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[54] **DEVICE FOR CONVEYING AND FEEDING GRANULAR MATERIALS**

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[52] **U.S. Cl.** **302/49**, 222/194

[51] **Int. Cl.** **B65g 53/46**

[58] **Field of Search** 222/194; 302/49

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Assistant Examiner—W. Scott Carson
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[57] **ABSTRACT**

A device for continuously feeding a granular material under a relatively low pressure into a fluid system maintained at a relatively high pressure, which comprises a stationary casing lying with its axis extending horizontally and having a cylindrical inner surface, and a rotor coaxially disposed in said casing for rotation therein and having a cylindrical outer surface of a diameter substantially equal to the diameter of the cylindrical inner surface of said casing. The rotor is formed therein with at least one U-shaped granular material receiving channels or chamber extending in a direction substantially parallel to the axis of said rotor and having both ends open in the outer surface of said rotor, while the casing has formed in its cylindrical wall granular material supply ports at the top portion thereof at such positions that said supply ports may be communicated with the open ends of the granular material receiving chamber of said rotor respectively when said chamber is brought to the top portion of said casing incident to rotation of said rotor, high pressure fluid inlet and outlet ports at one side thereof for communication with the open ends of said granular material receiving chamber respectively and pressure releasing ports at the opposite side thereof for communication with the open ends of said granular material receiving chamber respectively.

