

A Method and an Apparatus for Feeding Food Material,
an Apparatus for Thereby Extruding Bar-like Double-layered Food Material,
and an Apparatus for Enveloping Food Material

Field of the Application

The application generally relates to a method and an apparatus for feeding food material which is viscoelastic, such as material for a steamed bean-jam bun and a bean-paste, an apparatus for extruding bar-like double-layered food material, which is made of an inner food material enveloped with an outer food material, and an apparatus for enveloping a food material. More particularly, they relate to an apparatus for extruding food material and an apparatus for enveloping food material, which can stably provide food material, and which are compact and are better suited for high-mix low-volume manufacturing.

Background of the Application

Conventionally, an apparatus for feeding food material is comprised of vane pumps to provide outer food material and inner food material with a double nozzle to extrude bar-like double-layered food material, and an apparatus for controlling the vane pumps. An apparatus for enveloping food material is further comprised of a cutting apparatus to cut the bar-like double-layered food material to form a double-layered food product. (Reference 1)

In this conventional technology, each part of the food material held in hoppers is transferred into the vane pumps by screw conveyors. The measuring space that is defined by two vanes, a rotor, and the casings of the vane pumps is filled with the transferred food material, and then the food material is transferred into an exit-side flow path that communicates with the double nozzle, in correspondence with the rotations of the rotor of the vane pumps. Since the vanes move along the outer cams disposed in the housing of the vane pumps, the forward vane, which is disposed at the front side of the measuring space, sinks in the rotor, and then the measuring space communicates with the exit-side flow path. Further, in correspondence with the rotations of the rotor, the food material is pushed by the rear vane, which is disposed at the rear side of the measuring space, and is supplied to the double nozzle through the exit-side flow path. The bar-like

double-layered food material, which is made of an inner food material enveloped with an outer food material, is continuously extruded from the double nozzle having an inner nozzle and an outer nozzle, to form an extruding port. Then, the bar-like double-layered food material is cut to form enveloped food products having a substantially constant weight by the cutting apparatus disposed under the double nozzle.

In this conventional technology, however, the pressure of the food material which is transferred to the double nozzle by each vane of the vane pumps and which has a viscoelastic property is higher than that of the food material in the measuring space because of frictional resistance in the flow path from the vane pump to the extruding port, based on the properties of the food material. Thus, when the forward vane, which defines the measuring space, sinks in the rotor and then the measuring space communicates with the exit-side flow path of the apparatus for feeding food material, the pressure of the food material in the exit-side flow path decreases due to the food material having a relatively lower pressure in the measuring space. Thus, the pressure of the food material in the double nozzle also temporarily decreases, and then the quantity (flow rate) of the food material being extruded is reduced. Namely, the bar-like double-layered food material is pulsating while it is being extruded due to variations of the pressure of the food material in the exit-side flow path and the double nozzle. In particular, when the food material has many air bubbles or has a low fluidity, and when the food material is extruded from the narrow extruding port, the pulsating is significant. In this condition, if the bar-like double-layered food material is cut by the cutting apparatus being driven in a predetermined time cycle, the weight of the enveloped food products is dispersed, and the size and the configuration of them varies widely.

Further, since the forward vane sinks in the rotor, the height of the protrusion of the forward vane gradually decreases. Consequently, the quantity of the food material supplied to the double nozzle decreases, and the pressure of the food material is reduced. If the rate of the sinking of the forward vane is not constant, since the pressure of the food material in the exit-side flow path is varied, the bar-like double-layered food material is pulsating while it is being extruded from the double nozzle.

As an apparatus for transferring food material to the vane pump,

there are the screw conveyors, explained above, and a roller for transferring food material explained below. They are used in embodiments of the application. When the food material is transferred to the vane pump by using these conveyors, sometimes the measuring space is not completely filled with the food material. In this case, it is possible to increase the rate of rotation of these conveyors and increase the quantity of the food material to be transferred so that the measuring space is completely filled with the food material. However, if the rate of rotation of these conveyors is increased, since the food material is excessively stirred, there is a possibility of destroying its properties. Thus, the rate of rotation of these conveyors is limited. As explained above, if the measuring space is not completely filled with the food material, the same problem as explained in Reference 1 occurs, because the pressure of the food material in the measuring space becomes lower than that of it in the exit-side flow path.

In the apparatus for feeding food material for the inner and the outer food material, if the food material is transferred to the vane pump by the screw conveyors, there is a problem in that the size of the entire apparatus for feeding food material becomes larger.

Further, when, in small-lot production, many kinds of enveloped food products, such as a steamed bean-jam bun, are manufactured, there are intensive needs for reducing the food material remaining in the apparatus after manufacturing the products.

In high-mix low-volume manufacturing, when the types of products are changed, the apparatus for feeding food material has to be removed from the apparatus for extruding food material, and then it has to be cleaned. To improve the manufacturing efficiency, it is required that the apparatus for feeding food material can be easily removed from, and installed in, the apparatus for extruding food material.

Reference 1: Japanese Patent Laid-open Publication No. 2001-352960

Summary of the Application

The purposes of the application are to reduce pressure pulsations of food material in an exit-side flow path. These pulsations occur when the food material is continuously supplied to the exit-side flow path by a vane pump disposed in an apparatus for feeding food material. Bar-like double-layered

food material extruded from a double nozzle communicating with the exit-side flow path is pulsating while it is being extruded due to the variations of the pressure of the food material. Consequently, the weight and the size of the enveloped food products, which are manufactured by cutting the bar-like double-layered food material, vary widely. Thus, it is strongly required to reduce the pressure pulsations of the food material.

Another purpose of the application is to reduce the size of the entire apparatus for extruding bar-like double-layered food material so that it can be placed in a small space.

Further, another purpose of the application is to reduce the food material remaining in the apparatus after manufacturing the products, to improve the manufacturing efficiency, in case of high-mix low-volume manufacturing.

For high-mix low-volume manufacturing, when the types of products are changed, it is necessary to rapidly change the food material. Thus, another purpose of the application is to add a function to the apparatus for feeding food material so that it can be easily removed from, and easily installed in, the apparatus for extruding food material.

