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[54] **MIXING EQUIPMENT FOR DRY VEGETABLES**
7 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** ..... **259/81 R, 99/1**
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[50] **Field of Search** ..... 259/3, 14, 30, 81 R, 89, 90; 209/295, 321, 318; 99/1

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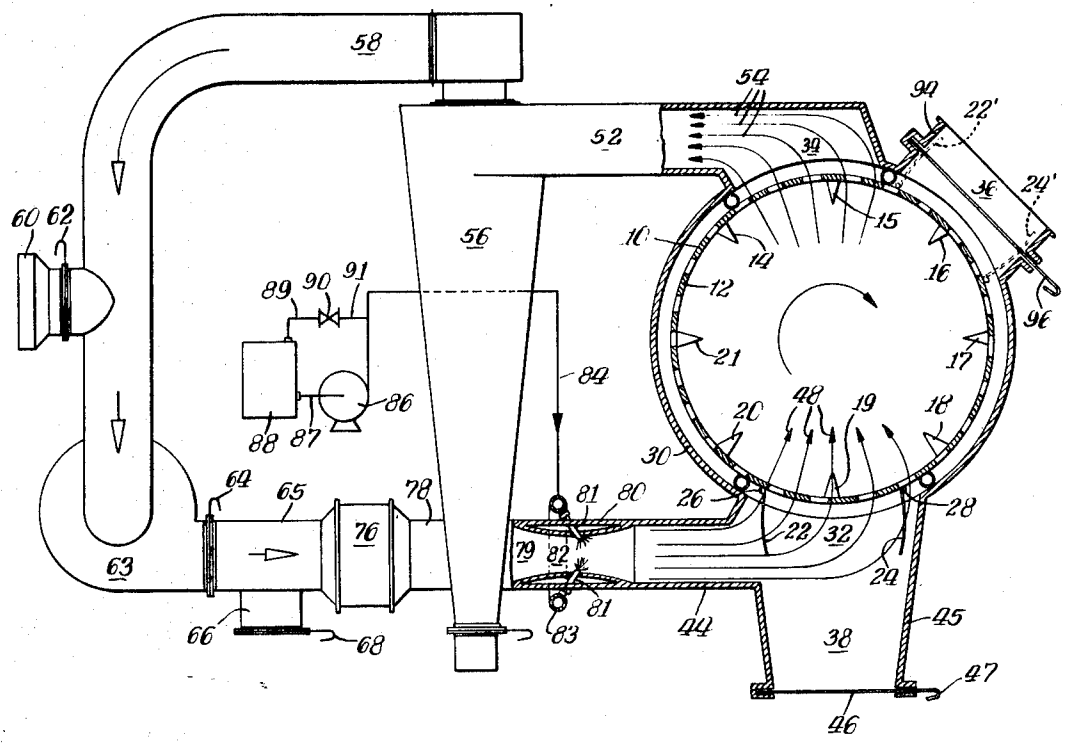
ABSTRACT: Covers a method and apparatus for mixing dry vegetables without breakage. The vegetables are placed within a cylindrical drum that is rotatable about a horizontal axis. This drum is closed at both of its ends, and its cylindrical wall is formed with many openings or perforations. A stream of air is passed upwardly through the bore of the drum, as it is rotated. The air enters the drum bore through an exposed lower section of the surface of the drum wall, and discharges through an upper section of the drum wall. The air has a sufficient velocity to fluidize the vegetables. A plurality of mixing blades are mounted on the interior surface of the drum wall, and extend radially inwardly and axially (longitudinally) of the drum. These blades coact with the airstream, upon rotation of the drum, to cause a gentle mixing action.

Treating material may be added to the airflow prior to its entry into the mixing drum. The openings in the drum wall permit dust and small broken pieces, that become entrained in the airflow, to be removed from the mixer.

Air flowing out of the drum is passed through a cyclone separator to permit settling of entrained material, and the air is then recirculated.