3 Claims, 9 Drawing Figures

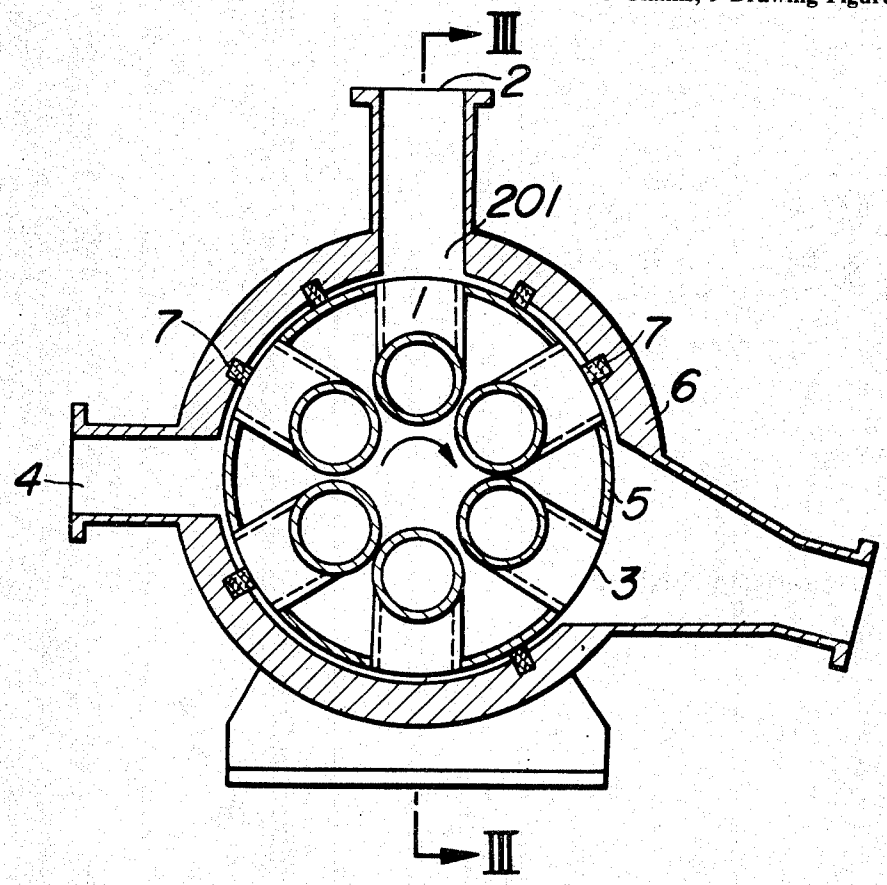


FIG. 1

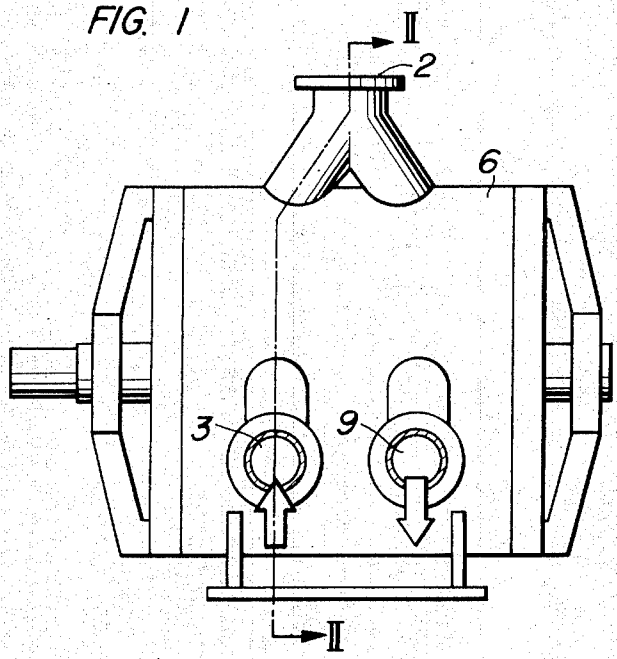


FIG. 2

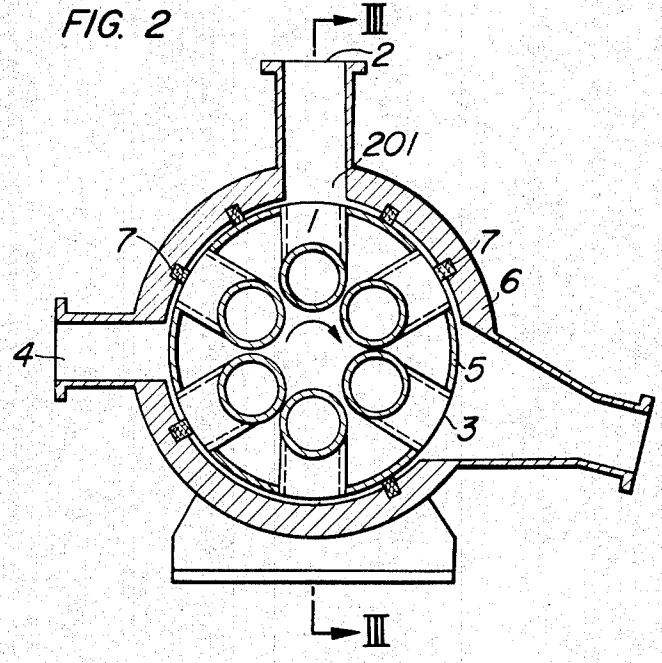


FIG. 3

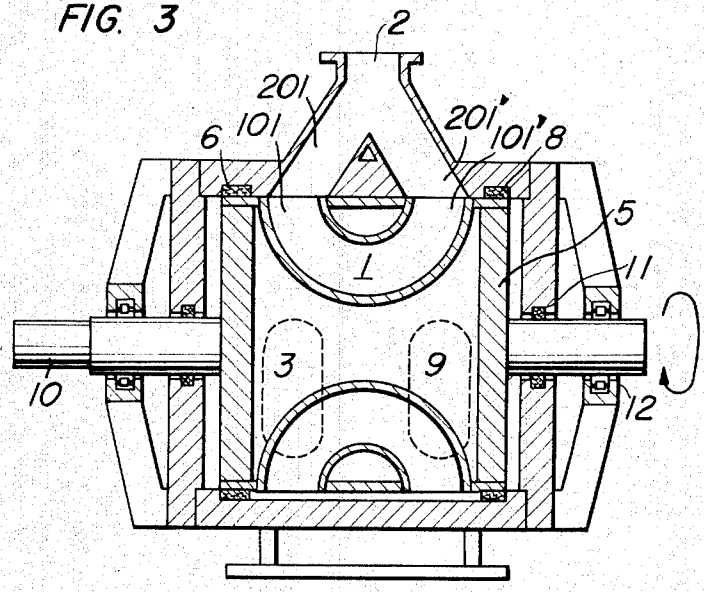


FIG. 4

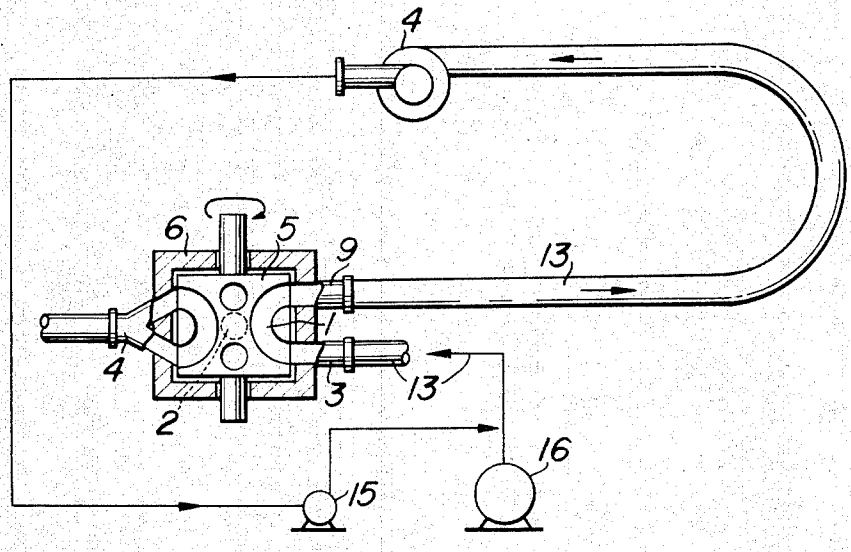


FIG. 5a

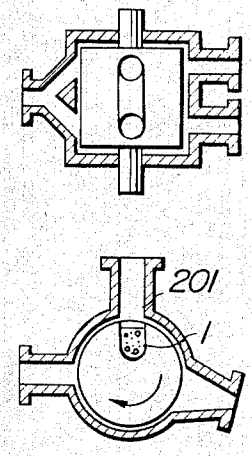


FIG. 5b

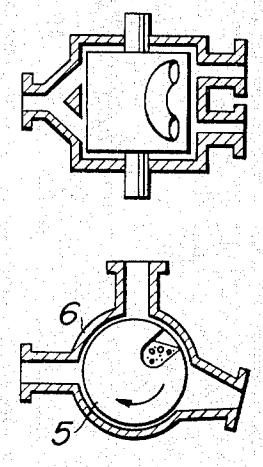


FIG. 5c

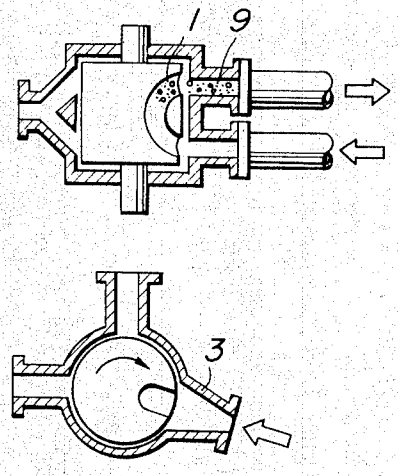


FIG. 5d

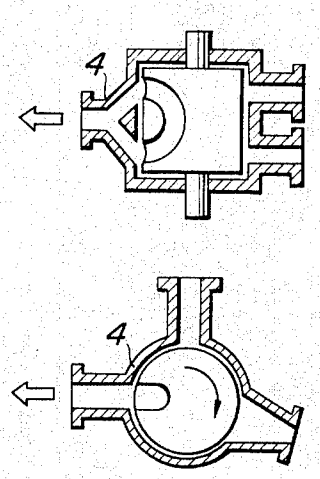
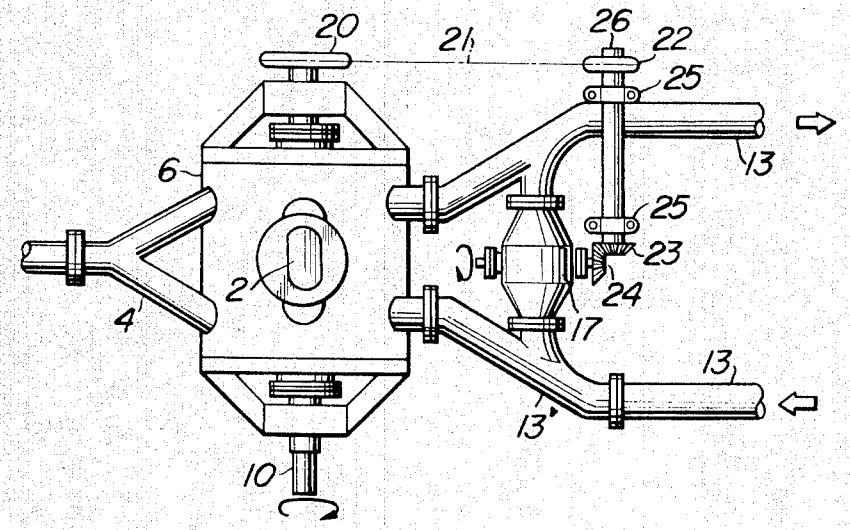


FIG. 6



DEVICE FOR CONVEYING AND FEEDING GRANULAR MATERIALS

This invention relates to a device for continuously efficiently feeding a granular material under a relatively low pressure into a system maintained at a relatively high pressure, which is adapted for use in such apparatus, for example, as the expanded food producing apparatus utilizing a hot gas disclosed in Japanese Pat. Publication No. 34747/71.

Conventional apparatus of the type described have suffered the disadvantages that the capacity of the system is decreased and the flow resistance in the system is increased by the granular material being processed attached heavily on the inner wall of the system, that the product is contaminated by the