The application intends to achieve the above purposes. The application relates to a method for continuously feeding food material held in a hopper to an exit-side flow path by a vane pump. It comprises a step to control the rate of rotation of the rotor of the vane pump so that the rate can be switched between a basic rate and a higher rate than the that of the basic one, while the vanes, which are disposed on the periphery of the rotor at even intervals, move to supply the food material to the exit-side flow path, wherein the switching of the rate of the rotor is repeated in correspondence with the location where each vane rotates.

The application relates to an apparatus for feeding food material, comprising: a vane pump to supply the food material to an exit-side flow path, and a controlling apparatus to control the vane pump, wherein the controlling apparatus is provided with a detecting apparatus to detect the angle of rotation of the rotor of the vane pump, wherein the controlling apparatus controls the rate of rotation of the rotor of the vane pump so that the rate can be switched between a basic rate and a higher rate than that of the basic one, while the vanes, which are disposed on the periphery of the rotor at even intervals, move to supply the food material to the exit-side flow

path, and wherein the switching of the rate of rotation of the rotor is repeated in correspondence with the location where each vane rotates.

The application relates to the apparatus, wherein the timing of the switching of the rate of rotation of the rotor from the basic rate to the higher rate (the timing to start to accelerate the rate of rotation of the rotor) can be adjusted.

The application relates to a method for continuously feeding food material held in a hopper to an exit-side flow path by a vane pump disposed at the bottom of the hopper, further comprising: a step for transferring the food material held in the hopper to the vane pump by rotating a roller for transferring food material disposed at the side of the vane pump.

The application relates to an apparatus for continuously feeding food material held in a hopper to an exit-side flow path by a vane pump disposed at the bottom of the hopper, further comprising: a means for transferring the food material held in the hopper to the vane pump by rotating a roller for transferring food material disposed at the side of the vane pump.

The application relates to an apparatus for continuously extruding bar-like double-layered food material which includes two kinds of food material, which double-layered food material consists of an inner food material enveloped by an outer food material, comprising: an apparatus for feeding the outer food material having a hopper to hold the outer food material and a vane pump for the outer food material disposed at the bottom of the hopper, an apparatus for feeding the inner food material having a hopper to hold the inner food material and a vane pump for the inner food material disposed at the bottom of the hopper, and a double nozzle that communicates with the apparatus for feeding the inner food material and the apparatus for feeding the outer food material to continuously extrude bar-like double-layered food material by enveloping the inner food material with the outer food material, wherein the vane pumps for the outer food material and the inner food material are disposed so that the axis of rotation of one of the vane pumps is vertically arranged and that of the other is horizontally arranged.

The application relates to the apparatus, wherein the vane pumps for the outer food material and the inner food material are disposed so that the axis of rotation of the vane pump for the outer food material is horizontally arranged and that of the vane pump for the inner food material is vertically

arranged.

The application relates to the apparatus, further comprising: an apparatus for controlling the vane pump for the outer food material, wherein the apparatus for controlling the vane pump has an apparatus for detecting the angle of rotation of the rotor of the vane pump for the outer food material and controls the vane pump for the outer food material so that it can switch between the basic rate of rotation of the rotor and the higher rate of rotation of the rotor than that of the basic one, while the vanes, which are disposed on the periphery of the rotor at even intervals, move to supply the food material to the exit-side flow path, and wherein the switching of the rate of rotation of the rotor is repeated in correspondence with the location of rotation of each vane.

The application relates to the apparatus, further comprising: a roller for transferring food material disposed at the side of the vane pump for the outer food material to transfer the food material held in the hopper for the outer food material to the vane pump for the outer food material by rotating the roller for transferring food material, and a screw conveyor disposed at the bottom of the hopper for the inner food material to transfer the food material held in the hopper for the inner food material to the vane pump for the inner food material by rotating the screw conveyor.

The application relates to the apparatus, further comprising: a connecting interface tube disposed between the apparatus for feeding the outer food material and the double nozzle, wherein the connecting interface tube is slidably installed between them, can seal the connecting interface surface for the food material, and allows the apparatus for feeding the outer food material to be easily removed from the apparatus for extruding bar-like double-layered food material and to be easily installed in it.

The application relates to the apparatus, further comprising: a connecting interface tube disposed between the apparatus for feeding the inner food material and the double nozzle, wherein the connecting interface tube is slidably installed between them, can seal the connecting interface surface for the food material, and allows the apparatus for feeding the inner food material to be easily removed from the apparatus for extruding bar-like double-layered food material and to be easily installed in it.

The application relates to the apparatus, further comprising: connecting interface tubes disposed between the apparatus for feeding the

outer food material and the double nozzle and between the apparatus for feeding the inner food material and the double nozzle, wherein the connecting interface tubes are slidably installed between them, can seal the connecting interface surfaces for the food material, and wherein the connecting interface tube disposed between the apparatus for feeding the outer food material and the double nozzle is smaller than that disposed between the apparatus for feeding the inner food material and the double nozzle.

The application relates to the apparatus, wherein the exit-side flow path of the apparatus for feeding the outer food material, which communicates with the double nozzle, is inclined downward.

The application relates to an apparatus for manufacturing enveloped food products by using the apparatus, further comprising: a cutting apparatus disposed under the double nozzle to cut the bar-like double-layered food material extruded from the double nozzle, and a linear conveyor apparatus disposed under the cutting apparatus to convey the enveloped food products cut by the cutting apparatus.

By the application of the method and apparatus for feeding the food material, when the vane pump continuously provides the exit-side flow path with the food material, it is possible to compensate for the decrease of the pressure of the food material in the exit-side flow path, and to inhibit any variation of the pressure. Further, it is possible to inhibit the pulsating flow of the bar-like double-layered food material continuously extruded from the double nozzle that communicates with the exit-side flow path, and to reduce the variations of the weight of the enveloped food products, which are cut from the bar-like double-layered food material by the cutting apparatus.

By the application of the method and apparatus for feeding the food material, since the food material held in the hopper is continuously provided with the exit-side flow path by the vane pump disposed at the bottom of the hopper, and since it is transferred to the vane pump by rotating a roller for transferring food material disposed at the side of the vane pump, it is possible to reduce the entire size of the apparatus for feeding food material and to reduce the food material remaining in the apparatus after manufacturing the products.

By the application of the apparatus for extruding the bar-like double-layered food material, since the apparatus is comprised of the

apparatuses for feeding the outer and inner food material, and since the vane pumps for the outer and inner food material are disposed so that the rotating axis of one of the vane pumps is vertically arranged and that of the other is horizontally arranged, it is possible to reduce the entire size of the apparatus for extruding bar-like double-layered food material.

