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(54) Plant matter packaging process.

(57) There is provided process for packaging plant matter (12), said process comprising cooling plant matter to a temperature above the temperature at which ice crystals begin to form therein, filling the plant matter into containers (23) therefor, evacuating the gaseous atmosphere from the cooled plant matter-containing containers, introducing into the evacuated containers a gaseous mixture comprising an inert gas and at least 4% oxygen, and sealing the containers containing said gaseous mixture and cooled plant matter. The process is particularly suited to the packaging of uncooked and unfrozen vegetables, fruits or fungi or mixtures thereof, especially when chopped or diced, and enables the shelf storage life of such material to be extended significantly.

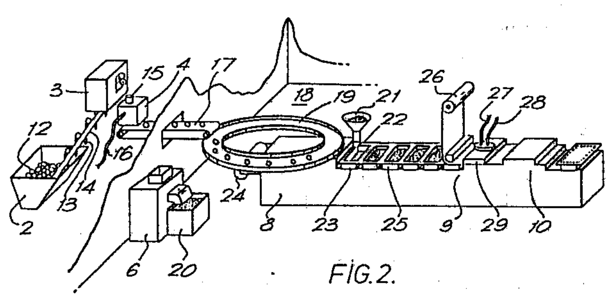

FIG. 2.

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Description

Plant matter packaging process

The present invention relates to a packaging process, in particular to a process for packaging material of plant origin, and especially such material in an uncooked state, and to packaged material produced thereby.

Fresh food products are frequently packaged for shop display in at least partially transparent containers, such as plastic bags or plastics trays or boxes having a plastics membrane lid or overwrap. Thus, in the case of meat products, it is known to package such products for supermarket display in an inert gas atmosphere within a heat-sealed transparent plastics container.

However, in the case of material of plant origin, for example vegetables, fruit, flowers and fungi, the fresh product has generally been packaged in perforated containers or in trays provided with an overwrap of a permeable plastics film, such as that generally referred to as cling-film. Packaged in this way, the fresh product has only a very limited shelf life, generally only a single day in the case of products which have been trimmed, cut or chopped before packaging.

It is an objective of the present invention to provide a packaging process by means of which the shelf life of packaged material of plant origin (hereinafter referred to as "plant matter") may be prolonged.

We have now surprisingly found that the shelf life for packaged plant matter may be prolonged by sealing the plant matter, when in a chilled state, within an oxygen-containing atmosphere within a container.

According to one aspect of the present invention there is therefore provided a process for packaging plant matter, said process comprising cooling plant matter to a temperature above the temperature at which ice crystals begin to form therein, filling the plant matter into containers therefor, evacuating the gaseous atmosphere from the cooled plant matter-containing containers, introducing into the evacuated containers a gaseous mixture comprising an inert gas and at least 4% oxygen, and sealing the containers containing said gaseous mixture and cooled plant matter.

It will be appreciated that the cooling of the plant matter may be performed before, during or after introduction of the plant matter into the containers; it is only necessary that the temperature of the plant matter be sub-ambient before the introduction of the gaseous mixture and the sealing of the containers. It will also be appreciated that where outdoor temperatures are low, no specific cooling step may be required in order to bring the plant matter to the required temperatures. Generally, however, the plant matter should be cooled to not less than about 0°C, to ensure that no undesirable formation of ice crystals occurs within the plant tissue, and to not more than 12°C, preferably not more than 8°C and especially preferably to a temperature within the range 2-7°C. As a general rule the lower the temperature to which the plant matter is cooled the better, especially where the plant matter is to be trimmed, cut or chopped before packaging as these operations are preferably done while the plant matter is in its cooled state.

Thus, for example, where onions are diced before packaging, the raw onion is preferably cooled to about 2-8°C, especially preferably 3-4°C, before topping and tailing, peeling and dicing in order that during these processing steps the temperature of the onion should not rise above about 5-9°C. Where any extensive pre-packaging preparation of the plant matter is required, the plant matter may desirably be subject to one or more additional cooling steps or even to continuous cooling, for example by the use of chilled conveyor systems, and some or all of the processing steps may if desired be effected within a controlled temperature environment in which the general air temperature may be maintained at a desired coolness, e.g. in the range 10-14°C.