deteriorated material detaching from the inner wall of the system, that a wear of packings and an increase of load on a rotor, caused by the deteriorated material caught between said packing and rotor, are unavoidable, and that the capacity of a granular material container per unit rotor is small and hence the operational efficiency is low.

The present invention aims to overcome such disadvantages of the conventional apparatus.

According to the present invention there is provided a device for continuously feeding a granular material under a relatively low pressure into a fluid system maintained at a relatively high pressure, which comprises a stationary casing lying with the axis thereof extending horizontally and having a cylindrical inner surface, and a rotor coaxially disposed in said stationary casing for rotation therein and having a cylindrical outer surface of a diameter substantially equal to the diameter of the inner cylindrical surface of said casing, said rotor being formed therein with at least one U-shaped granular material receiving channel or chamber extending in a direction substantially parallel to the axis of said rotor and being open at both ends in the outer surface of said rotor, and said casing having formed in its cylindrical wall granular material supply ports at the top portion thereof at such positions that said supply ports may be communicated with the open ends of said granular material receiving chamber respectively when said chamber is brought to the top portion of said casing incident to rotation of said rotor, a high pressure fluid inlet port and a high pressure fluid outlet port at one side thereof at a suitable level for communication with the open ends of said granular material receiving chamber respectively and pressure releasing ports at the other side thereof for communication with the open ends of said granular material receiving chamber respectively.

The inner surface of the casing is suitably spaced from the outer surface of the rotor to provide for free rotation of said rotor, and a plurality of axially extending linear packings are preferably provided at suitable locations in said space and annular packings at the opposite ends of said linear packings in contact therewith, for preventing the leakage of high pressure fluid through said space toward the low pressure side.

These packings may be fixed on the inner surface of the casing or on the outer surface of the rotor for rotation therewith.

