclosure achieves the intended objective via a station layout different from that in the prior art, and therefore structures of the processing devices are not described.

[0028] The servo motors are respectively disposed on the cup bottom forming turntable 3 and the cup rim forming turntable 4. A main power source and three parallel transmission shafts connected to the main power source are disposed below the machine frame. The main power source is a motor. The motor drives the three transmission shafts to rotate via gear transmission or other linkage ways, thereby driving linkage devices on the transmission shafts to move back and forth or move up and down. A linkage shaft extending front and back is not provided, but the servo motors are respectively disposed on the cup bottom forming turntable 3 and the cup rim forming turntable 4. The machine frame is arranged in a "7" shape, rather than a "T" shape, reducing space occupied by the whole machine in a front-rear direction. Each of the paper suction and feeding mechanism 1, the paper tube forming mechanism 2, the cup bottom forming turntable 3, and the cup rim forming turntable 4 includes a device in transmission connection with the transmission shafts. The whole transmission mechanism includes three horizontal shafts. Since a first-stage transmission shaft, a first driven shaft, and a second driven shaft are parallel to each other, there is no need to reserve space for transmission in another direction. The modular design improves space utilization and shortens the length of the machine body.

[0029] As shown in FIGS. 5 to 9, the upper molds each include integrally formed main mold body 61, i.e., the main mold body 61 is an integral structure. A bottom of the main mold body 61 is flat bottom surface 62, and does not

need to be recessed to form a concave bottom structure, achieving a simple structure and relatively simple manufacturing. A circumferential side of the main mold body 61 is cup body sleeving surface 63. The cup body sleeving surface 63 may allow a cup body of the paper cup to be sleeved on. The cup body of the paper cup is located on the cup body sleeving surface 63 when sleeved on the main mold body 61.

[0030] In addition, demolding gas outlet 64 is formed in the main mold body 61. The demolding gas outlet 64 is formed in the cup body sleeving surface 63. The demolding gas outlet 64 is configured for ventilation. Through the ventilation, the paper cup sleeved on an outer side of the cup body sleeving surface 63 is blown, and the paper cup sleeved on the outer side of the cup body sleeving surface 63 is demolded (separated). A demolding gas passage is disposed in the main mold body 61. The demolding gas passage 65 communicates with the demolding gas outlet 64. Demolding gas inlet 66 is further formed in the main mold body 61. The demolding gas inlet 66 communicates with the demolding gas passage 65. The demolding gas inlet 66 is configured to be connected to gas (a gas source) for gas blowing. The demolding gas inlet 66 communicates with the demolding gas outlet 64 via the demolding gas passage 65. After passing through the demolding gas passage 65, the gas is discharged from the demolding gas outlet 64 to blow the paper cup for demolding.

[0031] The following optimizations or further explanations may further be made on the basis of the above embodiment.

[0032] For instance, annular recess 67 is further formed on the cup body sleeving surface 63 of the main mold body 61. At least two annular recesses 67 are formed on the main mold body 61. The annular recesses 67 are vertically parallel to each other. By forming the annular recess 67 on the cup body sleeving surface 63, a contact area with the paper tube can be reduced. While the main mold body 61 is sufficiently supported, the contact area and the friction are reduced, and the demolding by ventilation (gas blowing) is smoother.

[0033] For further optimization, exhaust passage 68 is further formed in the main mold body 61. The exhaust passage 68 penetrates vertically. One end 69 of the exhaust passage 68 is located on the flat bottom surface 62 of the main mold body 61. Another end 610 of the exhaust passage 68 is located on a top of the main mold body 61. This structure is concise. Through the exhaust passage 68, air during assembly of the cup bottom and the cup body (i.e., the cup body) can be exhausted timely, reducing the problem of leakage due to poor bonding at the bottom (between the cup bottom and the cup body) of the paper cup.

[0034] In addition, for further optimization, the demolding gas outlet 64 may be formed in the annular recess 67 of the main mold body 61. When the cup body is sleeved on the cup body sleeving surface 63 of the main mold body 61 for paper cup forming, and when the demolding

gas outlet 64 discharges the gas, the gas first fills the annular recess 67, and then is blown to the paper cup for separation and demolding. The annular recess 67 functions to stabilize the pressure, such that the gas pressure for demolding the paper cup is more stable, and the paper cup is demolded and separated more stably.

[0035] In addition, a plurality of demolding gas outlets 64 may be circumferentially and uniformly distributed. By blowing the paper cup via the demolding gas outlets 64, the demolding and separation are more balanced, and the paper cup is separated more stably. The main mold body 61 in the figure is exemplified as a rotary body, which is not limited to a (circular) rotary body, and may also be a square rotary body, a quasi-square rotary body, an elliptical rotary body or the like.

[0036] Also for instance, a plurality of demolding gas outlets 64 may be distributed in same annular recess 67. By forming the demolding gas outlets 64 in the same annular recess 67, the processing is relatively simple, the structure is relatively simple, and the gas pressure for demolding can be formed quickly and uniformly in the same annular recess 67.

[0037] In addition, the demolding gas outlet 64 may be formed obliquely outward and downward. By blowing the paper cup obliquely outward and downward, the paper cup moves down smoothly, quickly, and stably.

[0038] In use, for instance, the upper mold of the paper cup forming machine without the concave bottom and the bottom pushing plate is assembled onto the turntable of the paper cup forming machine. The upper mold is in a vertical state. The cup body of the paper cup is sleeved on the cup body sleeving surface 63 (located on its outer side) of the upper mold of the paper cup forming machine, and a bottom of the cup body extends downward beyond the upper mold. A cup body surrounding allowance space is reserved below the flat bottom surface 62 of the main mold body 61. According to the paper cup forming machine, the cup bottom (paper) is inserted into the surrounding allowance space, crimped and rolled or pressed. During demolding, the gas is fed to the demolding gas inlet 66. The gas passes through the demolding gas passage and then is discharged from the demolding gas outlets 64 for gas blowing. The upper mold can meet the paper cup forming requirements when the paper cup is formed, and is mounted and debugged conveniently.

[0039] For the upper mold of the paper cup forming machine without the concave bottom and the bottom pushing plate, the bottom is the flat bottom surface 62, and is unnecessarily and additionally recessed inward (without the concave bottom structure). During demolding, the demolding gas outlet 64 is also used for gas blowing, and the paper cup is blown for demolding (separation), so the bottom pushing plate on the bottom of the main mold body 61 turns out to be unnecessary. The demolding gas inlet 66, the demolding gas passage 65, and the demolding gas outlet 64 cooperate to form a gas path structure, which is relatively simple. Without the concave bottom structure and the bottom pushing plate

for demolding, the structure is more concise, the manufacturing is more convenient, the paper cup forming requirements are met when the paper cup is formed, and the mounting and debugging are relatively convenient.