The initial cooling of the plant matter may be effected in a variety of ways and for differing types of plant matter the optimum cooling method may differ. Thus, for light leafy material, it has been found that vacumn cooling is adequate while for denser products, such as cabbages and onions for example, forced air current cooling, e.g. using an ice bank cooler, has been found to be more effective.

The requirement for the plant matter to be cooled to below what is generally regarded as ambient temperature before it is sealed into the containers is one of the critical steps of the process of the present invention. Thus, in practice it has been found that even with products that are not trimmed, cut or chopped before packaging, shelf life is significantly extended relative to similar products which are sealed at ambient temperature under a similar gaseous mixture and only subsequently are chilled.

It has been found that, unlike with meat products, it is not acceptable to seal plant matter within a vacuum or within a wholly inert atmosphere. To prevent growth of anaerobic bacteria, the gaseous mixture in which the plant matter is sealed must contain oxygen as well as the inert gas. The oxygen concentration in the gaseous mixture used in the process of the present invention is preferably lower than the oxygen concentration in normal air and especially suitably is in the range 4 - 15%, preferably 5 - 10% and particularly preferably 5 - 6%. Gaseous mixtures containing about 40% oxygen and about 60% inert gas have however also been considered.

Percentage concentration of the components of the gaseous mixture is in terms of the percentage of the total pressure of the gaseous mixture constituted by the partial pressure of the particular component.

Unlike meat products, plant matter is alive even after harvesting and even after packaging it continues to produce carbon dioxide. We have however found that where the gaseous mixture introduced into the containers in the process of the invention contains a sub-ambient concentration of oxygen, it is highly desirable to include carbon dioxide within the gaseous mixture, conveniently at concentrations of 2 to 18%, preferably 4 to 16%, and especially preferably 5 to 15%. The carbon dioxide in the gaseous mixture appears to stabilize the plant matter during the build up of carbon dioxide generated by the plant matter itself. If the initial carbon dioxide level is too low, then non-rigid containers have shown an initial tendency to collapse and a long-term tendency to rupture or blow due to excess internal pressure. If on the other hand the initial carbon dioxide level is too high, then non-rigid containers have shown an initial tendency to blow.

The inert gas, which for reasons for economy will generally be nitrogen, conveniently is present as about 75 to 95%, preferably 80 to 90%, of the gaseous mixture.

The optimum composition of the gaseous mixture has been found to be dependent on the nature of the plant matter being packed and also on the manner of the pre-packaging preparation of the plant matter. Thus for chopped or diced plant matter, carbon dioxide is preferably present in the gaseous mixture at or towards the lower end of the preferred concentration ranges specified above. In contrast, for plant matter which is to be packaged essentially in the form in which it was harvested, the preferred carbon dioxide concentration is generally towards the upper end of the ranges specified above.

Since the gaseous mixture is generally oxygen- and nitrogen-containing, the evacuation of air from the cooled plant matter-containing containers need not be particularly rigorous and indeed in order to avoid harming the appearance, taste or smell of the plant matter, a prolonged exposure to very low pressures is considered undesirable. In general, we have found that rapid evacuation to about 55 - 65 cm Hg below ambient pressure is entirely adequate. The subsequent introduction of the gaseous mixture will conveniently be such as to bring the pressure within the container immediately after sealing to ambient or slightly subambient. For aesthetic reasons, internal pressures above ambient will generally be avoided.

The containers used in the process of the present invention may be of any desired shape, configuration and size but should desirably be capable of being sealed in a substantially gastight manner. Convenient forms for the containers include trays, bowls, blister packs and bags. Where the container is not self-supporting, for example where it is in the form of a plastics bag, it may if desired be provided with a separate support means such as an outer box. For ease of production however, we have found it particularly desirable to use plastics trays which may be closed by heat sealing a plastics lid or membrane thereon. In the case of unchopped plant matter, such as whole peeled onions for example, it may be advantageous to use cup-like trays of a size and shape suited to receive a single unit of the plant matter, i.e. a single vegetable, fruit or the like. The trays may be formed in a continuous web and after the sealing of the trays the web can be cut into sections each containing the desired number of trays.

