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(71) Applicants:
- **Hefei Midea Refrigerator Co., Ltd.**
  Hefei, Anhui 230088 (CN)
- **Hefei Hualing Co., Ltd.**
  Hefei, Anhui 230601 (CN)
- **Midea Group Co., Ltd.**
  Foshan, Guangdong 528311 (CN)

(72) Inventors:
- **LIU, Xiaojun**
  Hefei, Anhui 230088 (CN)
- **CHEN, Xiaohua**
  Hefei, Anhui 230088 (CN)
- **ZHANG, Rucun**
  Hefei, Anhui 230088 (CN)
- **JIA, Li**
  Hefei, Anhui 230088 (CN)

(74) Representative: **RGTH**
Patentanwälte PartGmbB
Neuer Wall 10
20354 Hamburg (DE)

(54) **METHOD FOR FORMING AIR RETURN PIPE, FORMING DIE AND AIR RETURN PIPE**

(57) A method for forming an air return pipe, comprising: controlling a blank (26) to enter a forming cavity, controlling a die core (23) to press the blank (26) such that the blank (26) passes through a first die body (21), and obtaining a first length value of a first formed pipe section formed by the first die body (21); determining that the first length value reaches a first set parameter value, controlling a second die body (22) to press part of the first formed pipe section such that the part of the first formed pipe section is formed into a second formed pipe section, and obtaining a second length value of the second formed pipe section; determining that the second length value reaches a second set parameter value, and controlling the second die body (22) to stop pressing; and controlling a third formed pipe section formed by the first die body (21) to reach a third set parameter value. A forming die (20), comprising the die core (23), the first die body (21) and the second die body (22), wherein the forming cavity is formed between the die core (23) and the first die body (21), the second die body (22) is arranged on one side of a discharge end of the first die body (21) and is provided with a protrusion (223) facing a center of the second die body (22). An air return pipe (10), comprising a first pipe section (11), a second pipe section (12) and a third pipe section (14) which are formed by pressing, wherein the second pipe section (12) is located between the first pipe section (11) and the third pipe section (14), the second pipe section (12) is provided with an accommodation portion, and the accommodation portion is recessed towards a center of the second pipe section (12) and extends in an axial direction of the second pipe section (12). The plurality of pipe sections having different cross-sectional shapes are continuously pressed, so that the plurality of pipe sections are integrally formed, thereby eliminating welding spots between every two adjacent pipe sections, and reducing the leakage risk of the air return pipe.

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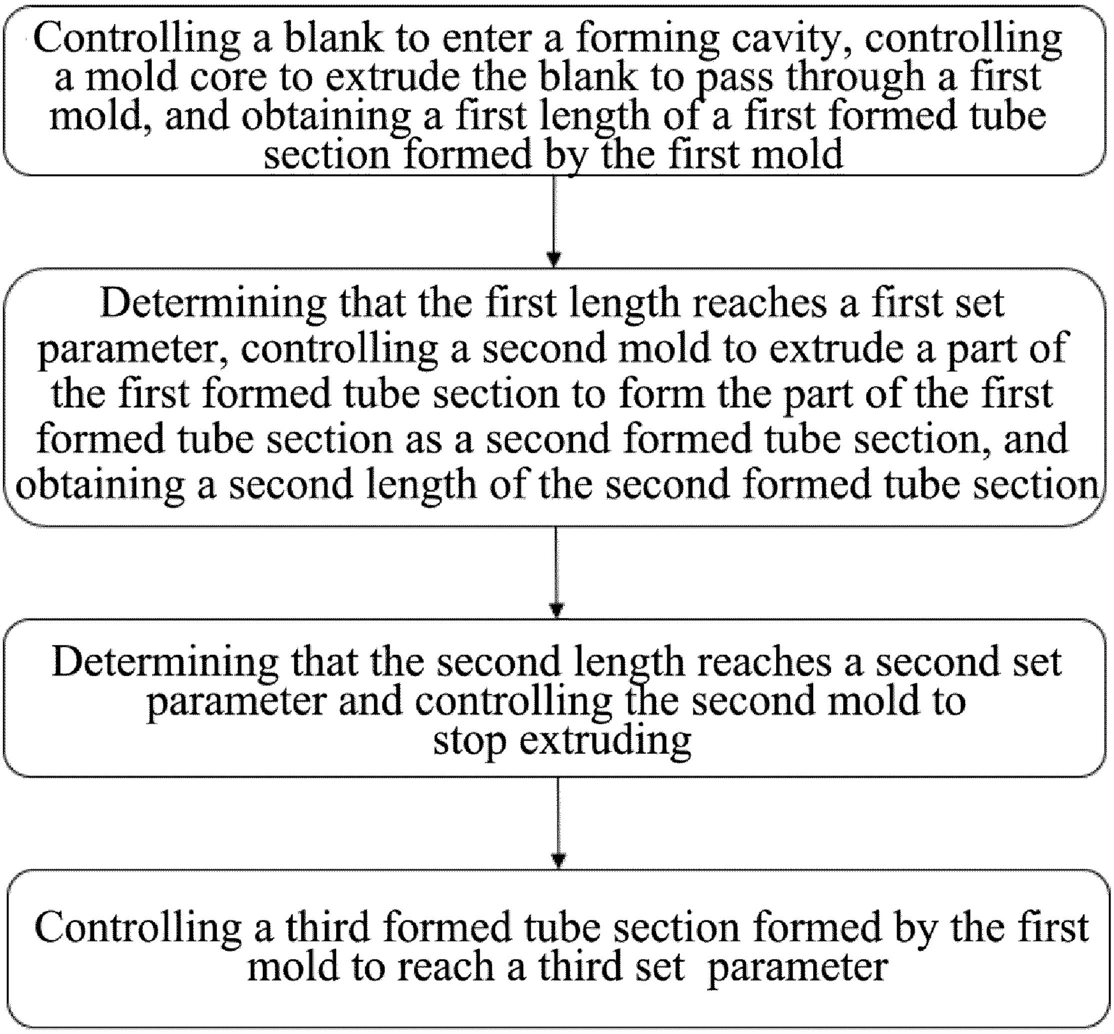
Controlling a blank to enter a forming cavity, controlling a mold core to extrude the blank to pass through a first mold, and obtaining a first length of a first formed tube section formed by the first mold
Determining that the first length reaches a first set parameter, controlling a second mold to extrude a part of the first formed tube section to form the part of the first formed tube section as a second formed tube section, and obtaining a second length of the second formed tube section
Determining that the second length reaches a second set parameter and controlling the second mold to stop extruding
Controlling a third formed tube section formed by the first mold to reach a third set parameter

FIG. 1

Description

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] The present application claims priority to Chinese patent application No. 202210424814.2 filed on April 21, 2022, entitled "Method for Forming Air Return Pipe, Forming Die and Air Return Pipe", which is hereby incorporated by reference in its entirety.

FIELD

[0002] The present application relates to the field of refrigeration equipment, and in particular, to a method for forming air return tube, a forming mold, and an air return tube.

BACKGROUND

[0003] Heat exchange tubes used in refrigeration equipment comprise generally an air return tube and a capillary tube. The air return tube has a circular cross-section and is fixed to the capillary tube for exchanging heat through aluminum foil and a heat shrink tube, etc. The heat exchange efficiency is low since the air return tube is in linear contact with the capillary tube.

[0004] To improve heat exchange efficiency, the capillary tube is embedded in the air return tube to enhance the heat exchange efficiency. In the related art, connection tubes with circular cross-sections are added at both ends of the air return tube, and the air return tube is connected to an evaporator and a compressor through the connection tube.

[0005] Although connection tubes are added at both ends of the air return tube to connect the air return tube to the evaporator and the compressor, leakage may easily occur at a weld joint between the connection tube and the air return tube, which increases a leakage risk of the air return tube in a foam layer of the refrigeration equipment, and affects the reliability of the refrigeration equipment.

BRIEF SUMMARY

[0006] The present application aims to solve at least one of the problems in the related art. The present application provides a method for forming an air return tube. Air return tubes with different cross-sectional shapes may be formed through continuously extruding and have good cross-sectional consistency, and the heat exchange and connection requirements of the air return tube are satisfied.

[0007] The present application provides a forming mold.

[0008] The present application provides an air return tube.