[0040] There are a variety of ways for the demolding gas passage 65. For instance, the demolding gas passage 65 includes vertical hole 611 and oblique hole 612. The oblique hole 612 communicates with the vertical hole 611. An upper port of the vertical hole 611 is configured as the demolding gas inlet 66. An entrance of the demolding gas inlet 66 is upward, such that the upper mold at a paper cup demolding station of the paper cup forming machine is supplied with the gas via a lifting gas supply nozzle above the demolding station for demolding. The vertical hole 611 is located at a center of the main mold body 61, and the oblique hole 612 is connected to a side of the vertical hole 611. The demolding gas passage 65 mainly including the vertical hole 611 and the oblique hole 612 is processed conveniently. Through drilling, corresponding holes can be formed, and communication between the holes can be realized.

[0041] Mounting portion 613 may be further connected to an upper end of the main mold body 61. The mounting portion 613 (such as a flange) is configured for assembly connection. Corresponding mounting connection hole 614 configured for mounting connection may be formed in the mounting portion 613. For instance, through the mounting portion 613, the connection to the turntable of the paper cup forming machine is realized. In addition, the mounting portion 613 and the main mold body 61 may be integrally formed.

[0042] The cup body surrounding allowance space is reserved below the flat bottom surface 62 of the main mold body 61. When the cup body of the paper cup is sleeved on the cup body sleeving surface 63 (located on its outer side) of the upper mold of the paper cup forming machine, the bottom of the cup body extends downward beyond the flat bottom surface 62 of the upper mold. Due to the cup body surrounding allowance space below the flat bottom surface 62 of the main mold body 61, the preformed cup bottom (paper) is inserted into the surrounding allowance space, crimped and rolled or pressed.

[0043] As shown in FIGS. 10 to 12, the cup bottom hot-air device includes heating mantle 51 and hot air generating device 52. Cavity 511 for allowing the cup bottom to enter is formed in the heating mantle 51. A bottom of the cavity 511 is provided with hot air head 53. A bottom of the hot air head 53 is fixedly connected to hot air guide tube 54. The hot air generating device 52 includes air outlet tube 521. An outlet end of the air outlet tube 521 communicates with the hot air guide tube 54. The hot air guide tube 54 can move up and down relative to the hot air generating device 52, so as to adjust a size of an air passage communicating between the air outlet tube 521 and the hot air guide tube 54.

[0044] As shown in FIG. 11, adjustment seat 55 in-

cludes a top provided with limiting portion 551 and a side provided with connecting portion 552. A bottom of the hot air guide tube 54 is inserted into the limiting portion 551 and is extendable into a chamber of the adjustment seat 55. Bearing bush 553 for guiding the hot air guide tube 54 to slide is disposed on an inner wall of the limiting portion 551. The connecting portion 552 is connected to the air outlet tube 521.

[0045] Guide tube fixing seat 541 is fixedly mounted outside the hot air guide tube 54. The guide tube fixing seat 541 is connected to a lifting power source.

[0046] As shown in FIG. 12, the hot air generating device 52 includes fixed mounting plate 523 for fixing to the machine frame. The fixed mounting plate 523 may be fixed to the machine frame by a bolt connection or a hoop mode. The hot air generating device may be a hot air gun, a hot air pump or the like. A side of the hot air generating device 52 away from the hot air guide tube 54 is provided with cold air tube 524 for charging cold air. The cold air is charged to the cold air tube via an air pump. The hot air generating device 52 heats the cold air and then discharges hot air via the air outlet tube 521.

[0047] A bottom of the adjustment seat 55 is provided with fixing plate 56. The fixing plate 56 and the adjustment seat 55 are fixed via connecting bolt 561. Adjusting spring 562 is sleeved on a position of the connecting bolt 561 located on the bottom of the fixing plate 56.

[0048] The heating mantle 51 is opposite to the hot air head 53, and is provided with exhaust port 512 for exhausting the hot air.

[0049] The working principle is as follows: In the pre-treatment process for forming and bonding the bottom of the paper cup, one or more stations are adopted to preheat the bottom of the paper cup, to facilitate processing of subsequent stations. Typically, the heating mantle is heated with the hot air, and then the paper cup or the bottom of the paper cup is transferred to the hot-air device for preheating.

[0050] The adjustment seat 55 is fixedly mounted on an outlet end of the hot air generating device 52. The hot air guide tube 54 is slidably disposed in the adjustment seat 55. The sealed chamber is formed in the adjustment seat 55. The chamber communicates with the hot air guide tube 54 and the hot air generating device 52. To adjust output airflow, in one implementation, when the hot air guide tube 54 moves down, it blocks a part of air from the air outlet tube 521 to adjust the size of the air passage. In another implementation, adjusting valve 522 is disposed at the air outlet tube 521 of the hot air generating device 52. The hot air guide tube 54 is connected to the adjusting valve 522. The adjusting valve may serve as a baffle to block an outlet of the hot air generating device 52. The hot air guide tube 54 moves up and down to drive the adjusting valve 522 to move, thereby changing an opening degree of the adjusting valve 522. When the hot air head 53 moves up, the output airflow is increased. When the hot air head 53 moves down, the output airflow is decreased.

[0051] In case of the cup or the cup bottom on the heating mantle 51, the heating mantle 51 moves up, and the hot air head 53 comes into contact with the cup bottom for preheating. While the cup bottom in the cavity 511 is heated, the hot air generating device 52 provides hot air ceaselessly. At this time, the hot air is also exhausted from the exhaust port 512 to avoid internal overheating. In case of no cup on the heating mantle 51, the heating mantle 52 moves down to narrow the air outlet of the hot air generating device 52. This can reduce the energy consumption, and prevent overheating of the heating mantle which causes adhesion of the paper sheet. After the air outlet is narrowed, maintaining a small amount of air can heat the mold better.

Claims

1. A high-speed servo paper cup forming machine, comprising: a machine frame, wherein a paper suction and feeding mechanism (1), a paper tube forming mechanism (2), a cup bottom forming turntable (3), and a cup rim forming turntable (4) are disposed on the machine frame; the paper suction and feeding mechanism (1), the paper tube forming mechanism (2), the cup bottom forming turntable (3), and the cup rim forming turntable (4) are sequentially connected for conveyance; the cup bottom forming turntable (3) and the cup rim forming turntable (4) are respectively connected to servo motors (8) that are respectively configured to drive the cup bottom forming turntable (3) and the cup rim forming turntable (4) to rotate; a plurality of upper molds (6) corresponding to respective stations are suspended at a bottom of the cup bottom forming turntable (3); a plurality of lower molds (7) corresponding to respective stations are disposed on the cup rim forming turntable (4); the cup bottom forming turntable (3) is circumferentially and sequentially provided with a paper tube loading station (31), a paper tube bottom preheating station (32), a cup bottom forming station (33), a bottom crimping station (34), a knurling station (35), and a mold changing station (36) along a conveying direction; a paper tube on the upper mold (6) is preheated by the paper tube bottom preheating station (32), and then enters the cup bottom forming station (33) to be connected to a cup bottom; and the cup bottom forming turntable (3) is linked to the cup rim forming turntable (4) via the mold changing station (36).
2. The servo motor-based paper cup forming machine according to claim 1, wherein the upper molds (6) each comprise a main mold body (61) integrally formed; a bottom of the main mold body (61) is a flat bottom surface (62); a circumferential side of the main mold body (61) is a cup body sleeving surface (63); a demolding gas outlet (64) is formed in the main mold body (61); the demolding gas outlet (64) is

formed in the cup body sleeving surface (63); a demolding gas passage (65) is disposed in the main mold body (61); the demolding gas passage (65) communicates with the demolding gas outlet (64); a demolding gas inlet (66) is further formed in the main mold body (61); and the demolding gas inlet (66) communicates with the demolding gas passage (65).