Where the container is to be formed of plastics material, this should preferably be of a thickness at least sufficient to make the resultant package capable of withstanding normal handling during storage, transportation and retail display. For semi-rigid containers, we have found PVC laminates of about 490-700 microns thickness to be suitable for the trays or container bases. For the lid or sealing membrane, where one is required, it may sufficient to use thinner plastics material and we have found PVC films of up to about 100 microns thickness to be satisfactory.

The sealed container, while it should be substantially gas-tight need not be entirely gas-impermeable and low to medium permeability sealing membranes may be adequate. Indeed, in certain circumstances, selectively permeable membranes which permit oxygen to enter the container or which permit carbon dioxide to vent from the container, for example membranes which are more permeable to carbon dioxide than to oxygen, may be desirable.

The process of the present invention is applicable to plant matter in general but is especially applicable to uncooked and unfrozen plant matter and to chopped or diced plant matter. Thus examples of plant matter packageable according to the process of the invention include vegetables (e.g. onions, cabbages and runner beans), fruit (e.g. strawberries) and edible fungi (e.g. mushrooms).

Similarly, the process may be used to advantage to package mixtures of plant matter, for example prepared salads.

If, after the process of the invention, the filled and sealed containers are stored under cooled conditions, conveniently at 0-12°C, preferably 2-9°C, and especially preferably about 3°C, the shelf life of the packaged plant matter is prolonged significantly. Thus whereas conventionally packaged chopped or diced plant matter must be sold the day it is placed on display in the shop, packages produced according to the present invention may remain on the cooled shelf for several days. As an example, it has been found that at temperatures of about 9°C diced onion packaged according to the invention may last for up to about 10 - 11 days without any noticeable deterioration. Generally, however, a total shelf life of no more than 5 days would be recommended for the packaged plant matter.

According to a further aspect, the present invention thus provides a plant matter package comprising a sealed container enclosing plant matter in an oxygen- and inert gas-containing gaseous mixture, said plant matter having at the time of sealing of said container been cooled to a temperature above the temperature at which ice crystals begin to form in said plant matter and said gaseous mixture having at said time of sealing had an oxygen content of at least 4%.

According to a still further aspect, the present invention also provides an apparatus for packaging plant matter, said apparatus comprising:

(a) means for chilling plant matter;

(b) means for filling plant matter into containers therefor;

(c) means for evacuating containers containing chilled plant matter;

(d) means for introducing a gaseous mixture comprising an inert gas and at least 4% oxygen into the evacuated containers; and

(e) means for sealing said containers.

Optionally also, the apparatus of the invention may comprise means for trimming, peeling, and, if desired, chopping the plant matter before it is filled into the containers. Furthermore, the apparatus may also comprise means for forming the containers into which the plant matter is to be filled.

A preferred embodiment of the present invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Figure I is a flow-sheet illustrating the processing steps performed by an apparatus according to the present invention during the packaging of whole or diced onions; and

Figure 2 is a schematic representation of a section of the apparatus whose operation is outlined in Figure I.

Referring to Figure I, onions from the field are placed in a cooler I, for example an ice bank cooler, in order to bring their temperature down to about 3°C. The onions are then taken from the cooler I to a cool store and subsequently are fed into a hopper 2 from which they are lifted individually by a conveyor. On the conveyor they are aligned by an operator before being topped, tailed and slit along the side by the three cutting blades of cutter 3. The conveyor then drops the onions through peeler 4 in which a jet of compressed air, conveniently at about II7 kPa (I7 psi), removes the outer skin. The peeled onions are then carried by a further conveyor to sorting zone 5. The sorting zone may, for example be in the form of a further conveyor or may be in the form of a rotating horizontal anular tray. At the sorting zone, those onions which are oversized or undersized, mildly blemished or unattractively cut may be removed and placed into dicer 6. The diced onion or the whole onions are then filled by filler 7 into plastics trays which have been formed in a continuous plastics web by tray former 8. The filled trays are then carried to sealing zone 9 where they are provided with a plastics membrane lid, evacuated (for example to 60 cmHg below atmospheric pressure), flushed with a gaseous mixture (e.g. of 90% nitrogen, 5% oxygen and 5% carbon dioxide) and heat-sealed. The trays are then led to trimmer I0 where the web of sealed trays is cut into individual package units which may be single trays or groups of trays as desired. The package units are then transferred into a controlled temperature cold storage zone II which is maintained at a constant temperature, preferably about 3°C.