[0009] According to the embodiments of the present application, the method for forming air return tube comprises:

> controlling a blank to enter a forming cavity, controlling a mold core to extrude the blank to pass through a first mold, and obtaining a first length of a first formed tube section formed by the first mold;
>
> determining that the first length reaches a first set parameter, controlling a second mold to extrude a part of the first formed tube section to form the part of the first formed tube section as a second formed tube section, and obtaining a second length of the second formed tube section;
>
> determining that the second length reaches a second set parameter, and controlling the second mold to stop extruding; and
>
> controlling a third formed tube section formed by the first mold to reach a third set parameter;
>
> where a cross-sectional shape of the first mold is different from a cross-sectional shape of the second mold.

[0010] In the method for forming air return tube according to the embodiment of the present application, a plurality of tube sections with different cross-sectional shapes may be continuously extruded through the method to form a plurality of tube sections integrally, which eliminates the weld joint between adjacent tube sections, reduces the leakage risk of the air return tube, ensures the consistency of the cross-section of the air return tube, and satisfies the heat exchange and connection requirements of the air return tube.

[0011] The forming mold according to the present application is used to perform the method for forming the air return tube described above, and the forming mold comprises a mold core, a first mold and a second mold, where a forming cavity is formed between the mold core and the first mold; and
the second mold is provided at a side of a discharge end of the first mold, the second mold comprises a first sub-mold and a second sub-mold provided at a side of the first sub-mold, the first sub-mold or the second sub-mold is provided with a protrusion, and the protrusion faces a center of the second mold.

[0012] According to the embodiments of the present application, the forming mold may continuously extrude to form the air return tube with different cross-sectional shapes, which meets the production requirements for continuous extrusion of air return tubes. The formed air return tube has stable dimensions and good cross-sectional consistency, and the forming procedure is simple and convenient to operate.

[0013] The air return tube according to the present application comprises a first tube section, a second tube section, and a third tube section formed by extrusion forming, where the second tube section is located between the first tube section and the third tube section, and the second tube section is provided with a receiver, where the receiver is recessed towards a center direction of the second tube section and extends along an axial direction of the second tube section.

[0014] According to the air return tube in the present application, the first tube section, the second tube section, and the third tube section are integrally formed, and the second tube section is provided with a receiver, which not only increases a contact area between the air return tube and a capillary tube, improves heat exchange efficiency, but also facilitates the connection of the air return tube, eliminates the weld joint between adjacent formed tube sections, and reduces the leakage risk of the air return tube.

[0015] Additional aspects and advantages of the present application will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the present application.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] To illustrate the solutions in the embodiments of the present application more clearly, the drawings used in the description of the embodiments are briefly described below. The drawings in the following description are only some embodiments of the present application, and other drawings may be obtained based on these drawings without any creative effort for those skilled in the art.

FIG. 1 is a schematic flowchart of a method for forming an air return tube according to an embodiment of the present application;

FIG. 2 is a schematic flowchart of a method for forming an air return tube according to an embodiment of the present application;

FIG. 3 is a first sectional view of a forming mold according to an embodiment of the present application;

FIG. 4 is a view from direction A in FIG. 3;

FIG. 5 is a second sectional view of a forming mold according to an embodiment of the present application;

FIG. 6 is a view from the direction B in FIG. 5;

FIG. 7 is a first schematic forming diagram of a method for forming an air return tube according to an embodiment of the present application;

FIG. 8 is a second schematic forming diagram of a method for forming an air return tube according to an embodiment of the present application; and

FIG. 9 is a schematic structural diagram of an air return tube according to an embodiment of the present application.

Reference numerals:

[0017]

10: air return tube; 11: first tube section; 12: second tube section; 13: gradually-varied tube section; 14: third tube section;

20: forming mold; 21: first mold; 211: first sub-mold; 212: second sub-mold; 213: first mold cavity; 22: second mold; 221: third sub-mold; 222: fourth sub-mold; 223: protrusion; 224: second mold cavity; 23: mold core; 231: form portion; 232: recess; 24: drive mechanism; 25: drive assembly; 26: blank.

DETAILED DESCRIPTION

[0018] Implementations of the present application are further described in detail below with reference to the drawings and embodiments. The following embodiments are used to illustrate the present application, but are not to limit the scope of the present application.

[0019] In the description of the present application, it should be noted that, the orientation or positional relations specified by terms such as "central", "longitudinal", "lateral", "up", "down", "front", "back", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", "outer" and the like, are based on the orientation or positional relations shown in the drawings, which is merely for convenience of description of the present application and to simplify description, but does not indicate or imply that the stated devices or components must have a particular orientation and be constructed and operated in a particular orientation, and thus it is not to be construed as limiting the present application. Furthermore, the terms "first", "second", "third" and the like are only used for descriptive purposes and should not be construed as indicating or implying a relative importance.

[0020] In the description of the present application, it should be noted that unless explicitly specified and defined otherwise, the terms "connected to" and "connected" shall be understood broadly, for example, it may be either fixedly connected or detachably connected, or can be integrated; it may be either mechanically connected, or electrically connected; it may be either directly connected, or indirectly connected through an intermediate medium. The specific meanings of the terms above in the present application can be understood by a person skilled in the art in accordance with specific conditions.

[0021] In the embodiments of the present application, unless otherwise expressly specified and defined, a first feature is "on" or "under" a second feature can refer to that the first feature is directly contacted with the second feature, or the first feature is indirectly contacted with the second feature through an intermediate medium. In addition, the first feature is "on", "above" and "over" the second feature can refer to that the first feature is directly above or obliquely above the second feature, or simply refer to that the level height of the first feature is higher than that of the second feature. A first feature is "under", "below" and "beneath" a second feature can refer to that the first feature is directly below or obliquely below the second feature, or simply refer to that the level height of the first feature is lower than that of the second feature.

[0022] In the description of this specification, description with reference to the terms "an embodiment", "some embodiments", "an example", "specific example", "some examples" and the like, refers to that specific features, structures, materials or characteristics described in combination with an embodiment or an example are comprised in at least an embodiment or example according to the embodiments of the present application. In this specification, schematic representations of the above terms are not necessarily directed to a same embodiment or example. Furthermore, the particular features, structures, materials or characteristics described can be combined in any suitable manner in any one or more embodiments or examples. In addition, those skilled in the art may combine the different embodiments or examples described in this specification, as well as the features of the different embodiments or examples, without conflicting each other.

[0023] The numbering of the parts in the embodiment of the present application itself, such as "first", "second", (1), (2), (3), step one, step two, etc. are only used to distinguish the described objects and do not have any order or technical meaning. Unless otherwise specified, "a plurality of" refers to two or more. The terms "comprising", "containing", "having", "with", etc. used in the embodiments of the present application are all open-ended terms, meaning they comprise but are not limited to. In the embodiments of the present application, the term "and/or" describes a related relationship of associated objects, and indicates that there may be three kinds of relationships. For example, A and/or B may represent that A exists alone, A and B exist simultaneously, and B exists alone. In the embodiments of the present application, expressions such as "exemplary" or "for example" are used to indicate examples, illustrations, or explanations. Any embodiments or design schemes described as "exemplary" or "for example" in the present application should not be interpreted as being more preferred or advantageous than other embodiments or design schemes. In an embodiment, the use of words such as "exemplary" or "for example" is intended to present relevant concepts in a concrete way. Unless otherwise defined, all technical and scientific terms used in the embodiments of the present application have the same meanings as those commonly understood by those skilled in the art belonging to the present application. If there is any inconsistency, the meaning stated in the present application or the meaning derived from the content recorded in the present application shall prevail.

[0024] Referring to FIG. 3 to FIG. 6 in detail, the present application provides a forming mold, comprising a mold core 23, a first mold 21, and a second mold 22, where a forming cavity is formed between the mold core 23 and the first mold 21.

[0025] As shown in FIG. 4 and FIG. 6, to conveniently manufacture the first mold 21, the first mold 21 may be provided as a split structure, that is, the first mold 21 comprises a first sub-mold 211 and a second sub-mold 212, and the first sub-mold 211 and the second sub-mold 212 are used for an initial extrusion forming of a tube body after being closed.