3. The servo motor-based paper cup forming machine according to claim 2, wherein an annular recess (67) is further formed in the cup body sleeving surface (63) of the main mold body (61); at least two annular recesses (67) are formed in the main mold body (61); the annular recesses (67) are vertically parallel to each other; an exhaust passage (68) vertically penetrating is further formed in the main mold body (61); one end of the exhaust passage (68) is located on the flat bottom surface (62) of the main mold body (61); and another end of the exhaust passage (68) is located on a top of the main mold body (61).
4. The servo motor-based paper cup forming machine according to claim 1, wherein the mold changing station (36) is disposed on each of the cup bottom forming turntable (3) and the cup rim forming turntable (4); and the cup rim forming turntable (4) is circumferentially provided with the mold changing station (36), a cup rim lubricating station (41), a cup rim pre-crimping station (42), a cup rim forming station (43), a cup interior detecting station (44) or a three-step rim crimping station, a defective cup ejection station (45), and a finished cup ejection station (46).
5. The servo motor-based paper cup forming machine according to claim 1, wherein a first cup bottom heating station (37) and a second cup bottom heating station (38) are disposed between the cup bottom forming station (33) and the bottom crimping station (34); a cup body detecting station (39) is disposed between the knurling station (35) and the mold changing station (36); nine working stations and a reserved station are disposed on the cup bottom forming turntable (3); and the cup rim forming turntable (4) is circumferentially provided with eight stations.
6. The servo motor-based paper cup forming machine according to claim 5, wherein a bottom of the cup bottom forming station (33) is provided with a cup bottom forming device (331); the cup bottom forming device (331) is connected to a base paper conveying device (332) and a waste paper discharging device (333); and the waste paper discharging device (333) extends out between the first cup bottom heating station (37) and the second cup bottom heating station (38).

7. The servo motor-based paper cup forming machine according to claim 1, wherein the paper suction and feeding mechanism (1) comprises a suction device (11) configured to suck out a paper sheet and a pushing device (12) configured to push out the paper sheet; a side of the pushing device (12) is provided with a paper sheet heating device (13); the paper tube forming mechanism (2) comprises a clamping device (21), an ultrasonic welding device (22), and a paper tube transfer device (23) configured to pick up the paper tube; and the paper tube transfer device (23) is connected to the paper tube loading station (31) via a paper tube loading manipulator (311). 5 10

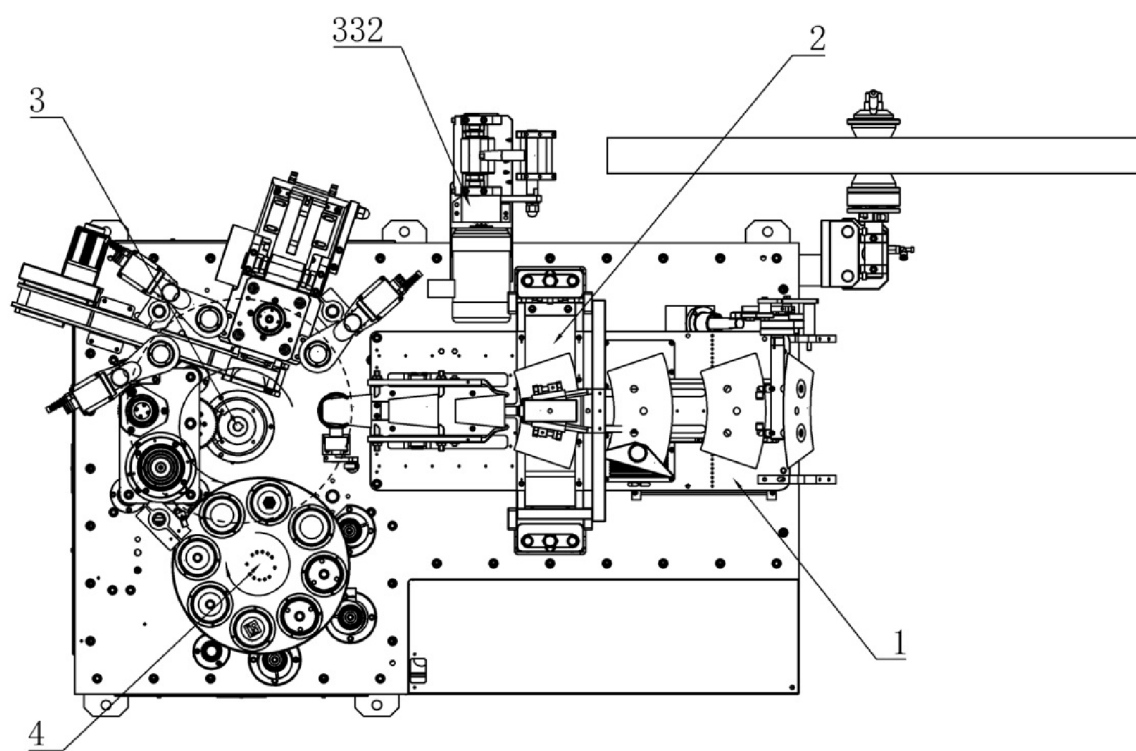
8. The servo motor-based paper cup forming machine according to claim 1, wherein the servo motors are respectively disposed on the cup bottom forming turntable (3) and the cup rim forming turntable (4); a main power source and three parallel transmission shafts connected to the main power source are disposed below the machine frame; and each of the paper suction and feeding mechanism (1), the paper tube forming mechanism (2), the cup bottom forming turntable (3), and the cup rim forming turntable (4) comprises a device in transmission connection with the transmission shafts. 15 20 25

9. The servo motor-based paper cup forming machine according to claim 1 or 5, wherein each of the paper tube bottom preheating station (32), the first cup bottom heating station (37), and the second cup bottom heating station (38) is correspondingly provided with a cup bottom hot-air device (5); the cup bottom hot-air device (5) comprises a heating mantle (51) and a hot air generating device (52); a cavity (511) for allowing the cup bottom to enter is formed in the heating mantle (51); a bottom of the cavity (511) is provided with a hot air head (53); a bottom of the hot air head (53) is fixedly connected to a hot air guide tube (54); the hot air generating device (52) comprises an air outlet tube (521); an outlet end of the air outlet tube (521) communicates with the hot air guide tube (54); and the hot air guide tube (54) moves up and down relative to the hot air generating device (52), so as to adjust a size of an air passage communicating between the air outlet tube (521) and the hot air guide tube (54). 30 35 40 45