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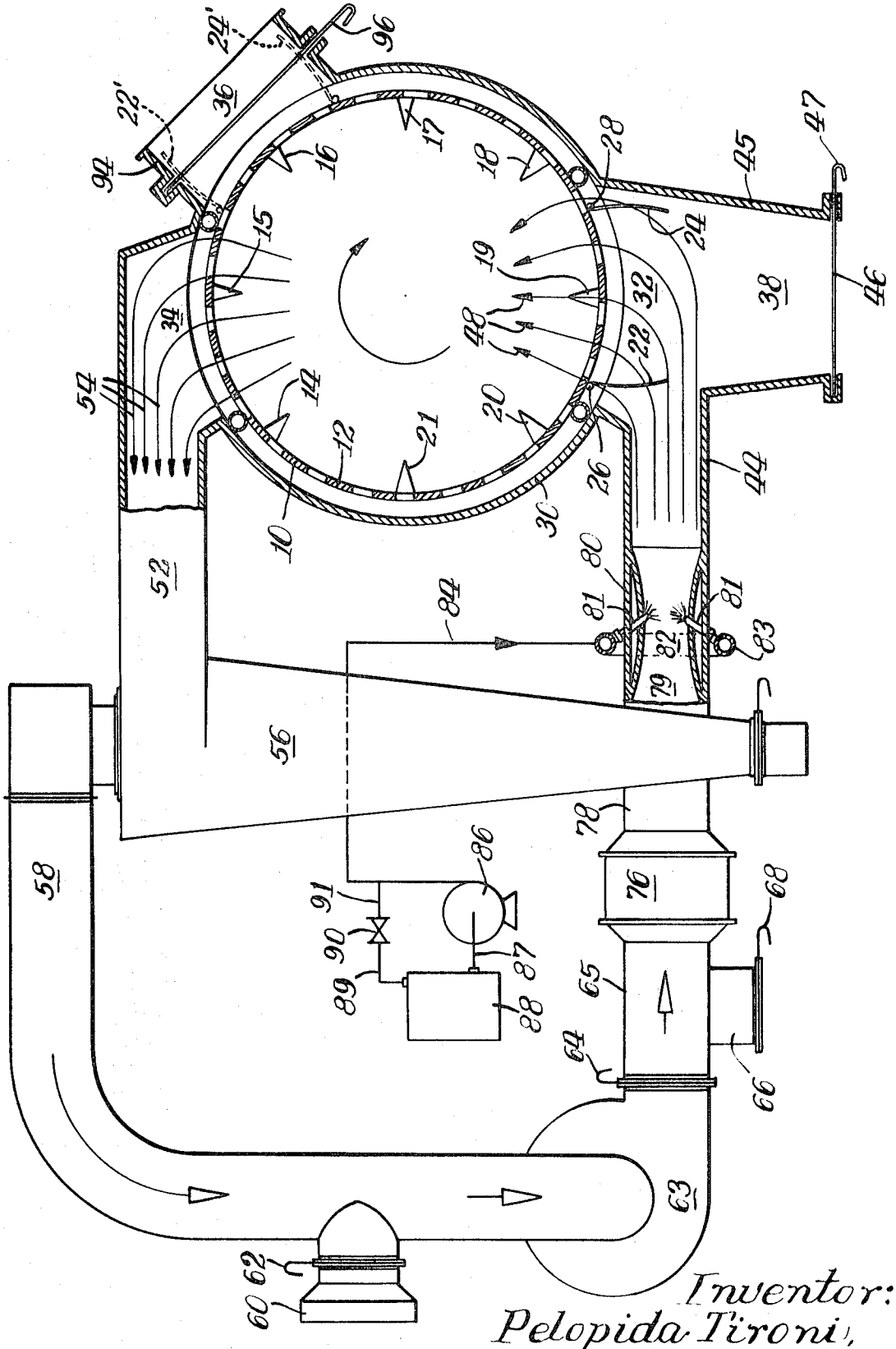

MIXING EQUIPMENT FOR DRY VEGETABLES

FIELD OF THE INVENTION

The present invention relates in general to a method and apparatus for mixing dry vegetables or other very brittle and breakable materials, for removing from the mixture particles smaller than a predetermined size, and for treating the remaining particles.