[0026] The second mold 22 is located at a side of a discharge end of the first mold 21. The second mold 22 comprises a third sub-mold 221 and a fourth sub-mold 222 located at a side of the third sub-mold 221. The third sub-mold 221 or the fourth sub-mold 222 is provided with a protrusion 223, where the protrusion 223 faces a center of the second mold 22, and after the third sub-mold 221 and the fourth sub-mold 222 are closed, at least one recess may be formed on a surface of the tube body extruded by the second mold 22.

[0027] The first mold 21 is used to form the tube body of an entire air return tube 10, and the second mold 22 is provided at a rear end of the first mold 21, that is, the second mold 22 is located at a side from which the formed tube section formed by the first mold 21 extends. On a whole tube body formed by the first mold 21, a recess, that is, a special-shaped cross-section structure, is formed at a local part of the tube body which is equivalent to that forming is performed by the second mold 22 again on the basis of the first mold 21.

[0028] In some embodiments of the present application, as shown in FIG. 4 and FIG. 6, a side of the second mold 22 facing the blank 26 is provided with the protrusion 223. In an embodiment, the protrusion 223 may be formed at the third sub-mold 221 or the fourth sub-mold 222, that is, one of the third sub-mold 221 or the fourth sub-mold 222towards the center of the second mold 22 corresponding to a recessed structure is provided with the protrusion 223.

[0029] When the protrusion 223 is provided at the third sub-mold 221, a drive mechanism 24 is correspondingly connected to the third sub-mold 221; when the protrusion 223 is provided at the fourth sub-mold 222, the drive mechanism 24 is correspondingly connected to the fourth sub-mold 222. When the protrusion 223 is provided at both the third sub-mold 221 and the fourth sub-mold 222, the drive mechanism 24 is connected to the third sub-mold 221 and the fourth sub-mold 222, respectively.

[0030] In some embodiments of the present application, the drive mechanism 24 may comprise a cylinder and connection pipeline, or the drive mechanism 24 comprises an oil cylinder and connection pipeline, etc.

The drive mechanism 24 may be any driver capable of performing a linear reciprocating movement to close the third sub-mold 221 and the fourth sub-mold 222, and separate the third sub-mold 221 from the fourth sub-mold 222.

[0031] In some preferred embodiments of the present application, the drive mechanism 24 and the protrusion 223 are provided at a same part, that is, the drive mechanism 24 is connected to the third sub-mold 221. Under an action of the drive mechanism 24, the third sub-mold 221 may move relative to the fourth sub-mold 222 and is switchable between a first position W1 and a second position W2.

[0032] At the first position W1, as shown in FIG. 6, the third sub-mold 221 and the fourth sub-mold 222 are closed, that is, the third sub-mold 221 moves downwards relative to the fourth sub-mold 222 to a location of the fourth sub-mold 222. The blank 26 is extruded by the first mold 21 to form a circular cross-section tube body, and then extruded by the second mold 22 to form a receiver for embedding a capillary tube, that is, a second formed tube section with a special-shaped cross-section. The first mold 21 and the second mold 22 may cooperate with the extrusion equipment to continuously extrude the circular cross-section tube section and the special-shaped section tube section.

[0033] At the second position W2, as shown in FIG. 4, the third sub-mold 221 is separated from the fourth sub-mold 222, that is, the third sub-mold 221 moves upwards relative to the fourth sub-mold 222 to a set distance, which may be an interval value, as long as the third sub-mold 221 does not interfere with the blank 26 to be extruded into a circular cross-section tube body. The set distance may also be a fixed value, at which the third sub-mold 221 does not interfere with the blank 26 to be extruded into a circular cross-section tube body.

[0034] The blank 26 is extruded by the first mold 21 to form a circular cross-section tube body, and the fourth sub-mold 222 in the second mold 22 is only used for supporting. The first mold 21 and the second mold 22 cooperate with the extrusion equipment to extrude the circular cross-section tube section, which is equivalent to that the second mold 22 retains a tube body structure formed by the first mold 21.

[0035] During the process of switching from the second position W2 to the first position W1, the drive mechanism 24 controls the third sub-mold 221 to gradually approach the fourth sub-mold 222, to form a gradually-varied tube section 13 connecting two tube sections with different cross-sectional shapes on the air return tube 10.

[0036] As shown in FIG. 7 and FIG. 8, as some embodiments of the present application, at least one of a first position sensor, a second position sensor and a third position sensor is provided at intervals at a rear end of the forming mold 20. That is, the first position sensor, the second position sensor and the third position sensor are provided at intervals on a side of the second mold 22 away from the first mode 21, and the second position sensor may be provided between the first position sensor and the third position sensor.

[0037] The first position sensor is used to detect that a start end of the air return tube 10 arrives at a first preset position, and output a signal to a control system for controlling the second mold 22 to approach the blank 26 and start extrusion.

[0038] That is, as shown in FIG. 8 and FIG. 9, the first position sensor is provided at a corresponding position of the first set parameter L1 along a delivery path of the air return tube 10 at a side at which the forming mold 20 extends out based on a length design requirement of the air return tube 10. When the start end of the air return tube 10 arrives at the position where the first position sensor is located, it indicates that a length of the circular cross-section tube section meets the requirement of the first set parameter L1. The first position sensor transmits a signal to the control system. After receiving the signal, the control system controls the second mold 22 gradually approach the blank 26 until the blank 26 is extruded to form a special-shaped section tube section.

[0039] The second position sensor is used to detect that the start end of the air return tube 10 arrives at a second preset position, and output a signal to the control system for controlling the second mold 22 to move away from the blank 26 and stop the extrusion.

[0040] That is, the second position sensor is provided at a corresponding position of a second set parameter L2 along the delivery path of the air return tube 10 at downstream of the first position sensor based on the length design requirement of the air return tube 10. When the start end of the air return tube 10 arrives at the position where the second position sensor is located, it indicates that the length of the special-shaped section tube section meets the requirement of the second set parameter L2. The second position sensor transmits a signal to the control system. After receiving the signal, the control system controls the second mold 22to gradually move away from the blank 26.

[0041] The third position sensor is used to detect that the start end of the air return tube 10 arrives at a third preset position, and one cycle of forming the air return tube 10 is completed. It is equivalent to that a stop end of the air return tube 10 is located at the first preset position.

[0042] That is, the third position sensor is provided at a corresponding position of the third set parameter L3 along the delivery path of the air return tube 10 based on the length design requirement of the air return tube 10. When the start end of the air return tube 10 arrives at a position where the third position sensor is located, it indicates that the length of the circular cross-section tube section meets the requirement of the third set parameter L3. The third position sensor transmits a signal to the control system and one cycle of forming of the air return tube 10 is completed.

[0043] In some embodiments of the present application, the first mold 21 may also be an integral structure, and the first mold 21 is provided at the extrusion equipment. An ingot is divided into several metal streams by the pressure action in the extrusion equipment (which may be a metal extruder), enters a weld chamber through a division hole, gathers in the weld chamber, and is welded again under an environment of high temperature, high pressure and high vacuum, and finally flows out through a gap between the first mold 21 and the mold core 23 to extrude to form a tube body with a circular cross-section.

[0044] In some embodiments of the present application, as shown in FIG. 4 and FIG. 6, to improve the forming accuracy of the special-shaped section tube section, the mold core 23 is connected with a drive assembly 25. The drive assembly 25 is used to drive the mold core 23 to translate, and a part of the mold core 23 enters a second mold cavity 224. The mold core 23 is provided with a form portion 231 and a recess 232. The form portion 231 matches with the first mold 21 to extrude to form a tube section with a circular cross-section, and the recess 232 is nested and matched with the protrusion 223 on the second mold 22, the recessed precision of extrusion molding is higher and it is easier to assemble with the capillary tube.

[0045] As shown in FIG. 4 and FIG. 6, an inlet of the first mold cavity 213 has a shape of a unicode U+516B, which may guide the blank 26 to flow into the gap between the first mold 21 and the mold core 23.

[0046] During the use of the forming mold 20 for the air return tube 10 provided in the embodiments of the present application, the drive mechanism 24 is controlled by a main program of the extrusion equipment. When the length of the circular cross-section tube section extruded by the first mold 21 is determined, the drive mechanism 24 drives the third sub-mold 221 to move downwards and be closed with the fourth sub-mold 222 to extrude the circular cross-section tube section extruded by the first mold 21, to form a recess at part of the extruded tube section. After the length of the recess is determined, the drive mechanism 24 drives the third sub-mold 221 to move upwards and separate from the fourth sub-mold 222, to maintain the circular cross-section tube section extruded by the first mold 21.