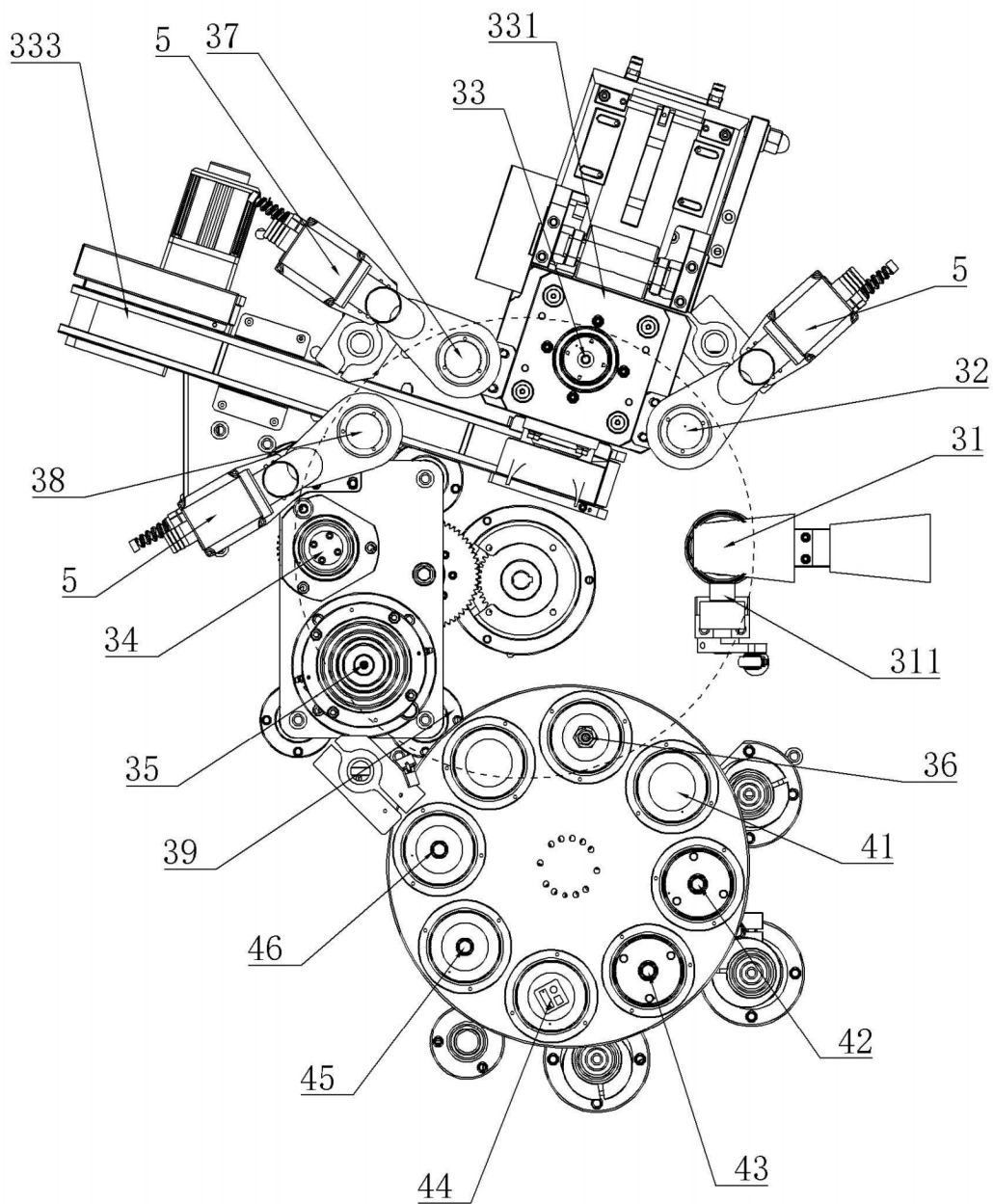
10. The servo motor-based paper cup forming machine according to claim 9, wherein an adjustment seat (55) is fixedly mounted on an outlet end of the hot air generating device (52); the hot air guide tube (54) is slidably disposed in the adjustment seat (55); a sealed chamber is formed in the adjustment seat (55); the chamber communicates with the hot air guide tube (54) and the hot air generating device (52); an adjusting valve (522) is disposed at the air outlet tube (521) of the hot air generating device (52); 50 55

the hot air guide tube (54) is connected to the adjusting valve (522); and the hot air guide tube (54) moves up and down to drive the adjusting valve (522) to move, thereby changing an opening degree of the adjusting valve (522).

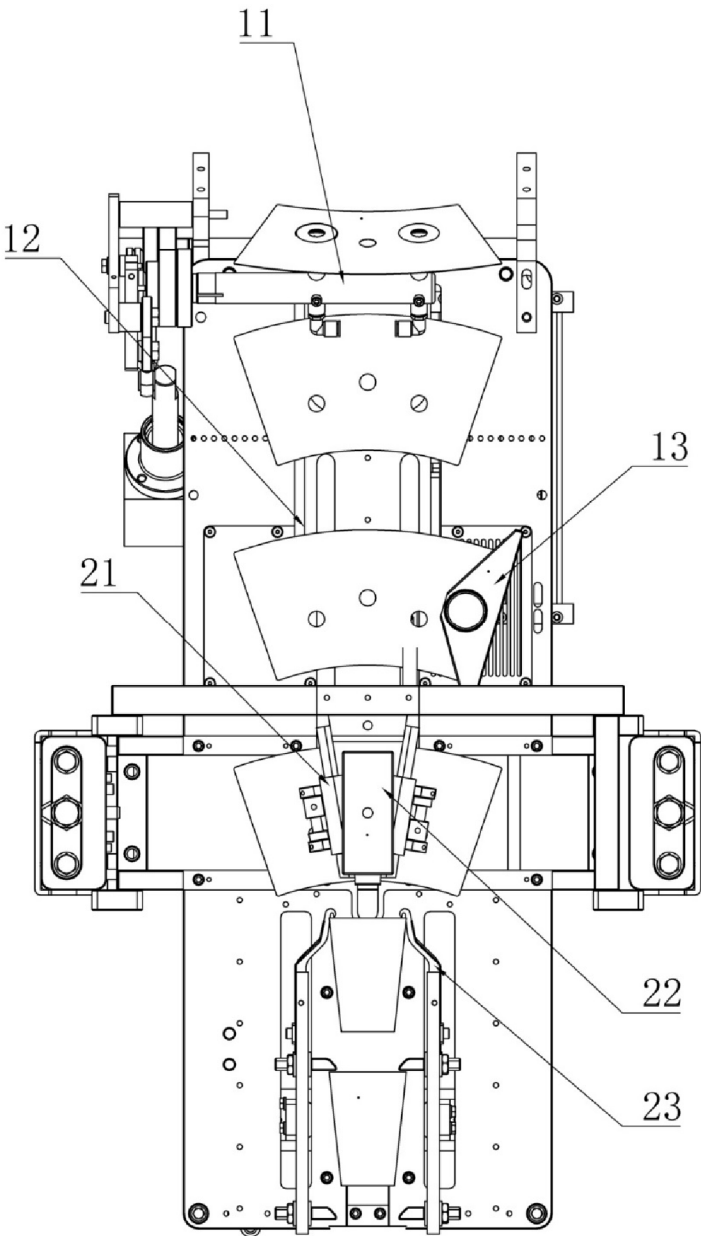
[FIG. 1]