By the application of the apparatus for extruding the bar-like double-layered food material, since the vane pumps for the outer and inner food material are disposed so that the axis of rotation of the vane pump for the outer food material is horizontally arranged and that of the vane pump for the inner food material is vertically arranged, it is possible to reduce the entire size of the apparatus for extruding bar-like double-layered food material so that it is especially better suited to enable the quantity of the outer food material that is consumed to be less than that of the inner food material.

By the application of the apparatus for extruding the bar-like double-layered food material, when the vane pump for the outer food material continuously provides the exit-side flow path with the food material, it is possible to compensate for the decrease of the pressure of the food material in the exit-side flow path, and to inhibit any variation of the pressure. Further, it is possible to inhibit the pulsating flow of the bar-like double-layered food material continuously extruded from the double nozzle that communicates with the exit-side flow path, and to reduce the variations of the weight of the enveloped food products, which are cut from the bar-like double-layered food material by the cutting apparatus.

By the application of the apparatus for extruding the bar-like double-layered food material, since the apparatus for extruding bar-like double-layered food material is further comprised of the roller for transferring food material disposed at the side of the vane pump for the outer food material, and the screw conveyor disposed at the bottom of the hopper for the inner food material, it is possible to reduce the entire size of the apparatus for extruding bar-like double-layered food material. Thus it is especially better suited to enable the quantity consumed of the outer food material to be less than that of the inner food material.

By the application of the apparatus for extruding the bar-like double-layered food material, since the connecting interface tube disposed between the apparatus for feeding the outer or inner food material and the

double nozzle, wherein the connecting interface tube is slidably installed between them, can seal the connecting interface surface for the food material, and allows the apparatus for feeding the outer food material to be easily removed from the apparatus for extruding bar-like double-layered food material and to be easily installed in it, it is possible to rapidly change food material, when the types of products are changed.

By the application of the apparatus for extruding the bar-like double-layered food material, since the connecting interface tube disposed between the apparatus for feeding the outer food material and the double nozzle is smaller than that disposed between the apparatus for feeding the inner food material and the double nozzle, it is possible to reduce the food material remaining in the apparatus after manufacturing the products.

By the application of the apparatus for extruding the bar-like double-layered food material, since the exit-side flow path of the apparatus for feeding the outer food material inclines downwardly, it is possible to reduce the food material remaining in the apparatus after manufacturing the products.

By the application of the apparatus, since the apparatus uses the apparatus, so that additionally it is comprised of a cutting apparatus and a linear conveyor apparatus, it is possible to reduce the entire size of the apparatus for manufacturing the enveloped food products. Thus it is especially better suited for high-mix low-volume manufacturing, for inhibiting the pulsating flow of the bar-like double-layered food material continuously extruded from the double nozzle, and for reducing any variations of the weight of the enveloped food products, which are cut from the bar-like double-layered food material by the cutting apparatus.

Brief Description of the Drawings

The foregoing and other objects, features, and advantages of the present application will be further understood from the following detailed description of the preferred embodiments and from the accompanying drawings, in which:

Fig. 1 relates to the first embodiment and shows an elevational view of an apparatus for extruding bar-like double-layered food material (1) having an apparatus for feeding the outer food material (10).

Fig. 2 shows a partial detailed view of the apparatus for extruding the bar-like double-layered food material (1) shown in Fig. 2.

Fig. 3 shows a cross-sectional view at the line A—A shown in Fig. 2.

Fig. 4 shows a detailed view of the apparatus for feeding the outer food material (10) shown in Fig. 2.

Fig. 5 relates to the first embodiment and illustrates the motion of the rotor (15) of the apparatus for feeding the outer food material (10).

Fig. 6 is a chart which shows weights of a divided outer food material WA.

Fig. 7 relates to the second embodiment and shows an elevational view of the apparatus for extruding bar-like double-layered food material (1) having an apparatus for feeding the outer food material (10).

Fig. 7(A) shows a plane view, partly in cross section, of the apparatus for extruding bar-like double-layered food material (1).

Fig. 7(B) shows an elevational view at the line B—B shown in Fig. 7(A).

Detailed Description of the Preferred Embodiments

First, the apparatus for feeding outer food material (10) of the first embodiment of the application is explained based on the Figures.

By Figs. 1—4, the apparatus for extruding bar-like double-layered food material (1) includes the apparatus for feeding outer food material (10) disposed on a support base (3) to supply the outer food material (WA) and the apparatus for feeding inner food material (20) disposed on the support base (3) to supply the inner food material (WB). The apparatus further includes a double nozzle (30) disposed between the apparatus for feeding the outer food material (10) and the apparatus for feeding the inner food material (20) to continuously extrude the bar-like double-layered food material (WC), which is made by enveloping the inner food material (WB) with the outer food material (WA).

A cutting apparatus (40) to cut the bar-like double-layered food material (WC) extruded from the double nozzle (30) is disposed under the double nozzle (30). Further, a linear conveyor apparatus (50) to convey the enveloped food products (WD) which are cut by a cutting apparatus (40) to a next process is disposed under the cutting apparatus (40). A control

apparatus (60) to control each apparatus is also provided.

The apparatus for feeding the outer food material (10) includes a hopper for the outer food material (11) to hold the outer food material (WA), and a roller for transferring food material (12) and a vane pump for the outer food material (13), which are disposed at the bottom of the hopper for the outer food material (11). The hopper (11) includes the roller for transferring food material (12) and the vane pump (13) at its bottom and is installed on the support base (3) so that it (11) can be easily removed from, and installed on, the base (3).

This embodiment is now explained in more detail. The hopper for the outer food material (11) has an opening (11A) to be charged with the outer food material (WA). The hopper (11) also has a concave portion (11B) for the roller for transferring food material (12) at its bottom to fit the contours of the roller for transferring food material (12) and a concave portion (11C) for the vane pump (13) at its bottom to fit the contours of the vane pump (13). Further, an exit-side flow path (11D) that communicates with the double nozzle (30) is disposed adjacent to the concave portion (11C) for the vane pump (13). It is possible to improve the flowability of the outer food material (WA) by inclining the exit-side flow path (11D) downward.