[0047] In some embodiments of the present application, a fourth position sensor and a fifth position sensor are provided at a movement path of the drive mechanism 24.

[0048] The fourth position sensor is used to detect the drive mechanism 24, to determine that the third sub-mold 221 is located at a position where it is closed with the fourth sub-mold 222, ensure that the drive mechanism 24 drives the third sub-mold 221 to move in place and avoiding the defective formation of recessed structures.

[0049] The fifth position sensor is used to detect the drive mechanism 24, and determine that the third sub-mold 221 is located at a position separated from the fourth sub-mold 222, with a set distance between it and the fourth sub-mold 222, ensure that the third sub-mold 221 leaves the stop end of the second formed tube section.

[0050] In some embodiments of the present application, the first position sensor, the second position sensor, the third position sensor, the fourth position sensor, and the fifth position sensor mentioned above may all comprise contact sensors and proximity sensors.

[0051] The contact sensor comprises micro switches. When the formed tube section touches the micro switch during the movement, the internal contact in the micro switch moves and outputs a signal.

[0052] The proximity sensor comprises an electromagnetic sensor, a photoelectric sensor, a differential transformer sensor, an eddy current sensor, a capacitive sensor, a reed switch sensor, a Hall sensor, etc. In a preferred embodiment, a photoelectric sensor is used, and the photoelectric sensor may output a signal when the start end of each formed tube section approaches the set distance from the photoelectric sensor.

[0053] According to the embodiment of the present application, the forming mold 20 may continuously extrude to form the air return tube 10 with different cross-sectional shapes, meeting the production requirement for continuous extrusion of the air return tube 10. The air return tube 10 has stable dimension, and good cross-sectional consistency, the forming mold 20 is easy to control, and convenient to operate.

[0054] Referring to FIG. 1 and FIG. 2 in detail, based on the above-mentioned forming mold 20, the method for forming an air return tube 10 provided in the present application comprises the following steps.

[0055] Step S101: controlling the blank 26 to enter the forming cavity, controlling the mold core to extrude the blank 26, to pass through the first mold, and obtaining the first length of the first formed tube section formed by the first mold.

[0056] That is, the blank 26 is delivered to the gap between the first mold 21 and the mold core 23, and the mold core 23 is moved in the first mold cavity 213 of the first mold 21, by a certain extrusion stroke to extrude the blank 26, the blank 26 is forced to produce directional plastic deformation, and extruded from the first mold 21, or extruded continuously from the first mold 21 to the second mold 22.

[0057] Step 102: in accordance with a determination that the first length reaches the first set parameter L1, controlling the second mold to extrude a part of the first formed tube section to form the part of the first formed tube section as the second formed tube section, and obtaining the second length of the second formed tube section.

[0058] In some embodiments of the present application, as shown in FIG. 2, in the step of determining that the first length reaches the first set parameter L1, it may be determined that the first length reaches the first set parameter L1 if the start end of the first formed tube section arrives at the first preset position.

[0059] That is, as shown in FIG. 7, the first position sensor detects the position of the start end of the first formed tube section extruded from the first mold 21, then the second mold 22 is controlled to start extrusion, and the rear end of the first formed tube section is continuously extruded to form the second formed tube section.

[0060] The first length is an actual length of the first formed tube section extruded by the first mold 21. The cross-sectional shape of the first formed tube section is circular. A position sensor (photoelectric sensor or micro switch) may be provided based on the length demand of the circular cross-section tube section. When a start end of the extruded circular cross-section tube section arrives at a position of the position sensor, it is determined that the length of the circular cross-section tube section meets the demand.

[0061] Then, the drive mechanism 24 is controlled to push the third sub-mold 221 towards the fourth sub-mold 222 and be closed with the fourth sub-mold 222. To achieve better forming effect of the formed tube section, the drive mechanism 24 descends slowly. The gradually-varied tube section 13 is continuously formed on part of the first formed tube section. After the third sub-mold 221 and the fourth sub-mold 222 are closed, the forming of the special cross-section tube section, that is, the forming of the second formed tube section, begins.

[0062] Step 103: determining that the second length reaches the second set parameter L2, and controlling the second mold 22 to stop extruding.

[0063] The second length of the second formed tube section extruded by the second mold 22 may be detected in the following modes.

[0064] In a first mode, as shown in FIG. 2, in the step of controlling the second mold to extrude the part of the first formed tube section to form the part of the first formed tube section as the second formed tube section, and obtaining the second length of the second formed tube section, it is determined that the second formed tube section reaches the second set parameter L2 if the start end of the first formed tube section arrives at the second preset position.

[0065] The first preset position and the second preset position are located in a delivery direction of the first formed tube section, and the second preset position is located at a downstream of the first preset position.

[0066] That is, the second position sensor detects that the start end of the second formed tube section extruded by the second mold 22 arrives at the position where the second position sensor is located, and it may be determined that when the second length reaches the second set parameter L2, the second mold 22 stops extruding, and the first mold 21 continues to extrude. The circular cross-section tube body structure formed by the extrusion of the first mold 21 is maintained, and the rear end of the second formed tube section is continuously extruded to form the third formed tube section.

[0067] As shown in FIG. 8, at least one position sensor is provided at the delivery path of the air return tube 10 along the movement path of the air return tube 10. In this embodiment, a first position sensor may be provided at point a of the delivery path of the air return tube 10, and the point a corresponds to the start end of the air return tube 10; a second position sensor is provided at point b of the delivery path of air return tube 10, and the point b corresponds to the start end of the second formed tube section in air return tube 10; a third position sensor is provided at point c of the delivery path of air return tube 10, and the point c corresponds to the start end of air return tube 10 and the stop end of air return tube 10. The forming length of each formed tube section is determined by collecting position information of each point.

[0068] It is also possible to set 6 position points along the movement path of the air return tube 10 on an outlet length of the formed tube section to obtain corresponding 6 position signals, namely the start end of the first formed tube section, the stop end of the first formed tube section, the start end of the second formed tube section, the stop end of the second formed tube section, the start end of the third formed tube section, and the stop end of the third formed tube section. The forming length of each formed tube section is determined by collecting position information of each point.

[0069] In a second mode, in the step of controlling the second mold to extrude the part of the first formed tube section to form the part of the first formed tube section as the second formed tube section, and obtaining the second length of the second formed tube section, if the second mold is located in a closed position, the first formed tube section is controlled to move a preset time based on a preset speed, and the second length is obtained based on the preset speed and the preset time.

[0070] That is, the start end of the first formed tube section is detected through the first position sensor, the drive mechanism 24 is controlled to push the third sub-mold 221 towards to the fourth sub-mold 222 and be closed with the fourth sub-mold 222. The fourth position sensor provided at the movement path of the drive mechanism 24 is used to detect that the third sub-mold 221 is closed with the fourth sub-mold 222. A timer may expire after a set time, and the set time is determined based on a target length of the second formed tube section and a feeding speed. After the timer reaches the set time, the drive mechanism 24 returns to separate the third sub-mold 221 from the fourth sub-mold 222, and the second length may also be obtained.

[0071] As shown in FIG. 4 and FIG. 6, during the forming of the second formed tube section, two position signals are provided at the movement path of the drive mechanism 24, namely, signals are used for determining that the third sub-mold 221 deepens into the position W1, and determining that the third sub-mold 221 returns to the position W2. After timing starts as it is determined that the third sub-mold 221 gradually deepens into position W1 and the time determined based on the length requirement of the special-shaped cross-section tube section expires, the third sub-mold 221 is controlled to gradually return to the position W2, the forming of the second formed tube section (special-shaped cross-section tube section) ends and the forming of the circular cross-section tube section enters.

[0072] Step 104: controlling the third formed tube section formed by the first mold to reach the third set parameter L3.

[0073] In some embodiments of the present application, as shown in FIG. 2, in the step of controlling the third formed tube section formed by the first mold 21 to reach the third set parameter L3, it is determined that the third formed tube section reaches the third set parameter L3 if the start end of the first formed tube section arrives at the third preset position; the first preset position and both the third preset position are located in the delivery direction of the first formed tube section, and the third preset position is located at the downstream of the first preset position.