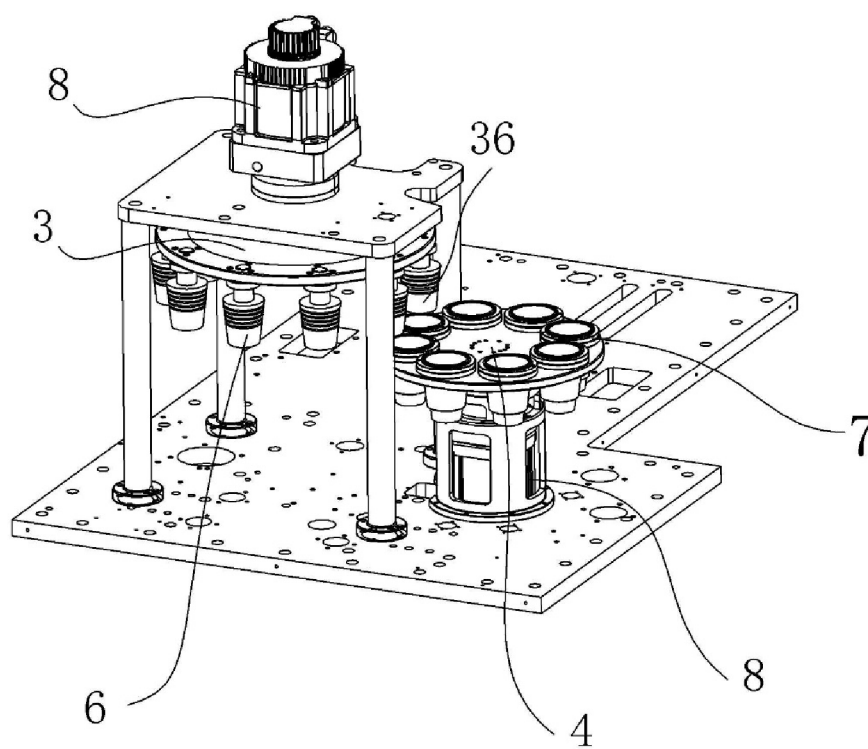
[FIG. 2]



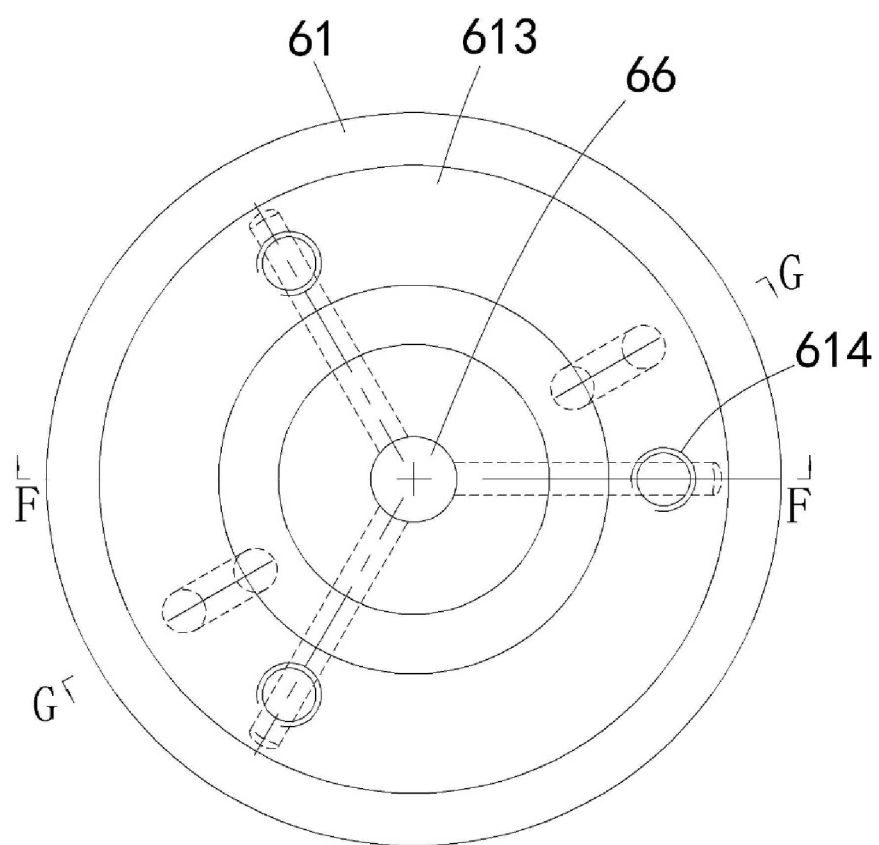
[FIG. 3]



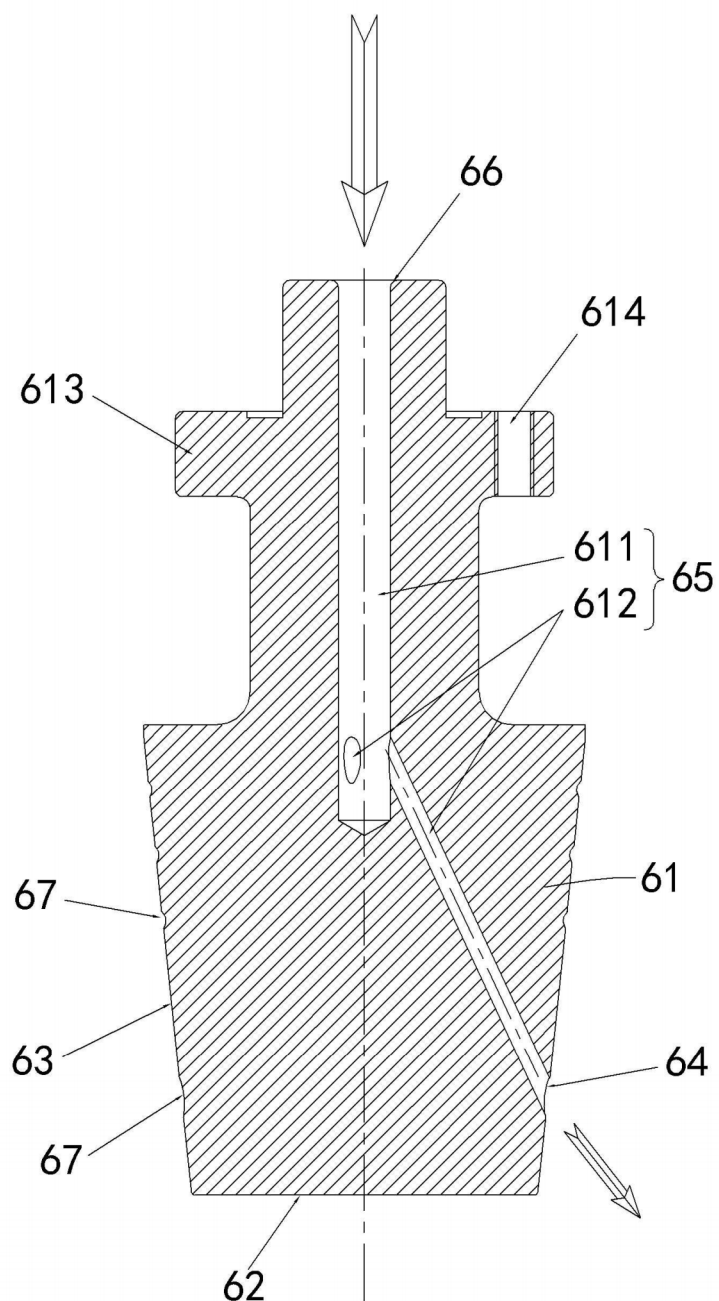
[FIG. 4]