The device of the invention constructed as described above operates in the following manner:

A granular material to be processed, which has previously been metered by suitable pre-treatment device (not shown), is supplied from the granular material

supply ports of the casing into the granular material receiving chamber through the open ends thereof when the open ends of said chamber have been brought into communication with said supply ports respectively incident to rotation of the rotor.

The quantity of the granular material to be charged into the granular material receiving chamber at one time is metered such that the surfaces of the material charged into the chamber may be slightly below the cylindrical surface of said rotor respectively.

Then, the granular material receiving chamber into which the granular material has been thus charged is brought into communication with the high pressure fluid inlet and outlet ports incident to rotation of the rotor. Since the surfaces of the granular material in the end portions of the chamber are slightly spaced from the outer surface of the rotor as described above, the attachment of the material to the packings during this stage can be minimized.

When the chamber has been brought into communication with the high pressure fluid inlet and outlet ports, the granular material in said chamber is blown into a high pressure fluid system by high pressure fluid jetting into said chamber from said inlet port, and flows in said system while being entrained in the high pressure fluid.

Since the granular material is conveyed by the force of inertia of the high pressure fluid, the attachment thereof to the inner wall of the granular material receiving chamber is minimized.

After the granular material has been fed into the high pressure fluid system, the pressurized fluid remains in the emptied granular material receiving chamber. The remaining pressurized fluid, however, is released from the chamber through the pressure releasing port when said chamber is brought into communication with said pressure releasing port as the rotor further rotates, and thus the pressure in said chamber is reduced to normal pressure.

The above described operation is repeated, thereby continuously feeding the granular material under a relatively low pressure into the fluid system maintained at a relatively high pressure.

It will be understood that the material feeding efficiency of the device can be enhanced by providing a plurality of granular material receiving chambers of the type described in the rotor.

When the rotor has a plurality of granular material receiving chambers as stated above, the diameter of the pressure fluid inlet and outlet ports in the casing is made sufficiently larger than the diameter of the openings of the respective chambers, and further the distance between the openings of the adjacent chambers is suitably selected such that two or more of the chambers may always be communicated with said high pressure fluid inlet and outlet ports. By so doing, the granular material can be fed into the high pressure system substantially constantly and the high pressure fluid inlet and outlet ports can be maintained in communication with any one of said chambers without being closed by the outer surface of the rotor, so that the pulsation of pressure in the system can be avoided.

In the event when it is impossible to maintain the high pressure fluid inlet and outlet ports in communication with one or more of the granular material receiving chambers as stated above, it is preferable to provide, exterior of the casing, a by-pass passage in the high

pressure system directly communicating said inlet and outlet ports with each other and to provide a valve in said by-pass passage, so as to compensate a change in the cross-sectional area of the fluid passage of said system by the degree of opening of said valve which is varied in timed relation with the rotation of the rotor and thereby to alleviate the pulsation of pressure in the system.

The provision of the valve is also effective to eliminate slight pulsation which occurs even when the high pressure fluid inlet and outlet ports are always in communication with one or more of the granular material receiving chambers.

The present invention will be further described by way of example with reference to the accompanying drawings.

FIG. 1 is a front elevational view of an embodiment of the device according to the present invention;

FIG. 2 is a sectional view of the device taken on the line A—A of FIG. 1;

FIG 3 is a sectional view taken on the line B—B of FIG. 2;

FIG. 4 is an illustrative view showing a practical arrangement incorporating the device of this invention;

FIG. 5*a* to 5*d* are a set of views illustrating the operation of the device step by step in sequence; and

FIG. 6 is a view of the device used with a high pressure fluid system which has a by-pass passage, a valve provided in said by-pass passage and a mechanism for transmitting rotation of the rotor to said valve for operating the latter in timed relation with the former.