[0074] That is, as shown in FIG. 8, the third position sensor detects that the start end of the first formed tube section arrives at the position of the third position sensor, and determines that an entire air return tube 10 meets the length required for a production drawing. The first mold 21 stops extrusion, the formed air return tube 10 is cut off or the first mold 21 continues to operate after the formed air return tube 10 is cut off.

[0075] The cross-sectional shape of the first mold is different from the cross-sectional shape of the second mold. This cross-section shape is the longitudinal cross-sectional shape of the first mold or the second mold, that is, the cross-sectional shape perpendicular to the axis direction of the air return tube.

[0076] In the above steps, the first length, the second length, and a third length are actual measured lengths of the corresponding formed tube sections of the air return tube during manufacturing; the first set parameter L1, the second set parameter L2, and the third set parameter L3 are all the forming lengths of the corresponding formed tube sections. That is, the first set parameter L1, the second set parameter L2, and the third set parameter L3 are the target lengths of each formed tube section in the air return tube 10 based on the design drawing requirements, and they are the reference lengths of each formed tube section in the actual production.

[0077] Through this molding method, a plurality of tube sections with different cross-sectional shapes may be continuously extruded, and a plurality of tube sections are formed integrally, which eliminates the weld joints between adjacent tube sections, reduces the leakage risk of the air return tube, ensures the consistency of the cross-section of the air return tube, and satisfies the heat exchange and connection requirements of the air return tube.

[0078] As shown in FIG. 9, the present application also provides the air return tube 10, comprising a first tube section 11, a second tube section 12, a gradually-varied tube section 13, and a third tube section 14 formed by extrusion. The second tube section 12 is located between the first tube section 11 and the third tube section 14, and the two ends of the second tube section 12 are connected to the first tube section 11 and the third tube section 14 through the gradually-varied tube section 13, respectively. The second tube section 12 is provided with a receiver, and the receiver is recessed towards the center direction of the second tube section 12 and extends along the axial direction of the second tube section 12.

[0079] The first tube section 11 and the gradually-varied tube section 13 correspond to the start end of the first formed tube section to the start end of the second formed tube section, the second tube section 12 corresponds to the second formed tube section, and the third tube section 14 and the gradually-varied tube section 13 correspond to the stop end of the second formed tube section and the stop end of the third formed tube section.

[0080] The first tube section 11 and the third tube section 14 are connected to the connection tubes provided at the evaporator and the compressor, respectively, while the second tube section 12 forms a receiver for embedding the capillary tube.

[0081] The first tube section 11 and the third tube section 14 are connected the connection tubes provided at the evaporator and the compressor, respectively; the capillary tube is embedded in the receiver, which may increase a contact area between the capillary tube and the air return tube 10; all tube sections are integrally formed, and no weld joints occur between adjacent tube sections, which ensures the sealing of the entire air return tube 10 and effectively prevent leakage of the air return tube 10.

[0082] The air return tube 10 provided in the present application integrates all tube sections and forms a receiver for embedding capillary tubes in the second tube section 12. This not only increases the contact area between the air return tube 10 and the capillary tube to improve heat exchange efficiency, but also facilitates the connection between the air return tube 10 and the connection tube, eliminates the weld joints between adjacent tube sections, and reduces the leakage risk of the air return tube 10.

[0083] Traditionally, the heat exchange tubes used in refrigeration systems of refrigerators or freezers are generally air return tubes 10 made of aluminum and capillary tubes made of copper, and the air return tubes 10 made of aluminum have a circular cross-section. The air return tube 10 is fixed to the capillary tube through aluminum foil, heat shrink tubes, etc. After being fixed in this way, the air return tube 10 is in linear contact with the capillary tube, which results in small contact area and low heat exchange efficiency.

[0084] Therefore, in the related art, the air return tube 10 is prolonged to increase the contact area between the air return tube 10 and the capillary tube, to improve heat exchange efficiency. However, it significantly increases the material and manufacturing costs of the air return tube 10, increases system costs, and reduces market competitiveness.

[0085] Therefore, in some the related arts, the capillary tube is fully or partially embedded inside the air return tube 10 to increase the contact area between the air return tube 10 and the capillary tube to improve heat exchange efficiency. In the related art, it is impossible to directly connect the two ends of the air return tube 10 with a special-shaped cross-section structure to the evaporator and compressor, circular cross-section connection tubes are welded at both ends of the special-shaped cross-section structure and connected to the evaporator and compressor.

[0086] In the above arrangement, two weld joints (brazing points or resistance weld joints) have been added at the connection between the air return tube 10 and both the evaporator and compressor, which increases the leakage risk in the foam layer of the air return tube 10 and reduces the reliability of the system.

[0087] However, the present application provides an air return tube 10, comprising the first tube section of circular cross-section structure as a start part, the second tube section of special-shaped cross-section structure as the middle part, and the third tube section of circular cross-section structure as the final part. That is, the cross-sectional shape of the air return tube 10 has changes from circular to special, and then from special to circular. This structure not only increases the contact area between the air return tube 10 and the capillary tube to improve heat exchange efficiency, but also facilitates the connection between the air return tube 10 and the connection tube, which eliminates the weld joints on the air return tube 10, reduces the leakage risk of system, and enhances the reliability of the system. Through this structure, the material and manufacturing costs of the air return tube 10 is reduced, and the market competitiveness of the tube body is improved.

[0088] Finally, it should be noted that the above implementation is only used to illustrate the present application and not to limit it. Although the present application has been described in detail with reference to the embodiments, those skilled in the art should understand that various combinations, modifications, or equivalent substitutions of the technical solution of the present application do not depart from the scope of the solution of the present application, and should be covered by the claims of the present application.

Claims

1. A method for forming an air return tube, comprising:

controlling a blank to enter a forming cavity, controlling a mold core to extrude the blank to pass through a first mold, and obtaining a first length of a first formed tube section formed by the first mold;
determining that the first length reaches a first set parameter, controlling a second mold to extrude a part of the first formed tube section to form the part of the first formed tube section as a second formed tube section, and obtaining a second length of the second formed tube section;
determining that the second length reaches a second set parameter, and controlling the second mold to stop extruding; and
controlling a third formed tube section formed by the first mold to reach a third set parameter;
wherein the cross-sectional shape of the first mold is different from a cross-sectional shape of the second mold.

2. The method of claim 1, wherein

in the step of determining that the first length reaches the first set parameter,
it is determined that the first length reaches the first set parameter if a start end of the first formed tube section arrives at a first preset position.

3. The method of claim 2, wherein in the step of controlling the second mold to extrude the part of the first formed tube section to form the part of the first formed tube section as the second formed tube section, and obtaining the second length of the second formed tube section,

it is determined that the second formed tube section reaches the second set parameter if the start end of the first formed tube section arrives at a second preset position;
wherein the first preset position and the second preset position are located in a delivery direction of the first formed tube section, and the second preset position is located at a downstream of the first preset position.

4. The method of claim 2, wherein in the step of controlling the third formed tube section formed by the first mold to reach the third set parameter,

it is determined that the third formed tube section reaches the third set parameter if the start end of the first formed tube section arrives at a third preset position;
wherein the first preset position and the third preset position are located in a delivery direction of the first formed tube section, and the third preset position is located at a downstream of the first preset position.

5. The method of claim 1, wherein

in the step of controlling the second mold to extrude the part of the first formed tube section to form the part of the first formed tube section as the second formed tube section, and obtaining the second length of the second formed tube section, the method comprises obtaining that the second mold is in a closed position, controlling the first formed tube section to move for a preset time at a preset speed, and obtaining the second length based on the preset speed and the preset time.

6. A forming mold for performing a method for forming an air return tube of any of claims 1 to 5, comprising a mold core, a first mold and a second mold, and a forming cavity is formed between the mold core and the first mold;
the second mold is provided at a side of a discharge end of the first mold, the second mold comprises a third sub-mold and a fourth sub-mold located at a side of the third sub-mold, the third sub-mold or the fourth sub-mold is provided with a protrusion, and the protrusion faces towards a center of the second mold.

7. The forming mold of claim 6, wherein at least one of a first position sensor, a second position sensor or a third position sensor is provided at a side of the second mold facing away from the first mold;
the first position sensor is used to detect that a start end of the first formed tube section arrives at the first preset position; the second position sensor is used to detect that a start end of the first formed tube section arrives at the second preset position; and the third position sensor is used to detect that the start end of the first formed tube section arrives at a third predetermined position.