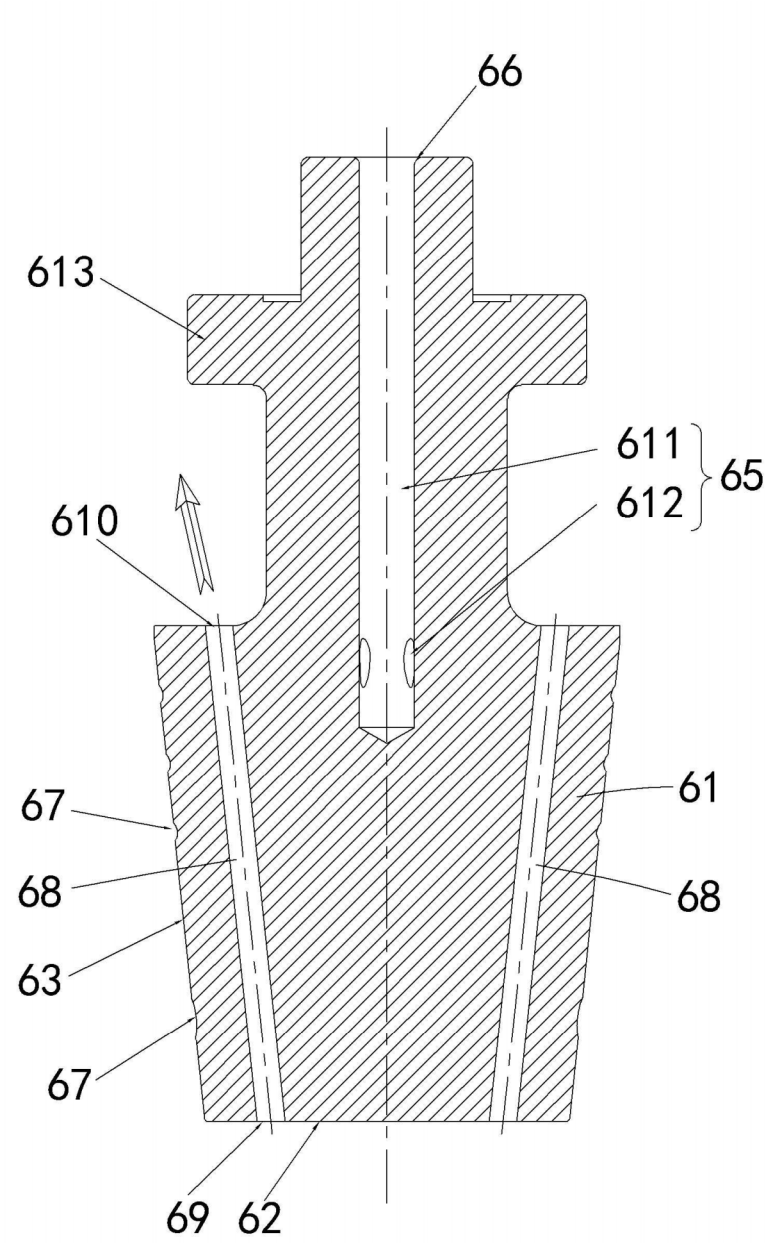
[FIG. 5]



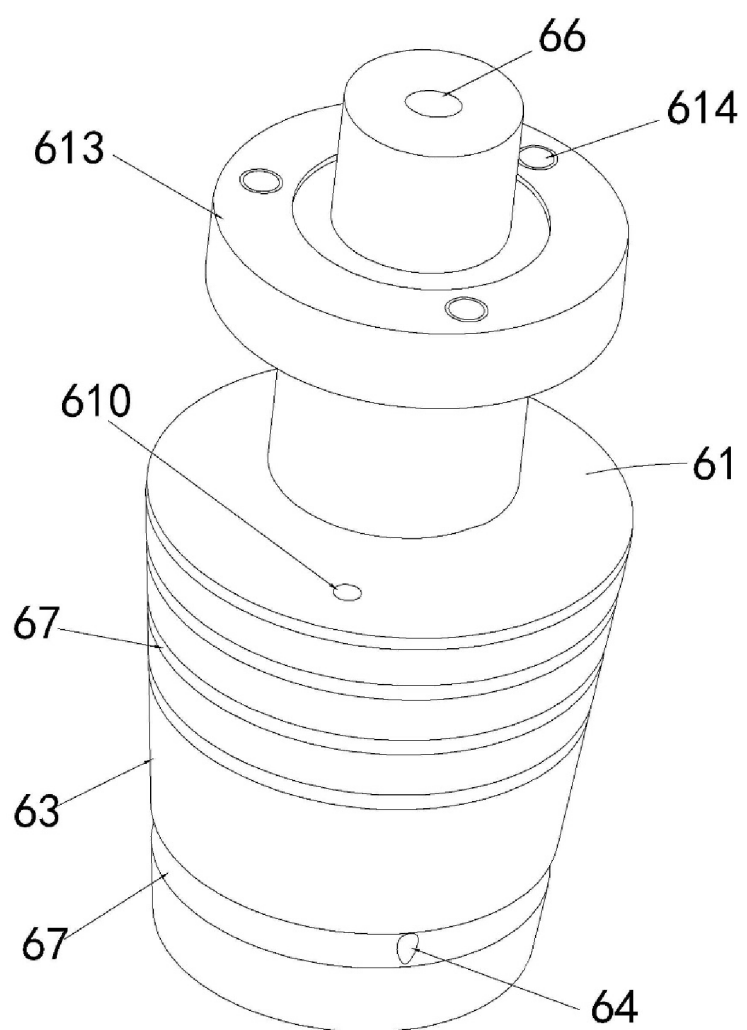
[FIG. 6]