DESCRIPTION OF THE PRIOR ART

Mixing of very brittle material, such as the dried and freeze-dried vegetables used in making up packaged soup, in a manner to obtain thorough mixing with minimum breakage, has been a difficult problem which to date has not been adequately solved. The use of tumbling drums or the movement of stirring arms within a container are well-known methods of obtaining the desired degree of mixing, but such mechanical agitation inevitable results in an unacceptable amount of breakage, particularly where the articles being mixed have disparate shapes and sizes.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a method and apparatus for mixing, sifting and treating dried materials such as vegetables in a single operation, thereby to minimize breakage and loss in the handling and treatment of such materials.

It is a further object of the invention to provide an apparatus for obtaining a homogenous mixture of dried vegetables or other like materials under controlled conditions whereby the material may be mixed, sifted and treated substantially without losses due to breakage within the mixer chamber.

The mixer comprises a perforated drum rotating on a horizontal axis, into which the vegetables or other materials to be mixed are placed. Air is blown through the drum, entering at the lower portion and exhausting at the upper portion, while the drum rotates. In this manner, the vegetables are entrained in the airflow and are agitated by the air to mix them thoroughly. In addition, the drum is provided with one or more blades that project into the fluidized bed of vegetable pieces, and that provide an additional mixing action. If the vegetables or other materials being mixed are to be treated, as by a liquid treating agent, the material is added to the airflow immediately prior to its entry into the mixing drum.

The drum may be provided with perforations of the size required for retaining pieces of the desired size while permitting discharge of broken pieces and dust, or may be provided internally with a net having a mesh of predetermined size to act as a sieve. In either event, the airflow entrains and carries the undesired particles out of the drum through the air outlet.

The discharged air is then passed through a cyclone separator to permit the settling and recovery of entrained material. The air is then either exhausted or recirculated through a blower for return to the drum.

Between the air inlet and outlet, the drum housing is spaced closely to the outer surface of the drum, with the annular space between the drum and housing being closed off at the inlet and outlet by means of airtight seals sliding on the outer surface of the drum. These seals, which advantageously may be roller bearings on which the drum rests, insure the vertical passage of airflow. The composition resulting from the vertical movement of air and rotation of the drum results in a thorough mixing of vegetables.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and additional objects, features and advantages of the present invention will be more fully appreciated from the following detailed description of a preferred embodiment of the invention, selected for purposes of illustration and shown in the accompanying drawing, which is a diagrammatic side elevation in partial section of a device constructed in accordance with one embodiment of the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawing, there is illustrated at **10** a rotary mixing drum, generally cylindrical in shape and mounted for rotation about a horizontal axis by means of a mounting shaft and power supply or drive motor means (not shown). The drum **10** comprises a circumferential wall **12** which is formed with a plurality of perforations **13** that allow air to flow freely through the drum wall. The size of the perforations depends upon the size of the material that is being mixed, and also upon the size of the substandard, broken, or dust particles which are to be removed from the drum by the airstream.

If desired, a fine mesh net may be affixed to the inner surface of wall **12** to act as a sieve, in which case the perforations in the wall can be relatively large to permit the free flow of air therethrough along with entrained dust particles and broken pieces.

The inner surface of the drum carries a plurality of mixing blades **14–21** respectively, that are spaced angularly from each other around the drum and that extend longitudinally thereof. Upon rotation of the drum, these blades carry materials to be mixed from the bottom region of the drum up to the top area of the drum (as viewed in the FIG.). Since the air tends to fluidize the material within the drum, the blades **14–21** do not cause the tumbling action normally associated with rotary drum mixers, but merely lift the material up to the top of the drum where it is dropped into the airflow and is supported thereby. This gentle mixing action substantially eliminates breakage.

The wall of the drum includes a pair of doors, or gates, **22** and **24** respectively, that are suitably mounted in the cylinder wall by means of hinges **26** and **28**, respectively. The doors are adapted to swing outwardly of the drum to permit the insertion of material to be mixed, when the doors are opened at the dotted line open position shown in the FIG., and to permit discharge of fully mixed material at the full line open position in the FIG. The doors extend the full length of the cylinder to permit complete emptying of the device.