8. The forming mold of claim 6, wherein the protrusion is provided at the third sub-mold and a drive mechanism is connected to the third sub-mold; the third sub-mold is switchable between a first position and a second position through the drive mechanism;

the third sub-mold is separated from the fourth sub-mold and spaced from the fourth sub-mold by a set distance when the third sub-mold is located at the first position; and
the third sub-mold is closed with the fourth sub-mold when the third sub-mold is located at the second position.

9. The forming mold of claim 8, wherein a fourth position sensor and a fifth position sensor are provided at a movement path of the drive mechanism;

the fourth position sensor is used to detect a position where the third sub-mold is closed with the fourth sub-mold; and
the fifth position sensor is used to detect a location where the third sub-mold is separated from the fourth sub-mold.

10. An air return tube, comprising a first tube section, a second tube section, and a third tube section formed by an extrusion forming, wherein the second tube section is located between the first tube section and the second tube section, and the second tube section is provided with a receiver, wherein the receiver is recessed towards a center direction of the second tube section and extends along an axial direction of the second tube section.

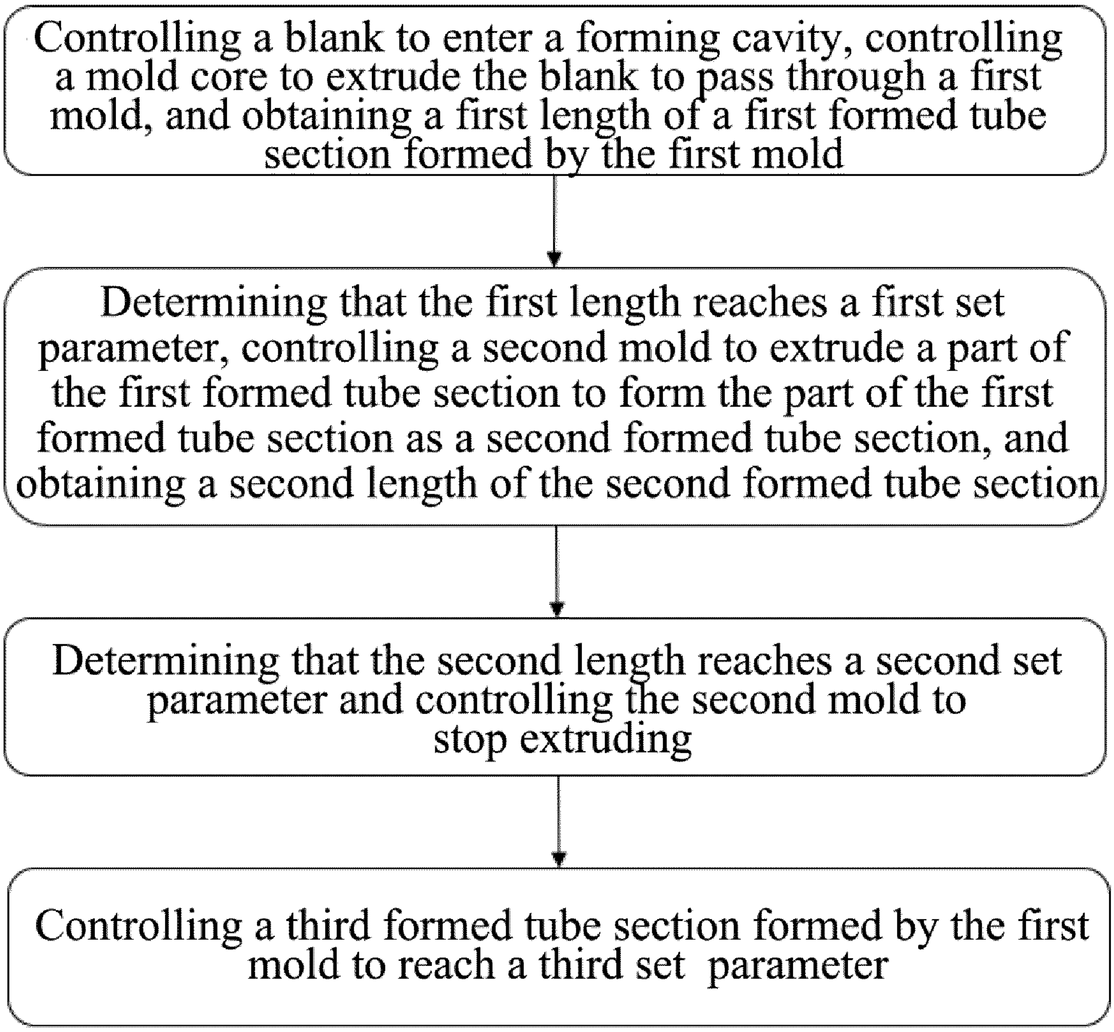
Controlling a blank to enter a forming cavity, controlling a mold core to extrude the blank to pass through a first mold, and obtaining a first length of a first formed tube section formed by the first mold
Determining that the first length reaches a first set parameter, controlling a second mold to extrude a part of the first formed tube section to form the part of the first formed tube section as a second formed tube section, and obtaining a second length of the second formed tube section
Determining that the second length reaches a second set parameter and controlling the second mold to stop extruding
Controlling a third formed tube section formed by the first mold to reach a third set parameter

FIG. 1

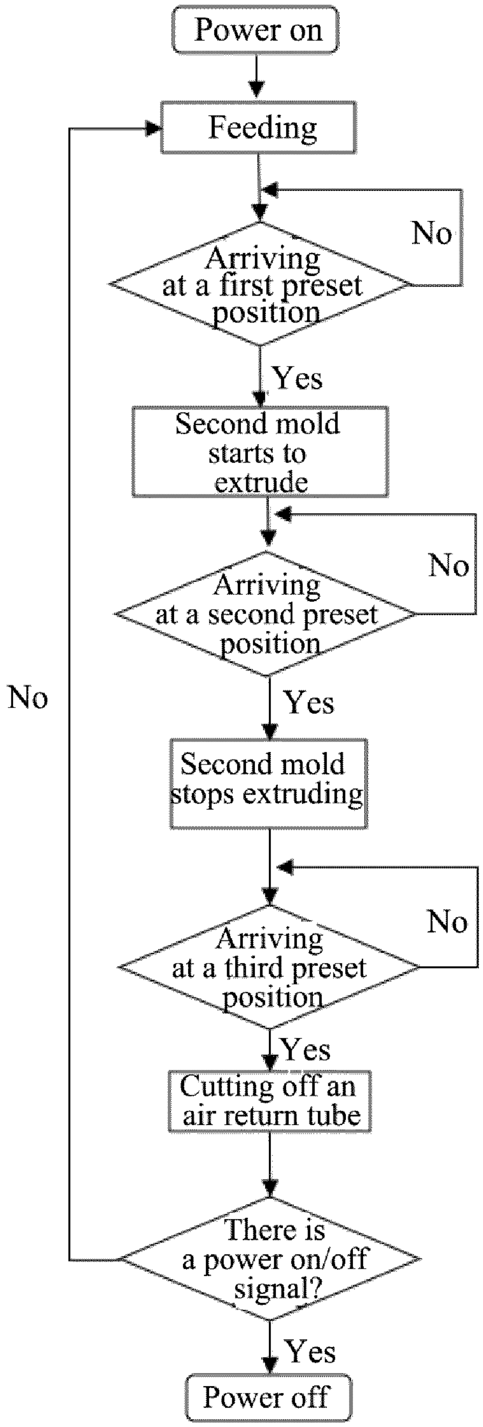
Power on
Feeding
Arriving at a first preset position
No
Yes
Second mold starts to extrude
Arriving at a second preset position
No
Yes
Second mold stops extruding
Arriving at a third preset position
No
Yes
Cutting off an air return tube
There is a power on/off signal?
No
Yes
Power off