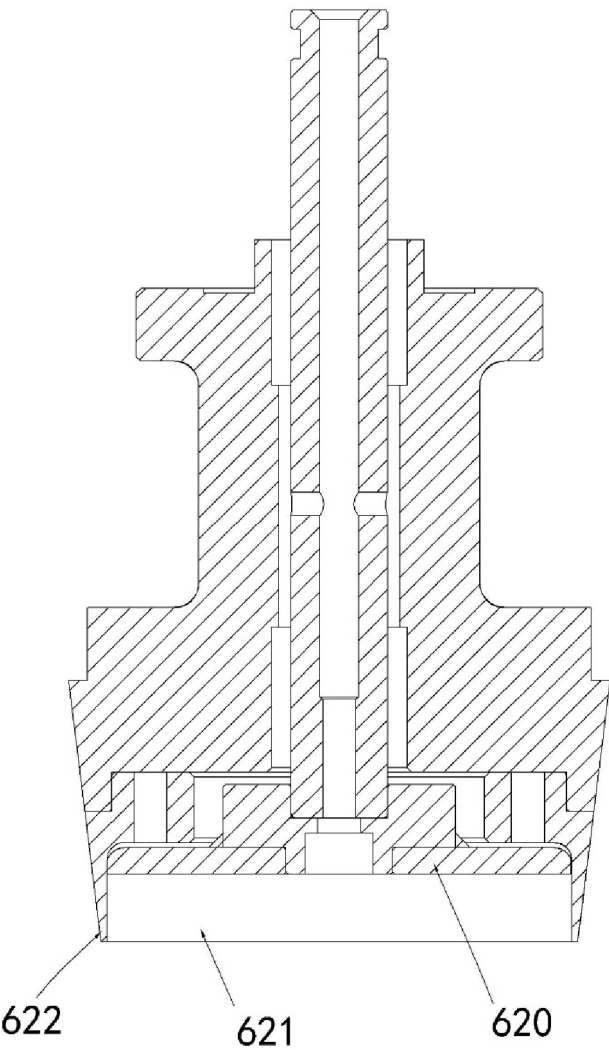
[FIG. 7]



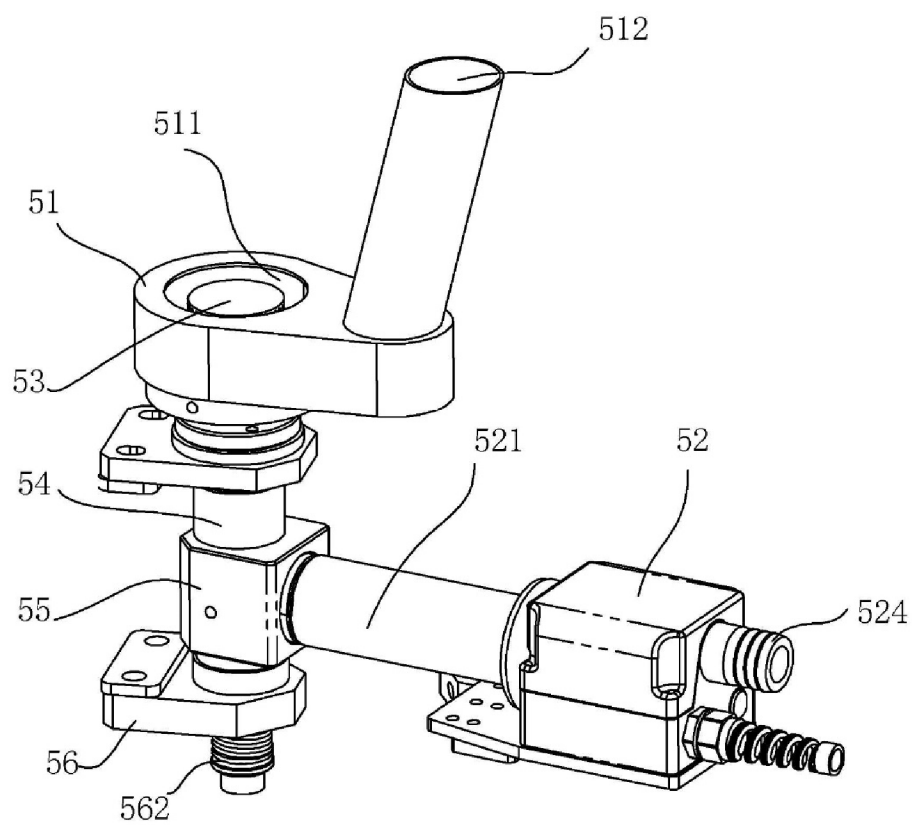
[FIG. 8]



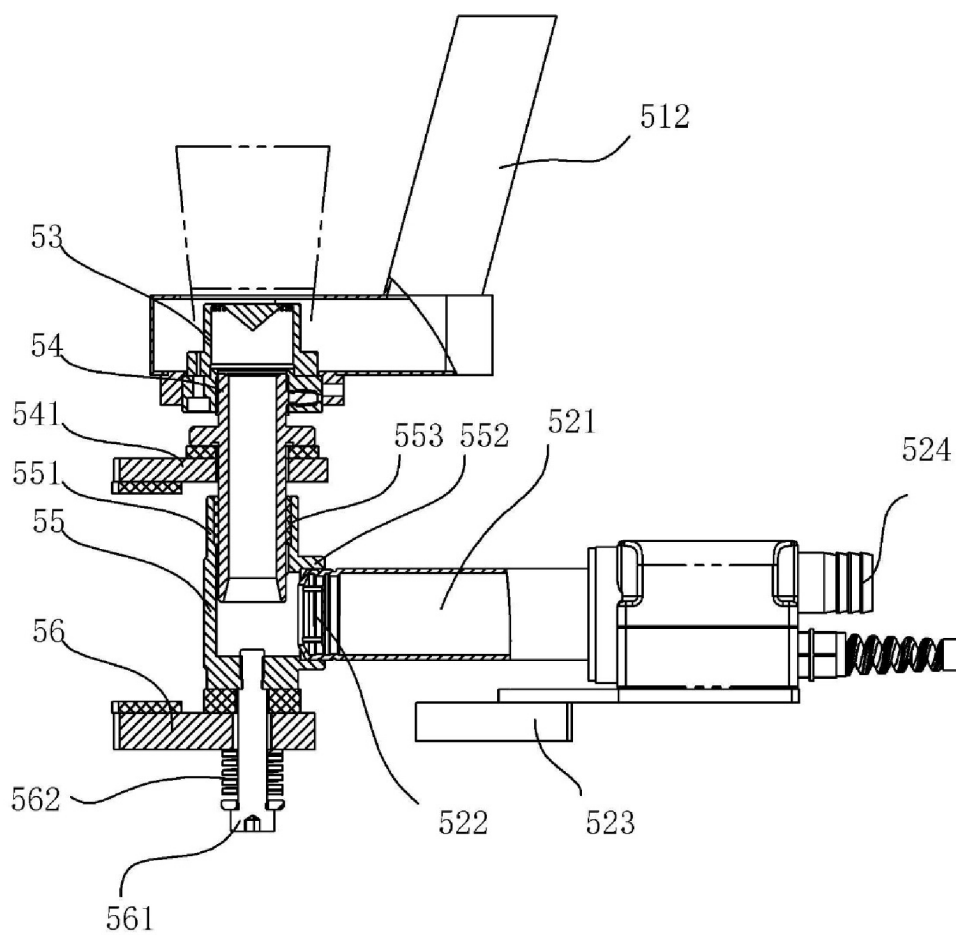
[FIG. 9]