Referring to FIGS. 1 to 3, a casing 6 lying with its axis extending horizontally and having a cylindrical inner surface has formed in its cylindrical wall granular material supply ports **201, 201'** at the top portion thereof, a high pressure fluid inlet port 3 and a high pressure fluid outlet port 9 at one side thereof at a suitable level, and pressure releasing ports 4 at the opposite side thereof.

In the casing 6 is concentrically rotatably disposed a cylindrical rotor 5 which has an outer diameter substantially equal to the inner diameter of said casing and supported by a rotary shaft 10 journalled in bearings 12 mounted in said casing. The rotor 5 is rotated in the casing 6 in a clockwise direction as viewed in FIG. 2, by a rotational force supplied thereto through the rotary shaft 10 from a driving source not shown.

The rotor 5 has formed therein six granular material receiving chambers 1 arranged radially with respect to the axis thereof and each chamber is in the form of a U-shaped channel convexly curved toward the center of the rotor and has both ends **101, 101'** open in the cylindrical surface of the rotor adjacent thhe edges of the opposite side surfaces of said rotor.

The tangential diameter of the high pressure fluid inlet and outlet port 3, 9 are made sufficiently larger than the diameter of the open ends **101, 101'** of the granular material receiving chambers 1 and the circumferential distance between the open ends of the adjacent chambers 1 is suitably selected, so that the open ends **101, 101'** of at least one granular receiving chamber may always be in communication with the high pressure inlet and outlet ports 3, 9 respectively.

In order to prevent the leakage of high pressure fluid through the gap between the inner surface of the casing 6 and the outer surface of the rotor 5, linear packings 7 are provided on the inner surface of the casing 6. Further, annular packings 8 are provided along the opposite edges of the cylindrical surface of the rotor 5 and annular packings 11 are provided around the rotary shaft 10 as shown, to prevent the leakage of high pressure fluid from the high pressure side toward the low pressure side.

The device described above is used in such apparatus, for example, as the expanded food producing apparatus utilizing a hot gas stream, disclosed in Japanese Pat. Publication No. 34747/71, and the high pressure fluid inlet and outlet ports 3, 9 are connected with a high pressure fluid system 13 which is supplied with high pressure fluid from a suitable pressure source 16, as shown in FIG. 4.

All of the six granular material receiving chambers 1 play the same role, which will be explained hereunder with reference to only one of them.

The granular material receiving chamber 1 receives a supply of granular material to be processed, from the granular material supply ports **201, 201'** in such a quantity that the surfaces of the charged granular material in the open end portions of the chamber may be slightly spaced from the cylindrical surface of the rotor, as shown in FIG. 5*a*. Then, the charged granular material receiving chamber is brought to the position shown in FIG. 5*b* as the rotor rotates in the clockwise direction. Because of the presence of air space above the surface of the charged granular material, the surfaces of granular material are inclined within the chamber as shown, during the rotational movement of said chamber. Therefore, the chance of contact of the granular material with the packings 7, 8 (FIG. 2) is decreased and hence the attachment of the material to the packings and the inner wall of the casing can be minimized.

Further, it should be appreciated that the packings which tend to project toward the center of the casing are maintained in the proper position so that wearing of the packings is prevented because of the presence of the solid surface of the rotor between the two openings of each granular material receiving chamber 1.

As the rotor further rotates and when the open ends of the granular material receiving chamber 1 have brought to positions communicating with the high pressure fluid inlet and outlet ports 3, 9 respectively, as shown in FIG. 5*c*, high pressure fluid admitted into the chamber from the high pressure fluid inlet port 3 blows the granular material out of said chamber and forces it into the high pressure fluid system from the high pressure fluid outlet port. Thus, the granular material is fed into the high pressure fluid system.

When the open ends of the chamber 1 have been brought into communication with the pressure releasing ports 4 incident to rotation of the rotor, as shown in FIG. 5*d*, the high pressure fluid remaining in the chamber 1 is released therefrom and normal pressure is restored in said chamber. Then, the chamber 1 is returned to the position shown in FIG. 5*a* incident to the rotation of the rotor and the above-described operation is repeated.