The roller for transferring food material (12) transfers the outer food material (WA) to the vane pump for the outer food material (13) by rotating its roller. The roller for transferring food material (12) is connected to a rotating shaft (14) supported by the hopper (11) and arranged horizontally and rotatably. The roller for transferring food material (12) and the rotating shaft (14) rotate together in the direction shown by an arrow R1. Since a plurality of grooves is disposed at the surface of the roller for transferring food material (12) at even intervals, it can efficiently transfer the outer food material (WA) to the vane pump (13).

The vane pump for the outer food material (13) is used to measure a quantity of the outer food material (WA) and to transfer it to the exit-side flow path (11D). The vane pump (13) includes a rotor (15) and three sets, namely, six parts, of the vanes (16). The rotor (15) is horizontally and rotatably supported by the hopper for the outer food material (11) and arranged parallel to the rotating shaft (14) of the roller for transferring food material (12). Slits (15A) are radially formed in the rotor (15). Further, the three sets, namely, the six parts, of the vanes (16) are slidably inserted in

the slits (15A). A pair of cams (17), which form a cam surface to allow the vanes to radially move along its surface, is disposed at the hopper for the outer food material (11).

The surface of the each cam is now explained in more detail based on the rotations of the rotor (15) in the direction shown by an arrow R2. As shown in Fig. 4, the curved surface (17A) of the cam is formed so that the vane (16) gradually sinks in the rotor (15). The curved surface (17B) of the cam is formed so that the tip of the vane (16) corresponds to the periphery of the rotor (15). The curved surface (17C) is formed so that it is symmetrical to the curved surface (17A), and so that the vane (16) gradually comes out from the peripheral surface of the rotor (15). The curved surface (17D) is formed so that the height of the vane (16) that is projected from the rotor (15) is maintained at a maximum value.

The vane pump for the outer food material (13) forms a measuring space (13A) defined by the periphery of the rotor (15), two vanes adjacent to each other (for example, 16A and 16B, shown in Fig. 4), and the concave portion (11C) of the pump casing of the vane pump (13), which casing forms a circular surface corresponding to the curved surface (17D) of the cam, in the interval of the curved surface (17D).

In correspondence with the rotations of the rotor (15), the forward vane (16A) contacts and slides on the curved surface (17D) of the cam (17), and then the vane (16A) moves in the slit (15A) and gradually sinks in the rotor (15).

The rear vane (16B), which defines the measuring space (13A), continues to move along the inside of the concave portion (11C) for the vane pump (13) and supplies the outer food material (WA) to the double nozzle (30) through the exit-side flow path (11D) of the hopper (11). As shown in Fig. 4, the space (13B) between the position of the vane (16B) and that of the vane (16A) is to hold the outer food material (WA) to supply it. The outer food material (WA) filled in the measuring space (13A) is sequentially transferred to the double nozzle (30) by moving each vane in the space (13B). In this embodiment, six measuring spaces (13A) are formed at every revolution of the rotor (15). It is possible to integrate the cam (17) with the hopper for the outer food material (11).

The rotating shaft (14) inserted into the roller for transferring food material (12) and the rotor (15) of the vane pump for the outer food material

(13) are respectively connected to a roller driving shaft (18) and a pump driving shaft (19) disposed in the support base (3) through connecting interfaces (18A) and (19A) so that they can rotate together.

For example, as shown in Fig. 3, at the connecting interfaces (18A) and (19A), grooves are disposed at the end surfaces of the roller driving shaft (18) and the pump driving shaft (19). In contrast, the projections are disposed at the end surfaces of the rotating shaft (14) inserted into the roller for transferring food material (12) and the rotor (15) of the vane pump for the outer food material (13) so that they can respectively engage the roller driving shaft (18) and the pump driving shaft (19) and can transfer the driving force. It is preferable to position the rotating shaft (14) and the rotor (15) by using guide shafts (not shown) disposed around the end surfaces of the roller driving shaft (18) and the pump driving shaft (19). Since the above method for connecting the shafts is used, as explained in detail later, the apparatus for feeding the outer food material can be easily removed from and installed in the apparatus for extruding food material.

The roller driving shaft (18) and the pump driving shaft (19) are connected to a control motor (M1) through a power transfer mechanism using gears and rotate in the direction shown by the arrow in Fig. 4.

It is possible to use two control motors to drive the roller for transferring food material (12) and the vane pump (13) and to adjust the rate of them individually.

As shown in Figs. 1-3, the apparatus for feeding an inner food material (20) includes a hopper for the inner food material (21) to hold the inner food material (WB) and screw conveyors (22R) and (22L), which are horizontally and rotatably disposed at the bottom of the hopper for the inner food material (21). The directions of the helices of the rotor blades of the screw conveyors (22R) and (22L) are opposite from each other, and the pitches of the rotor blades of them are identical.

The screw conveyors (22R) and (22L) are connected to the control motor (M2) disposed in the support base (3) through a power transfer mechanism, such as gears, and rotate reversely from each other so as to convey the food material. The inner food material (WB) is transferred to the vane pump for the inner food material (23) by rotating the screw conveyors (22R) and (22L).

The vane pump for the inner food material (23) is similar to that for

the outer food material (13). It has three sets, namely, six parts, of the vanes (26), which are slidably inserted in the slits of the rotor (25). The vane pump (23) has a pump casing (24) connected to the end surface of the hopper for the inner food material (21). An opening (24A) is disposed at the end surface of the hopper (21). The rotor (25) is vertically and rotatably disposed at the side of the opening (24A). The lower end of the shaft of the rotor (25) is connected to the control motor (M3) through a power transfer mechanism, such as gears.

A plurality of slits (25A) is radially formed in the rotor (25) at even intervals. Each of three vanes (26A), (26B), and (26C) is slidably supported in the radial direction of the rotor (25). A cam (27), having a proper curved surface to move the vanes (26A), (26B), and (26C) in the radial direction in correspondence with rotations of the rotor (25), is disposed in the pump casing (24).

The vane pump for the inner food material (23) forms a measuring space (23A) defined by the periphery of the rotor (25), two vanes adjacent to each other (for example, 26A and 26B, shown in Fig. 3), and the inner surface of the pump casing (24). The forward vane (26A), disposed at the front side of the measuring space, moves along the curved surface (27A) of the cam (27) that is disposed in the pump casing (24) in correspondence with the rotations of the rotor (25), and gradually sinks in the rotor (25) by being moved in the slit (25A) along the curved surface (27A). The rear vane (26B), which defines the measuring space (23A) and is disposed at the rear side of it, moves along the inner surface of the pump casing (24) and supplies the inner food material (WB) to the double nozzle (30) through the exit-side flow path (24B) of the pump casing (24). It is possible to integrate the cam (27) with the pump casing (24).