In order to prevent the onions from warming up unduly before the trays are sealed, the sorting zone 5, dicer 6, filler 7, tray former 8, sealing zone 9 and trimmer I0 are preferably housed within a controlled cold temperature zone in which the air temperature is maintained at a constant operator-acceptable temperature, preferably about I2 to I4°C.

Packages from the storage zone II will be delivered to the retailer in refrigerated lorries. In these lorries, the temperature again should preferably be maintained at about 3°C. The retailer should also preferably display the packages on cooled shelves and should maintain the package temperature at about 3 to I0°C, preferably 3 to 8°C.

In figure 2, part of the apparatus discussed in connection with figure I is shown in more detail. Referring to this figure, cooled onions I2 are lifted out of hopper 2 by pairs of prongs I3 on a first conveyor I4. The onions carried on the prongs are aligned by an operator before entering cutter 3 in which one pair of knife blades is caused to top and tail each onion and a third blade is caused to slit the side of the onion. The first conveyor then deposits the slit onions in the receiving tube I5 of peeler 4. As the onions pass down the tube, a jet of compressed air, supplied by hose I6, peels off the outer cut skin and the peeled whole onions are deposited on a second conveyor I7.

The hopper, first conveyor, cutter and peeler assemblies used in this apparatus are similar in opertion to assemblies used conventionally for peeling wet small onions for pickling. Such machines are manufactured for example by M. & P. (Engineering) Limited of Heywood, Lancashire.

The second conveyor I7 carries the peeled whole onions into a controlled temperature cold room I8 which is maintained at 55°F (I2.8°C) and then deposits the onions onto a rotating anular tray I9. Onions for dicing are removed by operators from the rotating tray and are placed in dicer 6 which deposits the diced onion in a stainless steel bin 20. Diced onion from bin 20 is fed into the hopper 2I of a metered filling unit 22. The filling unit deposits a pre-selected quantity of diced onion into each packaging tray 23. Alternatively, whole peeled onions from rotating tray I9 may be placed manually into the packaging trays.

The packaging trays 23 are produced in a continuous plastics web by the thermo-forming of a PVC laminate web 24 in tray former 8. In tray former 8, the laminate web, conveniently a 3-ply laminate of 500 micron thickness, is heated to II0-I50°C and vacuum formed using moulds of the desired shape. The moulds are cooled with chilled water to ensure that the trays are cooled before they are filled. The filled trays 25 then have a sealing membrane in the form of a plastics web 26 (for example a I00 micron thickness anti-mist treated PVC web) laid over them as they are fed to sealing zone 9. At sealing zone 9 the at least partly covered trays are evacuated using vacuum line 27 and are then flushed with the gaseous mixture using gas line 28. Gas line 28 is preferably provided with a pressure valve to ensure that the final pressure within the sealed trays is within the desired range. Heater unit 29 is then clamped down over the flushed tray to heat-seal the sealing mebrane to the rim of the tray.

Leaving the sealing zone, the sealed tray is passed to the trimmer I0 where a knife blade or guillotine is to separate the adjoining trays or to cut the continuous web of trays into units each containing the desired number of trays. Thus where whole onions are packed into individual cuplike trays, it may be desirable to cut the web to produce units each containing two, four, six or eight onions.

Using the apparatus described above, it is possible to minimise wastage of raw material by dicing undersized or oversized onions and a packaging rate of the order of 10 kg/minute can readily be achieved.

Claims

1. A process for packaging plant matter (12), said process comprising cooling plant matter to a temperature above the temperature at which ice crystals begin to form therein, filling the plant matter into containers (23) therefor, evacuating the gaseous atmosphere from the cooled plant matter-containing containers, introducing into the evacuated containers a gaseous mixture comprising an inert gas and at least 4% oxygen, and sealing the containers containing said gaseous mixture and cooled plant matter.