All of the other granular material receiving chambers play the same role as above described and thereby the granular material under a relatively low pressure can be continuously fed into the high pressure fluid system.

By providing a by-pass passage of a suitable diameter in the high pressure fluid system, directly connecting

the high pressure fluid inlet and outlet sides with each other by-passing the casing **6**, providing a valve **17** in said by-pass passage and operating said valve **17** in timed relation with the rotation of the rotor, as shown in FIG. **6**, the pulsation of pressure in the high pressure fluid system **13** can be prevented.

Namely, in the event when the resistance to fluid varies with the variation of the cross-sectional area of the high pressure fluid system due to the position of the rotating rotor, the degree of opening of the valve **17** is varied in a manner to compensate said variation in the cross-sectional area, whereby the pulsation of pressure in the system **13** can be prevented.

The shaft of the valve **17** is operatively connected to the rotary shaft **10** of the rotor through a rotation transmitting mechanism shown in FIG. **6**, so that said valve may be operated in timed relation with said rotor.

In FIG. **6**, reference numeral **20** designates a sprocket mounted on an extension of the rotary shaft **10, 21** a drive chain, **22** another sprocket, and **23, 34** bevel gears.

Although the present invention has been described and illustrated herein in terms of a specific embodiment thereof, it is to be understood that many changes and modifications are possible without deviating from the spirit of the invention and the scope of the invention defined in the appended claims.

What is claimed is:

1. A device for feeding granular foodstuff into a high pressure fluid system of an apparatus for producing expanded foodstuff comprising:

a stationary casing having a cylindrical inner surface aligned with its axis extending horizontally, said casing having in its wall at a top portion thereof two granular foodstuff inlet ports which converge into one granular foodstuff passing port, high pressure inlet and outlet ports positioned laterally of the casing, and a pressure releasing port; a rotor having a diameter substantially equal to that of the inner surface of said casing, said rotor having a plurality of radially disposed foodstuff receiving chambers, each of said chambers being formed as a U-shaped tube with a constant circular cross section terminating in two end openings formed in the cylindrical surface of said rotor, said two openings being spaced from each other in the axial direction of the rotor leaving therebetween a substantially long supporting surface of the rotor, which openings register with said two granular foodstuff inlet ports and said high pressure inlet and outlet ports incident to the rotation of the rotor; a first group of linear packings accommodated in axially extending grooves formed in a region of the inner surface of said casing between said granular foodstuff inlet ports and said high pressure inlet and outlet ports, at least two of said linear packings being spaced circumferentially from one another by a distance greater than the diameter of one of said two end openings so that the entire length of at least one of said packings is in a continuous surface contact with said rotor, a second group of linear packings accommodated in axially extending grooves formed in a region of said inner surface of said casing between said high pressure inlet and outlet ports and said pressure releasing port, at least two of said second group of linear packings being spaced circumferentially from one another by a distance greater than the diameter of one of said two end openings so that the entire length of at least one of said packings is in continuous surface contact with said rotor, said substantially long support surfaces on said rotor supporting said linear packings, said first and second groups of linear packings extending beyond the axial extent of said U-shaped foodstuff receiving chambers, and two annular packings at the opposite ends of said linear packings in contact therewith.

2. A device as claimed in claim **1** comprising a means for putting a predetermined quantity of granular foodstuff into said granular foodstuff receiving chamber through said granular foodstuff inlet ports so as to leave slightly empty spaces in the granular foodstuff receiving chamber at the end portions thereof.

3. A device as defined in claim **1** wherein said high pressure fluid system connected with said casing includes means operating in timed relation with the rotation of said rotor for inhibiting the pulsation of the pressurized fluid coupled to said high pressure inlet port, said means including a by-pass passage directly communicating the high pressure fluid inlet and outlet ports with one another externally of said casing, a valve provided in said by-pass passage, and rotation transmitting means mechanically coupling the shaft of said rotor to said valve for changing the cross-sectional area of said by-pass passage in timed relation with the rotation of said rotor.

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