In the above explanation, the apparatus for feeding the outer food material (10) contains the roller for transferring food material (12) and the vane pump for the outer food material (13) that have rotating axes horizontally arranged, and the apparatus for feeding the inner food material (20) contains the screw conveyors (22R) and (22L) having the rotating axes horizontally arranged and the vane pump for the inner food material (23) that have rotating axes vertically arranged. However, the apparatus for feeding the outer and inner food materials (10) and (20) is not limited to these configurations. Namely, the apparatus for feeding the outer food

material (10) may have screw conveyors having the rotating axes horizontally arranged and the vane pump for the outer food material that has the rotating axes vertically arranged, and the apparatus for feeding the inner food material (20) may have a roller for transferring food material and a vane pump for the inner food material that have rotating axes horizontally arranged.

As shown in Fig. 2, the double nozzle (30) has a nozzle (35) to extrude the inner food material (WB) and a nozzle (36) for the outer food material (WA) surrounding the nozzle (35). The nozzles (35) and (36) can be freely removed from and installed in the double nozzle. The nozzle (35) for the inner food material and the nozzle (36) for the outer food material are respectively connected to the apparatus for feeding the inner and the outer food material (20), (10) through connecting interface tubes (37A) and (37B).

The connecting interface tube (37A) is slidably inserted in the nozzle (36) for the outer food material and the apparatus for feeding the outer food material (10). The connecting interface tube (37A) has O-rings to seal the food material at the sliding surface. Further, the connecting interface tube (37B) can also be slidably inserted in the nozzle (35) for the inner food material and the apparatus for feeding the inner food material (20).

When the quantity of the inner food material used to manufacture enveloped food products is less than that of the outer food material, it is possible to reduce the outer food material remaining in the apparatus for feeding the outer food material (10) after manufacturing the products by reducing the size of the connecting interface tube (37A), which is disposed between the apparatus for feeding the outer food material (10) and the double nozzle (30), so that it becomes smaller than the connecting interface tube (37B), which is disposed between the apparatus for feeding the inner food material (20) and the double nozzle (30).

Now, a method for removing the apparatus for feeding the outer food material (10) from the apparatus for extruding bar-like double-layered food material (1) and installing the apparatus (10) in it is explained.

The apparatus for feeding the outer food material (10) is supported by the bar (72) that protrudes from the support base (3) and that is attached to the support base (3) by rotating the knob (71) having threads at its distal end. (See Figs. 3 and 4.)

Further, at the connecting portions between the apparatus for

feeding the outer food material (10) and other elements, namely, at the connecting portion (18A), which connects the roller driving shaft (18) to the rotating shaft (14), at the connecting portion (19A), which connects the pump driving shaft (19) to the vane pump (13), and at another connecting portion, which connects the double nozzle (30) to the apparatus (10) by using the connecting interface tube (37A), no mechanical fasteners, such as screws, are used to fix these elements. Thus, it is possible to easily remove the apparatus for feeding the outer food material (10) from the apparatus for extruding bar-like double-layered food material (1) and to easily install the apparatus (10) in it by just rotating the knob 71.

The apparatus for extruding bar-like double-layered food material (1) is provided with the double nozzle (30) explained above. Thus, the bar-like double-layered food material (WC), which is made by enveloping the inner food material (WB) with the outer food material (WA), is extruded from the double nozzle by supplying the outer food material (WA) from the apparatus for feeding the outer food material (10), and by supplying the inner food material (WB) from the apparatus for feeding the inner food material (20). The form of the port of each nozzle to extrude the food material may be selected from various forms, such as a circular one, a quadrilateral one, a polygonal one, etc. It can be also designed so that a plurality of the food material constitutes layered food material.

The cutting apparatus (40) is disposed under the double nozzle (30). The cutting apparatus (40) is comprised of a plurality of shutters (42) to cut the bar-like double-layered food material (WC) extruded from the double nozzle (30) and to form the enveloped food products (WD). A plurality of shutters (42), which are well known, as for example, by Japanese Patent Nos. 2916515 and 3016246, can be used. Further, the cutting apparatus (40) moves up and down in synchronization with the motions of the vertical moving table (51) of the linear conveyor apparatus (50), explained below.

The linear conveyor apparatus (50) is disposed below the cutting apparatus (40). The vertical moving table (51) can be freely moved up and down by a cam (54) and a link mechanism connected to a control motor (M4) to move it up and down. A driving roller (52) is connected to a control motor (M5) through a series of gears (not shown). A belt (53) wound around a plurality of rollers, such as the roller of the vertical moving table (51) and the driving roller (52), moves up and down in correspondence with the motions of

the vertical moving table (51). The belt (53) supports the lower surface of the bar-like double-layered food material (WC) when the cutting apparatus (40) cuts it into the enveloped food products (WD). The driving roller (52) is driven by intermittently driving the control motor (M5), and then the enveloped food products (WD) are transferred to a next step by moving the belt (53).

As shown in Fig. 1, the apparatus for extruding bar-like double-layered food material (1) is provided with the control apparatus (60). The control apparatus (60) is provided with a control panel (61) having a control switch to control the quantity of the outer food material (WA) and the inner food material (WB) to be supplied, the angular rate, the angular acceleration, and the timing to start the acceleration of the rate of rotation of the rotor (15) of the vane pump for the outer food material (13) and the rotor (25) of the vane pump for the inner food material (23). It also controls the rate to divide the enveloped food products (WD), the rate of transfer by the belt (53), and the activation and the shutoff of the elements of the apparatus for extruding the bar-like double-layered food material (1). The control apparatus (60) also has a control apparatus (62) to drive each control motor based on the data that is input.

As shown in Fig. 3, a pulse encoder (65) is connected to the pump driving shaft (19) of the apparatus for feeding the outer food material (10), to detect the angle (D) of rotation of the rotor (15). A driving gear (63) is fixed on the pump driving shaft (19) connected to the rotor (15). Further, the pulse encoder (65) is fixed to a bracket (66), which is supported on the support base (3), and a driven gear (64) is fixed on the rotating shaft (65A) of the pulse encoder (65), and the driven gear (64) engages the driving gear (63). The number of teeth of the driven gear (64) equals that of the driving gear (63). Thus, since the pulse encoder (65) rotates in synchronization with the rotor (15), it can detect the angle (D) of rotation of the rotor (15).