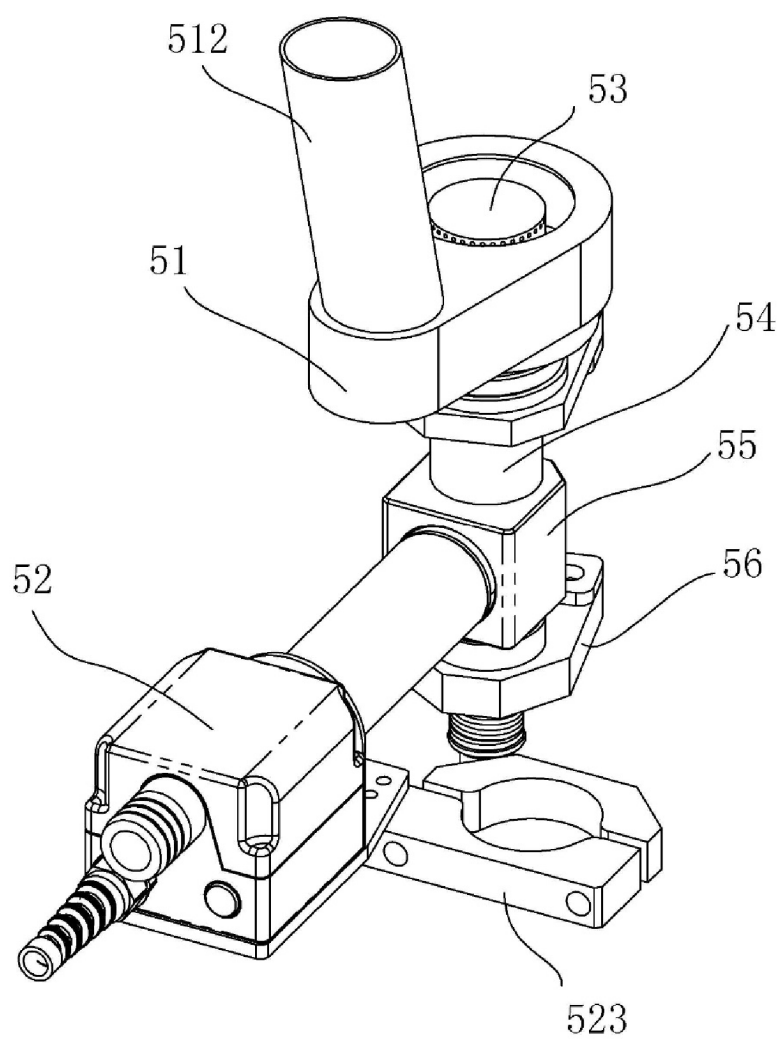
[FIG. 10]



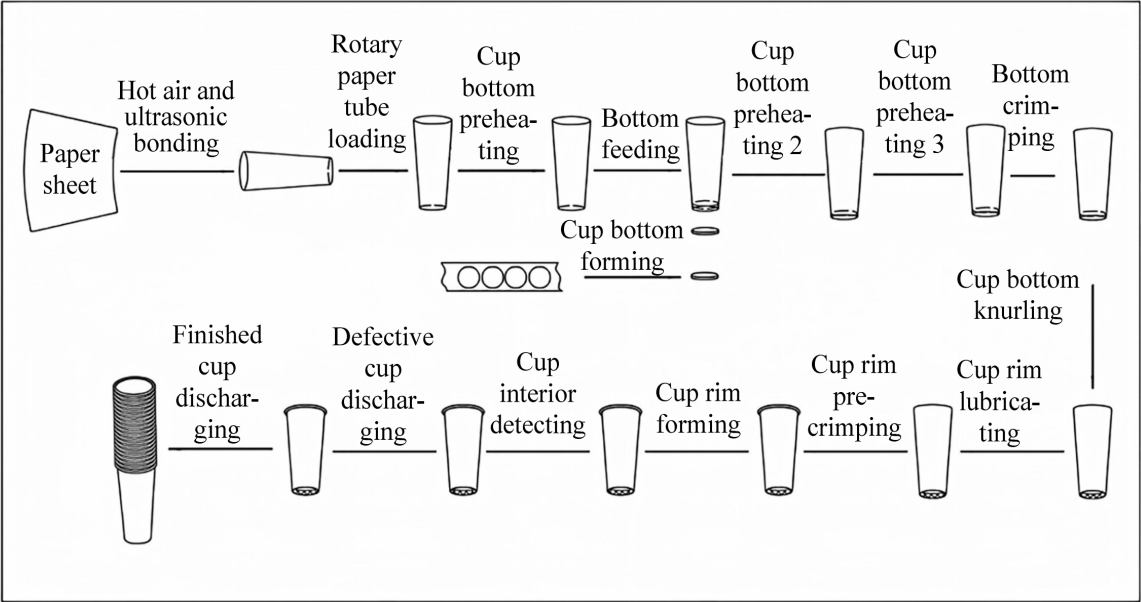
[FIG. 11]



[FIG. 12]



[FIG. 13]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/105229

A. CLASSIFICATION OF SUBJECT MATTER

B31B50/00(2017.01)i; B31B50/04(2017.01)i; B31B50/07(2017.01)i; B31B50/74(2017.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:B31B

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

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

CNTXT, CNABS, DWPI, WPABS, VEN, CNKI, CJFD: 纸杯, 杯子, 输送, 成型, 转盘, 分度盘, 滚花, 加热, 换位, 模具, paper, cup, convey+, form+, turntable, divid+, plate, knurl+, heat+, transposition, mold

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 117754914 A (ZHEJIANG NEW DEBAO MACHINERY CO., LTD.) 26 March 2024 (2024-03-26) see claims 1-10	1-10
X	CN 101181826 A (DAI DAOJIN) 21 May 2008 (2008-05-21) see description, pages 6-9, and figures 1-6	1
A	CN 106142677 A (ZHEJIANG NEW DEBAO MACHINERY CO., LTD.) 23 November 2016 (2016-11-23) see entire document	1-10
A	KR 101801005 B1 (IM JANG SU) 24 November 2017 (2017-11-24) see entire document	1-10
A	WO 2022161044 A1 (ZHEJIANG DISCOVER MACHINERY MANUFACTURING CO., LTD.) 04 August 2022 (2022-08-04) see entire document	1-10

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"D" document cited by the applicant in the international application	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 08 October 2024	Date of mailing of the international search report 20 October 2024
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2024/105229

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN	117754914	A	26 March 2024	None	
CN	101181826	A	21 May 2008	None	
CN	106142677	A	23 November 2016	None	
KR	101801005	B1	24 November 2017	None	
WO	2022161044	A1	04 August 2022	None	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 100577404 C [0002]