FIG. 2

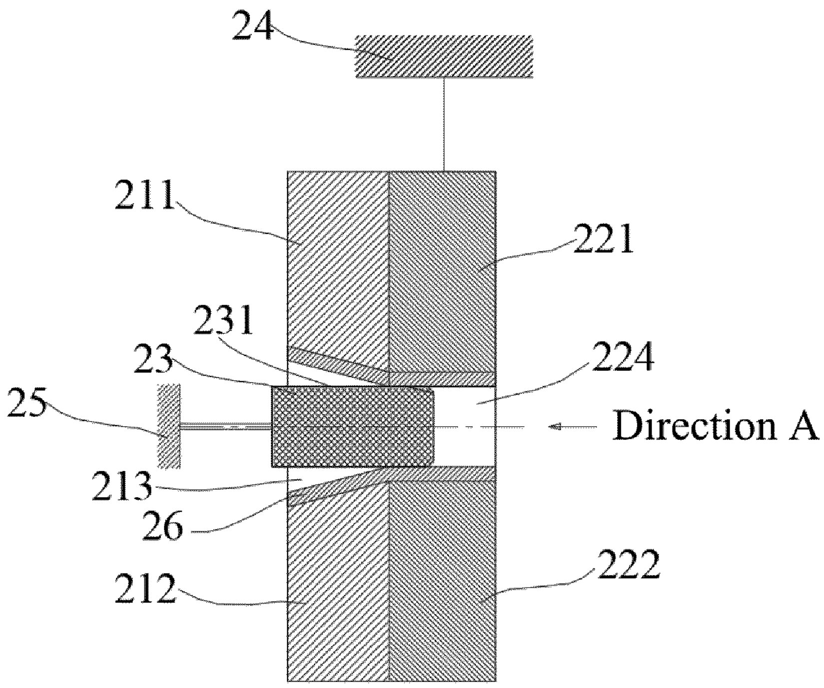
24
211
221
231
23
224
25
Direction A
213
26
222
212

FIG. 3

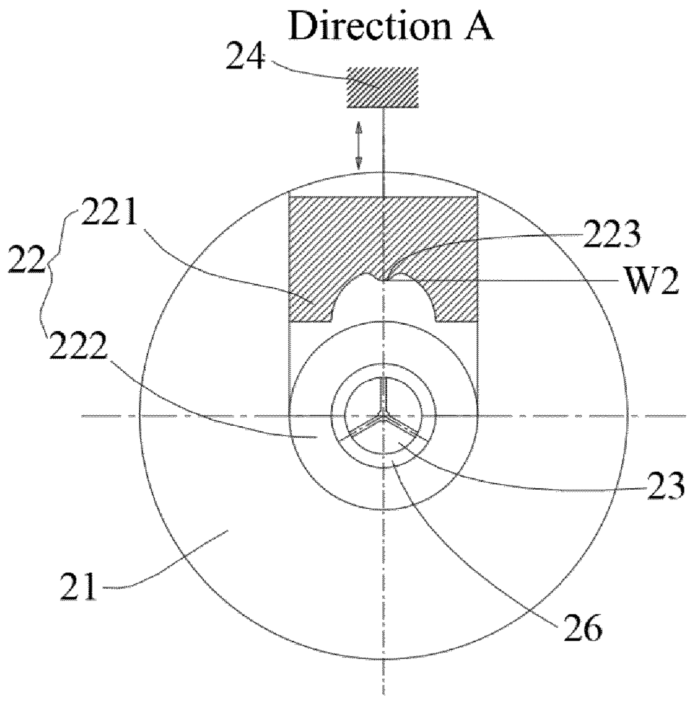
Direction A
24
221
22
223
W2
222
23
21
26

FIG. 4

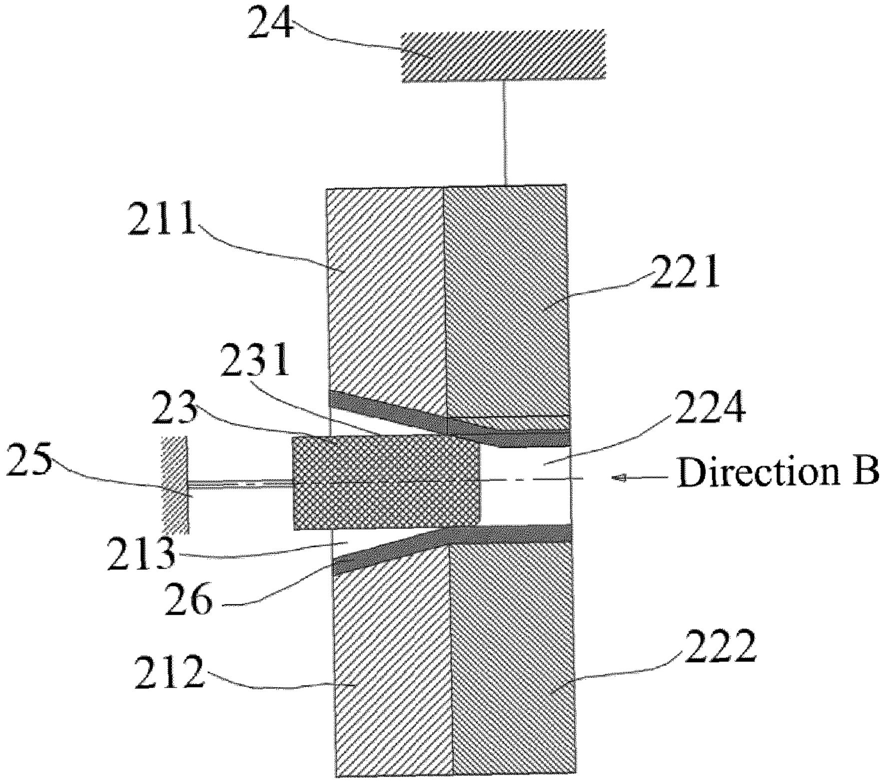
24
211
221
231
224
23
25
Direction B
213
26
222
212

FIG. 5

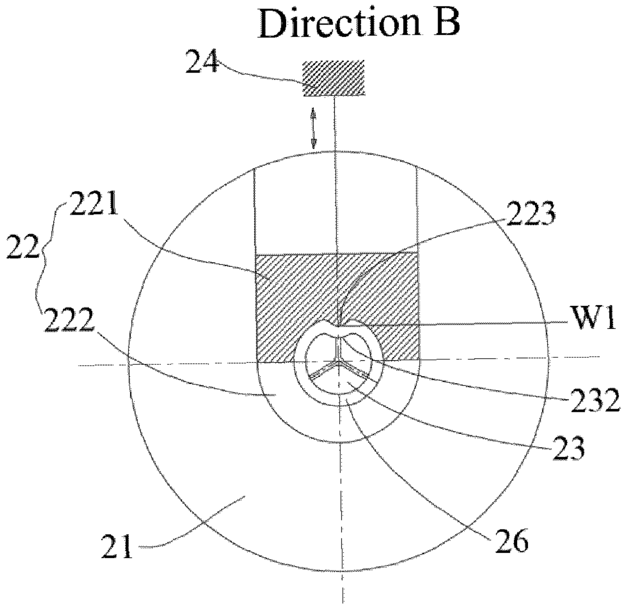
Direction B
24
221
22
222
223
W1
232
23
26
21