Now a method for controlling the rate of rotation (equal to the angular velocity) of the rotor (15) is explained. The position of the vane (16B) shown in Fig. 4 is defined as the reference position of the rotor (15) and as "0" degrees. As explained above, the position of the vane (16B) is the starting point of the space (13B) for supplying the outer food material (WA). The position of the vane (16A) corresponds to the ending point of the curved surface (17D) of the cam (17) and corresponds to the starting point of the

curved surface (17A). Further, at the position of the vane (16B), the position of the rotating shaft (65A) of the pulse encoder (65) is defined as the reference position of the rotating shaft (65A) and as "0" degrees.

Fig. 5 shows a change of the rate (V) of rotation of the rotor (15). The horizontal scale of Fig. 5 shows the angle (D) of rotation of the rotor (15) rotating in the direction of the arrow (R2), and the vertical scale shows the rate (V). The interval of the rotor (15) is defined by the angle formed by the adjacent slits (15A) (equal to the angle formed by the adjacent vanes [16]), and the rotor (15) rotates at a reference-rotating rate (V1) at the portion of the interval defined by an angle (D1) from the reference position. Then the rotor (15) rotates at rate (V2) that is higher than the reference-rotating rate (V1), at the portion of the interval defined by an angle (D2). Then, the rotor (15) has its rate of rotation reduced and rotates at the reference-rotating rate (V1) at the remaining portion of the interval defined by an angle (D3). This cycle of the rotor (15) is repeated six times while it rotates one round.

The values of the reference-rotating rate (V1), the higher rate of rotation (V2), and the angles (D1), (D2), and (D3) can be inputted by using the control panel (61). Further, as explained above, the angles (D1), (D2), and (D3) are detected by the pulse encoder (65), and the data on the angles (D1), (D2), and (D3) are transmitted to the control apparatus (62).

Examples 1-7

Now, test results of cutting food dough for a steamed bean-jam bun (kasuga manju) as the outer food material (WA) by using the apparatus for extruding bar-like double-layered food material (1) are explained.

In these embodiments, the nozzle for the inner food material (35) of the double nozzle (30) is plugged, and the nozzle for the outer food material (36) having a nozzle diameter of 38 mm is used. Further, the reference-rotating rate (V1) of the rotor (15) is set at one revolution per minute, and the angle (D2), which is the portion of the interval to rotate at a higher rate of rotation, is set at 15 degrees. The rate of cutting the bar-like double-layered food material by the cutting apparatus (40) is set at 20 times a minute.

Besides the above conditions, the angle (D1) is set at "0" degrees, "10" degrees, "20" degrees, and "30" degrees, and the higher rate of rotation (V2)

is set at $1.05 \times V1$, $1.1 \times V1$, $1.2 \times V1$. The tests for cutting the food material are performed with a combination of these parameters. The samples of the tests consist of 30 food products which are continuously cut by the cutting apparatus.

Comparative Example 1

In comparative example 1, the rotor (15) rotates at the reference-rotating rate ($V1$) (at a constant rate), and the other parameters are the same as those of examples 1–7. Namely, comparative example 1 shows a conventional method for cutting the bar-like double-layered food material.

Now examples 1–7 are compared with comparative example 1. Table 1 shows the results of examples 1–7 and comparative example 1. It contains the angle ($D1$), the higher rate of rotation ($V2$), the maximum weight of the products (unit: grams), the minimum weight of the products (unit: grams), and the standard deviation of the weights of the products. If the value of the standard deviation is small, it can be understood that the variations of the weights are small.

Fig. 6(A) is a sequential line graph indicating the weights of the products of example 3 in sequence. Fig. 6(B) is the sequential line graph indicating in sequence the weight of the products of comparative example 1.

It is clearly found that the values of the standard deviations of examples 2–6 are smaller than those of comparative example 1, by comparing the standard deviations of the weights of their products. Namely, the variations of the weights of the products of examples 2–6 are smaller than those of comparative example 1. It is clearly found that the changes of the sequential line of Fig. 6(A) are smaller than those of Fig. 6(B), by comparing Fig. 6(A) to Fig. 6(B). Thus, it is also found that the pulsating flow of the outer food material (WA) extruded from the double nozzle (30) of examples 2–6 is smaller than that of comparative example 1. From these facts, it is also found that in examples 2–6 the change of the pressure of the outer food material (WA) at the exit-side flow path is smaller than that of comparative example 1. Thus, in examples 2–6, the pulsations of the pressure of the outer food material (WA) are reduced.

It is clearly found that the minimum weight of the products of

examples 1 and 7 is almost equal that of examples 2–6, by comparing examples 1 and 7 with examples 2–6. However, the maximum weight and the standard deviations of the weights of the products of examples 1 and 7 are greater than those of examples 2–6. From these results, it is clearly found that the pulsating flow of the outer food material (WA) extruded from the double nozzle (30) of examples 1 and 7 is greater than that of examples 2–6.

For example 1, since the rate of the rotor (15) increases before the pressure of the outer food material (WA) in the exit-side flow path (11D) decreases, and since the quantity of the food material to be supplied to the double nozzle increases, it is clearly found that the pressure in the exit-side flow path further decreases. From this fact, it is found that the outer food material (WA) does not start to be transferred to the double nozzle just after the vane (16A) starts to sink in the rotor (15), and the exit-side flow path (11D) of the hopper (11) starts to communicate with the measuring space (13A). Namely, some more time is necessary before the outer food material (WA) can start to be transferred to the double nozzle.

For example 7, since the pressure of the outer food material (WA) in the exit-side flow path (11D) temporarily decreases, and then the pressure gradually increases, it is found that the rate of the rotor (15) increases at the portion of the interval in which the pressure of the food material is relatively high.

The average weights of the food products of examples 1–7 are greater than those of comparative example 1. The reason is that the quantity of the outer food material (WA) which is transferred from the vane pump for the outer food material (13) to the double nozzle (30) increases, because the rate of rotation of the rotor (15) increases at the interval where the rotor rotates at the higher rate of rotation (V2).