2. A process as claimed in claim 1 wherein said gaseous mixture contains from 4 to 15% oxygen.

3. A process as claimed in either of claims 1 and 2 wherein said gaseous mixture contains from 2 to 18% carbon dioxide.

4. A process as claimed in any one of the preceding claims wherein said gaseous mixture contains from 80 to 90% of said inert gas.

5. A process as claimed in any one of the preceding claims wherein uncooked plant matter is filled into said containers.

6. A process as claimed in any one of claims 1 to 5 wherein said plant matter is cooled to a temperature in the range 2 to 7° C.

7. A process as claimed in any one of claims 1 to 6 wherein the steps of filling, evacuating, introducing and sealing are performed in a controlled temperature environment maintained at a temperature of from 10 to 14° C.

8. A process as claimed in any one of the preceding claims wherein said plant matter comprises optionally chopped or diced vegetable, fruit or fungus or a mixture thereof.

9. A process as claimed in any one of the preceding claims wheein the step of evacuating is so effected as to reduce the pressure in said containers to 55 to 65 cmHg below ambient.

10. A plant matter package comprising a sealed container enclosing plant matter in an oxygen- and inert gas-containing gaseous mixture, said plant matter having at the time of sealing of said container been cooled to a temperature above the temperature at which ice crystals begin to form in said plant matter and said gaseous mixture having at said time of sealing had an oxygen content of at least 4%.

11. A package as claimed in claim 10 containing optionally chopped or diced uncooked vegetable, fruit or fungus or a mixture thereof.

12. A package as claimed in either of claims 10 and 11 comprising a plastics tray closed by a plastics lid or membrane to form a substantially gas-tight container.

13. An apparatus for packaging plant matter, said apparatus comprising:

(a) means for chilling plant matter (12);

(b) means (21,22) for filling plant matter into containers (23) therefor;

(c) means (27) for evacuating containers containing chilled plant matter;

(d) means (28) for introducing a gaseous mixture comprising an inert gas and at least 4% oxygen into the evacuated containers; and

(e) means (29) for sealing said containers.

14. An apparatus as claimed in claim 13 further comprising means (8) for forming said containers.

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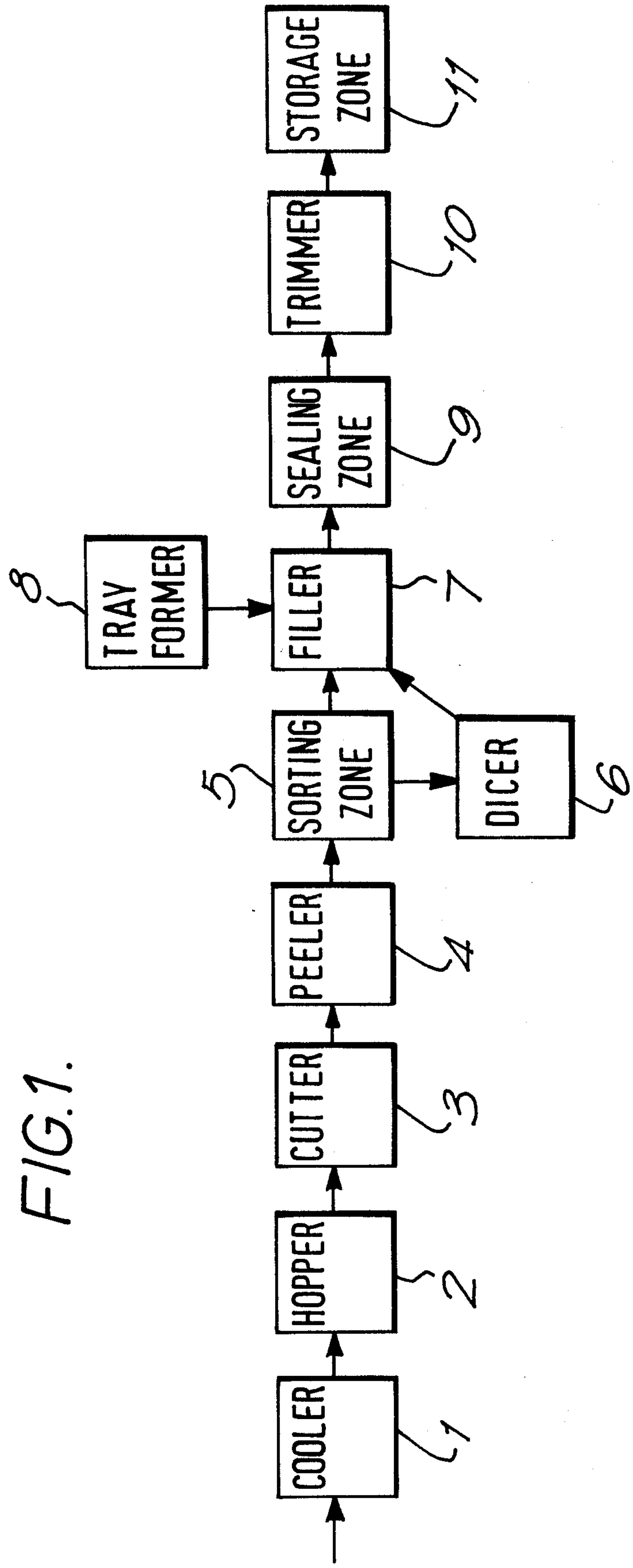