FIG. 6

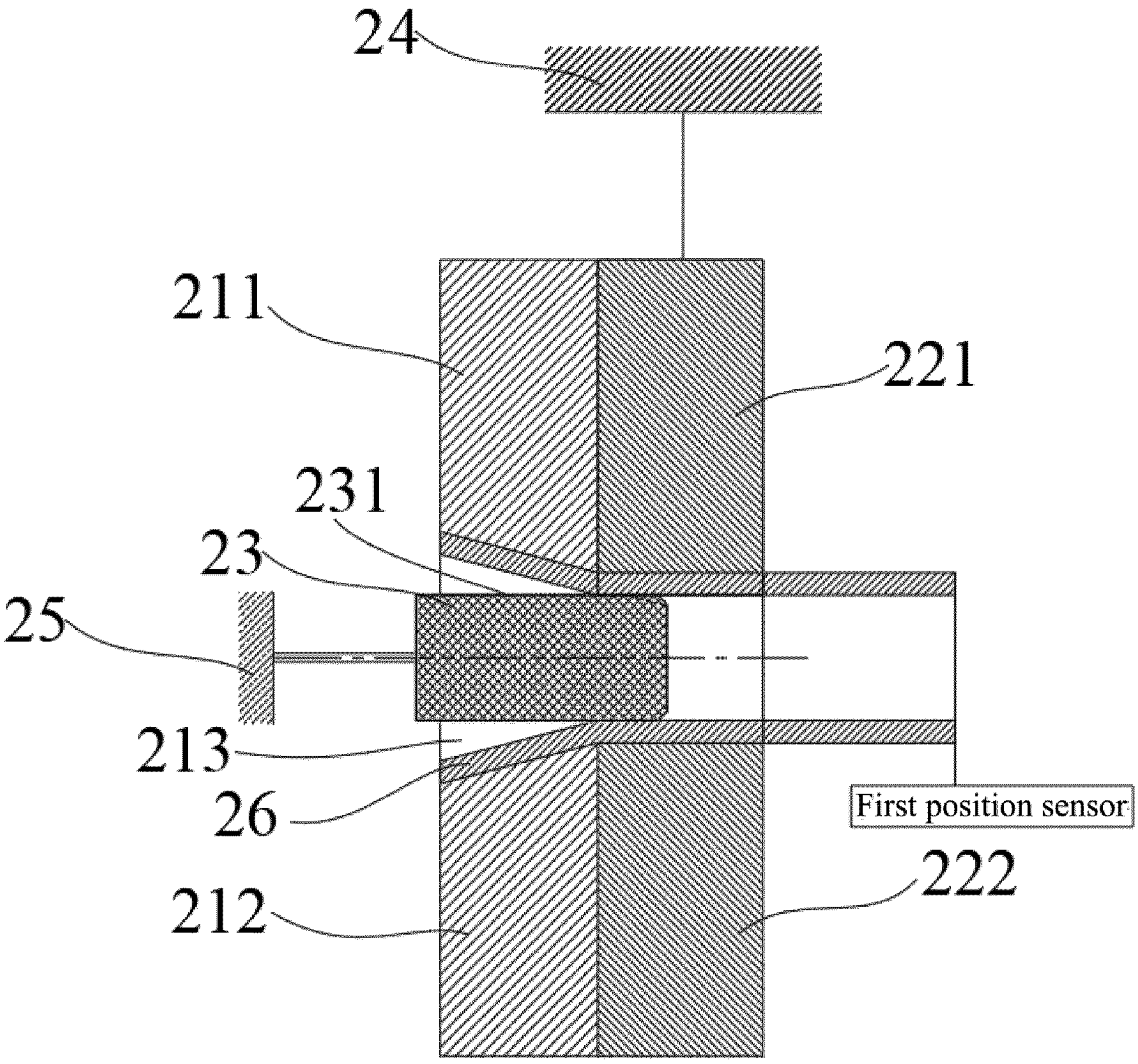

FIG. 7

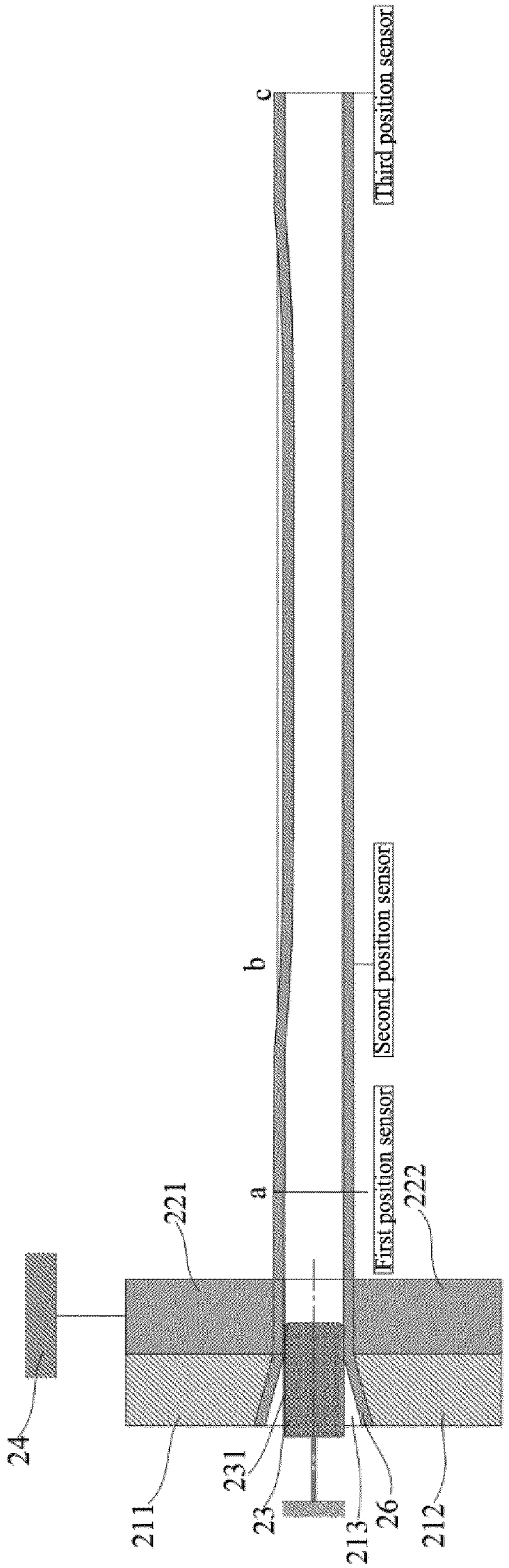
24
221
211
231
23
213
26
212
222
a
b
c
First position sensor
Second position sensor
Third position sensor

FIG. 8

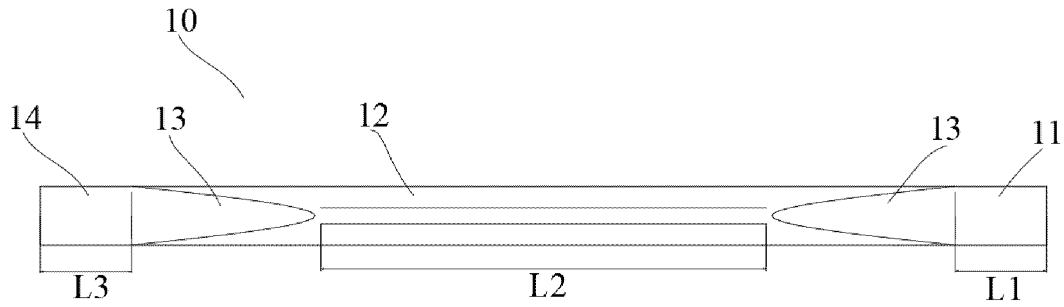

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/082535

A. CLASSIFICATION OF SUBJECT MATTER

B21C37/06(2006.01)i; B21C37/15(2006.01)i; B21C23/08(2006.01)i; B21C25/08(2006.01)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: B21C

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; ENTXTC; WPABS; ENTXT; CJFD: 回气管, 换热管, 毛细管, 换 3D 热, 模具, 成型, 成形, 挤压, 模芯, 挤压杆, 管段, 多段, 变 3D 截面, 焊点, 传感器; return 3D pipe, heat exchange pipe, tube, capillary tube, heat exchange, mo?ld, form+, extru+, core, rod, multi-section pipe, variable cross-section, joint, sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 217979970 U (HEFEI MIDEA REFRIGERATOR CO., LTD. et al.) 06 December 2022 (2022-12-06) description, paragraphs 5-42, and figures 1-10	1-10
X	CN 103736768 A (SOUTHWEST PETROLEUM UNIVERSITY) 23 April 2014 (2014-04-23) description, paragraphs 28-46, and figure 1	1-10
A	CN 210463680 U (GUANGDONG MIDEA REFRIGERATION EQUIPMENT CO., LTD. et al.) 05 May 2020 (2020-05-05) entire document	1-10
A	KR 20100038548 A (KOREA BUNDY CO., LTD.) 15 April 2010 (2010-04-15) entire document	1-10
A	CN 102072598 A (HAIER GROUP CORP. et al.) 25 May 2011 (2011-05-25) entire document	1-10
A	US 2021039149 A1 (SAMSUNG ELECTRONICS CO., LTD.) 11 February 2021 (2021-02-11) entire document	1-10

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

* Special categories of cited documents:
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 May 2023	**15 June 2023**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**	 Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/082535

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 217979970 U	06 December 2022	None	
CN 103736768 A	23 April 2014	None	
CN 210463680 U	05 May 2020	None	
KR 20100038548 A	15 April 2010	None	
CN 102072598 A	25 May 2011	None	
US 2021039149 A1	11 February 2021	US 11498104 B2	15 November 2022
		WO 2021025425 A1	11 February 2021
		KR 20210016847 A	17 February 2021

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202210424814 **[0001]**