Example 8

Under the same conditions as in example 3, tests for cutting dough for sponge cake buns (dough for baking) to be used as the outer food material (WA) were performed. The samples of the tests consist of 30 food products which were continuously cut by the cutting apparatus.

Comparative Example 2

For comparative example 2, the rotor (15) rotates at the reference-rotating rate (V1), and the other parameters are the same as those of example 8. Namely, comparative example 2 shows a conventional method for cutting bar-like double-layered food material.

Table 2 shows the results of example 8 and comparative example 2. It is clearly found that the values of the standard deviations of example 8 are smaller than those of comparative example 1, by comparing the standard deviations of the weights of the products of them. Namely, the variations of the weights of the products of example 8 are smaller than those of comparative example 2. Thus, it is clearly found that for example 8 the pulsating flow of the bar-like food material of the outer food material (WA) extruded from the double nozzle is reduced.

It is found that the changes in the sequential line of Fig. 6(A) are smaller than those of Fig. 6(B), by comparing Figs. 6(A) and Fig. 6(B). Thus, it is also found that the pulsating flow of the outer food material (WA) extruded from the double nozzle (30) of examples 2–6 is smaller than that of comparative example 1. From these facts, it is also found that in examples 2–6 the change of the pressure of the outer food material (WA) at the exit-side flow path is smaller than that of comparative example 1. Thus, in examples 2–6, the pulsations of the pressure of the outer food material (WA) are reduced.

Example 9

Next, food dough for a steamed bean-jam bun (kasuga manju) as the outer food material (WA) and a strained bean-jam as the inner food material (WB) are loaded in the hoppers of the apparatus for extruding bar-like double-layered food material (1), and then the enveloped food products (WD) are manufactured by cutting the bar-like double-layered food material (WC), which includes the inner food material (WB) enveloped with the outer food material (WA) and which is extruded from the double nozzle (30). For example 9, the double nozzle (30) having the nozzle for the inner food material (35) and the nozzle for the outer food material (36), which respectively have a nozzle diameter of 36 mm and 37 mm, is used. The

reference-rotating rate (V1) of the rotor (15) is set at one revolution per minute, and the higher rate of rotation (V2) is set at $1.1 \times V1$. About the angles of the rotor (15), the angles (D1), (D2), and (D3) are respectively set at 10 degrees, 15 degrees, and 35 degrees. The angle (D2) defines the interval where the rotor (15) rotates at the higher rate of rotation (V2). The rate of rotation of the rotor (25) of the vane pump (23) disposed in the apparatus for feeding an inner food material (20) is set at a predetermined constant value. Further, the operating rate of the cutting apparatus is set at 20 times per minute. The 30 samples of the enveloped food products to be continuously manufactured are then selected.

Comparative Example 3

In comparative example 3, the rotor (15) rotates at the reference-rotating rate (V1), and the other parameters are the same as those of example 9. Namely, comparative example 3 shows a conventional method for cutting the bar-like double-layered food material.

Besides Table 2, Table 3 also shows the results of example 9 and comparative example 3. It is found from the results that the values of the standard deviations of example 9 are smaller than those of comparative example 3, by comparing the standard deviations of the weights of the products of them. Namely, the variations of the weights of the products of example 9 are smaller than those of comparative example 3. Thus, it is found that for example 9, the pulsating flow of the bar-like double-layered food material (WC) extruded from the double nozzle (30) is reduced by controlling the rate (V) of the rotor (15) of the vane pump for the outer food material (13) disposed in the apparatus for feeding the outer food material (10) of the apparatus for extruding bar-like double-layered food material (1), and it is found that the variations of the weights of the products, which are cut by the cutting apparatus, are also reduced.

From the results of the examples, it is found that the outer food material (WA) can be stably supplied to the double nozzle so that the temporary decrease of the pressure of the food material in the exit-side flow path (11D) is made up for by controlling the rate (V) of rotation of the rotor (15). In accordance with the changes of the number of vanes, the properties of the food material, and the quantity of the food material to be supplied to

the double nozzle, the movements of the rotor (15) can be modified by changing the profile of the cam (17).

Next, the second embodiment of the apparatus for feeding the outer food material (10) of the application is explained based on Fig. 7. Fig. 7(A) shows a plane view, partly in cross section, of the apparatus for extruding bar-like double-layered food material (1). Fig. 7(B) shows an elevational view at the line B—B shown in Fig. 7(A). In the second embodiment, the same denotations of the numbers as those of the first embodiment are used for the same elements as those of the first embodiment. The explanations of the same elements as those of the first embodiment are omitted.

The apparatus for extruding bar-like double-layered food material (1) of the second embodiment is comprised of an objective body (67), a photodetector (68), and a bracket (69), instead of the driving gear (63), the driven gear (64), the pulse encoder (65), and the bracket (66) of the control apparatus (60) of the first embodiment. The objective body (67) is fixed to the pump driving shaft (19) connected to the rotor (15), so that the position of rotation of it for the shaft (19) can be freely set. The photodetector (68) for detecting the objective body (67) is fixed to the bracket (69), which is supported on the support base (3). The portions (67A) that protrude from the objective body (67) are disposed on its periphery at even intervals, which periphery is divided into six parts.

The position of rotation of the objective body (67) shown in Fig. 7(B) corresponds to that of the vanes (16). Namely, the position of the objective body (67) shown in Fig. 7(B) is the reference position of the rotor (15). When the objective body (67) rotates at an angle (D1) from the reference position at the reference-rotating rate (V1), the photodetector (68) detects the portion (67A) that protrudes from the objective body (67), and then the signal generated by the photodetector (68) is communicated to the control apparatus (60). The control apparatus (60) controls the control motor (M1) so that the rotor (15) rotates at a predetermined and higher rate of rotation (V2). Then, when the rotor (15) rotates at an angle (D2), since the photodetector (68) cannot detect the portion (67A), the control apparatus (60) begins to control the control motor (M1) so that the rotor (15) rotates at the reference-rotating rate (V1).

It is possible to adjust the angle of rotation of the objective body (67) to that of the pump driving shaft (19) by providing either the objective body

(67) or the shaft (19) with a scale, and providing the other with a mark. For example, the apparatus for extruding bar-like double-layered food material (1) having the same condition as in example 3 can be set up by setting the angle of the portion (67A) of the objective body (67) (corresponding to the angle [D2]) at 15 degrees, and by fixing the objective body (67) to the pump driving shaft (19) so that the angle (D1), which is the angle of rotation from the reference position of the rotor (15), becomes 10 degrees.