FIG.1.

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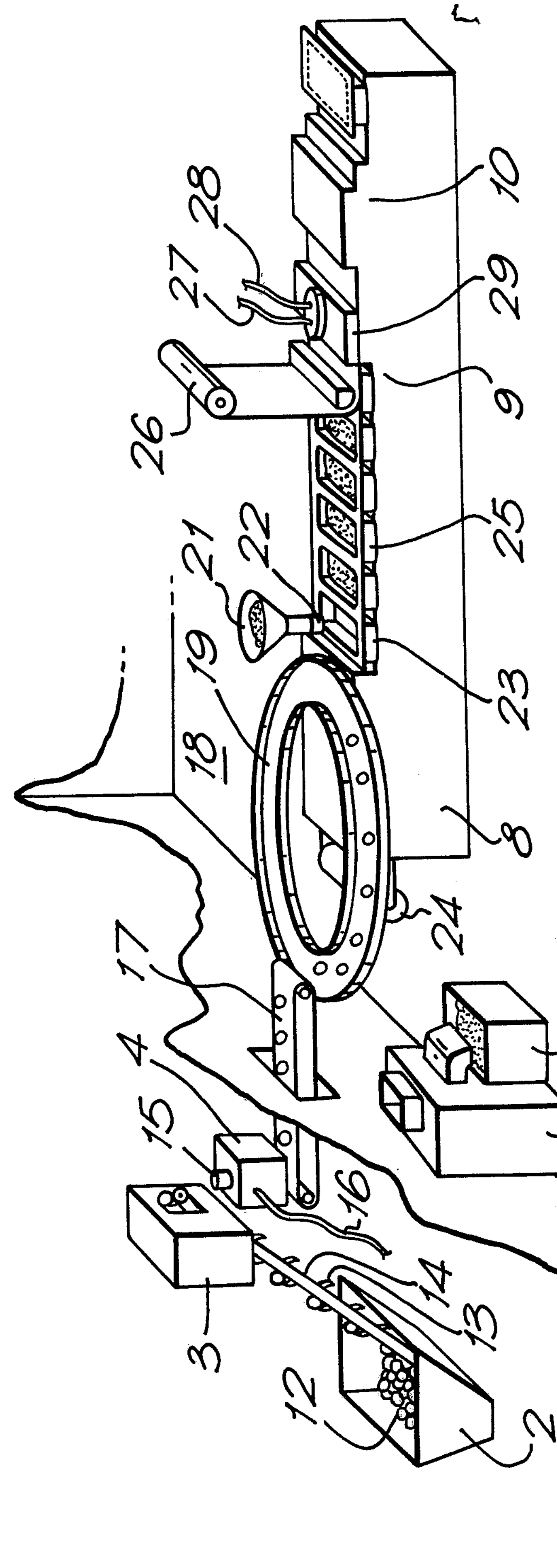

FIG.2.