In the apparatus for extruding bar-like double-layered food material (1) of the second embodiment, the rotor (15) can be controlled by a control apparatus having a simpler constitution than that of the first embodiment. Further, despite the fact that the food material used in the apparatus may be of one type or plural types, if the properties of the food material are similar, the apparatus (1) of the second embodiment is suited for using these materials. In the second embodiment, though the photodetector (68) is used as a means for detecting the angle of rotation of the objective body (67), a limit switch, which can detect the angle of rotation by contacting the objective body (67), can also be used.

The embodiments of the apparatus for extruding bar-like double-layered food material (1) of the application are explained above. However, the apparatus is not limited to these embodiments, and one can make various improvements in the scope of the claims. For example, in the above embodiments, though it is explained that the rate of rotation of the rotor (15) of the apparatus for feeding the outer food material (10) is controlled, it is possible to reduce the variations of the pressure of the inner food material (WB) in an exit-side flow path (24B) and to inhibit the pulsating flow of the inner food material extruded from the double nozzle (30) by controlling the rate of the rotor (25) of the apparatus for feeding the inner food material (20). Further, it is possible to inhibit the pulsating flow of the bar-like double-layered food material extruded from the double nozzle (30) by controlling the rate of both the rotor (15) and the rotor (25).

In the above embodiments, though it is explained that the rate of rotation of the rotor (15) of the apparatus for feeding the outer food material (10) is controlled by using the two-staged rate as shown in Fig. 5, it is possible to control it by using the multi-staged rate or another rate having a non-linear relationship, to inhibit the pulsating flow of the bar-like double-layered food material. It is also possible to control the rate of

rotation of the rotor (25) of the apparatus (20) by the same method.

Further, in the above embodiments, though it is explained that the cutting apparatus (40) cuts the bar-like double-layered food material (WC) extruded from the double nozzle (30) to manufacture the enveloped food products (WD), it is possible to cut the bar-like double-layered food material (WC) extruded from the double nozzle (30) to manufacture the bar-like double-layered food material having a predetermined length. Since the pulsating flow of the bar-like double-layered food material extruded from the double nozzle (30) can be inhibited, the variations of the weight of the divided bar-like double-layered food material are reduced, and it is possible to manufacture food products having a stable configuration.

Further, it is possible to use a flat-type nozzle for one material having, for example, a long and thin shape in cross section, instead of the double nozzle for plural materials.

What we claim is:

1. An apparatus for continuously extruding bar-like double-layered food material which includes two kinds of food material and which comprises of an inner food material enveloped by an outer food material, comprising:

an apparatus for feeding the outer food material having a hopper to hold the outer food material and a vane pump for the outer food material disposed at the bottom of the hopper,

an apparatus for feeding the inner food material having a hopper to hold the inner food material and a vane pump for the inner food material disposed at the bottom of the hopper,

a double nozzle that communicates with the apparatus for feeding the inner food material and the apparatus for feeding the outer food material, to continuously extrude bar-like double-layered food material by enveloping the inner food material with the outer food material, and

a roller for transferring food material disposed so that its rotating axis is horizontally arranged,

wherein the vane pumps for the outer food material and the inner food material are disposed so that the rotating axis of one of the vane pumps is vertically arranged and that of the other is horizontally arranged,

wherein the roller is disposed at the side of and transfers the food material held in the hopper to the vane pump that has its rotating axis horizontally arranged.

2. The apparatus of claim 1, wherein the vane pumps for the outer food material and the inner food material are disposed so that the rotating axis of the vane pump for the outer food material is horizontally arranged and that of the vane pump for the inner food material is vertically arranged.

3. The apparatus of either of claim 1 or 2, further comprising:

an apparatus for controlling the vane pump for the outer food material,

wherein the apparatus for controlling the vane pump has an apparatus for detecting an angle of rotation of the rotor of the vane pump for the outer food material and controls the vane pump for the outer food material so that it switches between a basic rate of rotation and a rate of

rotation higher than the basic one, while the vanes, which are disposed on the periphery of the rotor at even intervals, move to supply the food material to the exit-side flow path, and

the switching of the rate of rotation of the rotor is repeated in correspondence with the location of rotation of each vane.

4. The apparatus of either of claim 1 or 2, further comprising:

a screw conveyor disposed at the bottom of the hopper for the inner food material to transfer the food material held in the hopper for the inner food material to the vane pump for the inner food material by rotating the screw conveyor.

5. The apparatus of either of claim 1 or 2, further comprising:

a connecting interface tube disposed between the apparatus for feeding the outer food material and the double nozzle,

wherein the connecting interface tube is slidably installed between them,

the tube can seal the connecting interface surface for the food material, and

the tube allows the apparatus for feeding the outer food material to be easily removed from the apparatus for extruding bar-like double-layered food material and to be easily installed in it.

6. The apparatus of either of claim 1 or 2, further comprising:

a connecting interface tube disposed between the apparatus for feeding the inner food material and the double nozzle,

wherein the connecting interface tube is slidably installed between them,

the tube can seal the connecting interface surface for the food material, and

the tube allows the apparatus for feeding the inner food material to be easily removed from the apparatus for extruding bar-like double-layered food material and to be easily installed in it.

7. The apparatus of either of claim 1 or 2, further comprising:

connecting interface tubes disposed between the apparatus for

feeding the outer food material and the double nozzle and between the apparatus for feeding the inner food material and the double nozzle,

wherein the connecting interface tubes are slidably installed between them,

the tubes can seal the connecting interface surface for the food material, and

the connecting interface tubes disposed between the apparatus for feeding the outer food material and the double nozzle are smaller than these disposed between the apparatus for feeding the inner food material and the double nozzle.

8. The apparatus of either of claim 1 or 2,

wherein the exit-side flow path of the apparatus for feeding the outer food material, which communicates with the double nozzle, is inclined downward.

9. The apparatus for manufacturing enveloped food products by using the apparatus of claim 3, further comprising:

a cutting apparatus disposed under the double nozzle to cut the bar-like double-layered food material extruded from the double nozzle, and

a linear conveyor apparatus disposed under the cutting apparatus to convey the enveloped food products cut by the cutting apparatus.