A housing **30** surrounds the rotary drum mixer **10** and is closely spaced thereto except at the air inlet opening, generally indicated at **32**, the air outlet opening, generally indicated at **34**, the material inlet opening **36**, and the material outlet opening **38**. The annular space between the housing **30** and the drum wall **12** is sealed off on either side of the air outlet opening **34** by means of suitable wipers, roller bearings, or other suitable sealing means **40**, **41**, respectively. Similarly, this annular space is sealed off from the air inlet opening **32** and from the material outlet areas **32** and **38** by means of suitable wipers, rollers, or other suitable sealing members **42**, **43**, respectively. The seals **40**, **41**, **42** and **43** respectively contact the outer surface of the drum **12** and prevent air from flowing around the outside of the drum, thus forcing air that is delivered to the air inlet area **32** to follow the desired path through the perforated walls of the drum and into the bore of the drum itself.

The air inlet area **32** is defined by a suitable air inlet conduit **44** which joins with the housing **30** adjacent the location of the sealing member **42**. The cross-sectional shape of the inlet conduit may be round or may be generally oval, but preferably is expanded at the inlet area **32** so as to extend longitudinally for the length of the drum **10**, thus assuring an even distribution of the airflow within the drum. This air inlet area **32** thus forms, in effect, a plenum chamber from which air flows into the drum.

The air inlet conduit **44** is also connected to a material outlet chute **45** which defines the material outlet area **38**. The chute **45** is connected to the housing **30** adjacent the sealing member **43**. The material discharge area **38** thus forms an extension of the air inlet area **32**. The bore of the discharge chute **45** is sufficiently large to accommodate the drum doors

22 and 24 respectively, when they are opened, and to receive the mixed vegetables from the mixer drum. A closure plate 46 is slidably mounted across the lower end of the chute 45. This closure plate 46 is formed with a handle portion 47, so that it can serve as a manually operable sliding valve, to open or to close off the lower end of the chute 45.

With the air inlet area 32 and the material outlet area 38 forming, in effect, a single plenum chamber, the fluidizing air from the conduit 44 tends to enter the drum 10 over a substantial section of the bottom surface portion of the drum wall 12, i.e., that portion between the sealing members 42 and 43, thus producing a generally upward flow of air into the bore of the drum, as indicated by the arrows 48.

The air flowing through the drum is discharged through the area 34 and enters the bore of an air outlet duct 52, as indicated by the arrows 54. The discharging air carries with it undesired dust particles and undersized material from within the drum. Thus, any small pieces which may be included in the material being mixed are removed by the air flowing into the duct 52.

The effluent air passes from the duct 52 into a cyclone separator 56 (or other suitable separator device) for removal of the entrained particles. These particles settle at the bottom of the separator for later recovery, while the air is removed from the separator by way of a recycling conduit 58. If desired, this air may be exhausted to the atmosphere instead of being recycled, but where the materials being mixed are also being treated, as by dried air, heated air, or air to which a treatment material such as fat has been added, it may be desired to recirculate. Alternatively, a portion of the air may be exhausted, with a proportionate amount of new air being added. Such new air may be brought into the system through an inlet pipe 60 that is provided with an adjustable valve 62.

A compressor or fan 63 is connected to the conduit 58, to withdraw air from the conduit and to supply it under pressure to the system. The fan 63 discharges through a valve 64 into a line 65. A stub pipe 66 communicates with the line 65, and is provided with an adjustable bleeder valve 68 to permit the venting of air downstream of the fan. The line 65 is connected to a heat exchanger 76, to permit the airflow to be heated or cooled, as desired.

The heat exchanger 76 is connected through a line 78 to the inlet 79 of a venturi 80. A plurality of nozzles 81 are disposed to be in a position to inject a treating material, either in powdered or liquid form, into the airstream as it leaves the constricted throat 82 of the venturi.

To supply the treating material to the nozzles, a manifold ring 83 is mounted out the line 78, at the location of the venturi throat, and is connected through a supply line 84 with a pump 86, that can draw flowable treating material through a line 87 from a supply container 88. To permit adjustment of the pressure at which the treating material is delivered through the nozzles 81, a recirculating system, consisting of a line 89, a valve 90, and a line 91, is disposed to interconnect the supply line 84 with the tank 88, so that an adjustment of the valve 90 can be used to adjust the delivery pressure to the nozzles.

The venturi communicates with and discharges into the air inlet conduit 44. The airflow route has thus been described for the apparatus.

To permit the charging of the drum with a quantity of dehydrated vegetables or other material that is to be mixed, the drum is provided with the pair of doors 22, 24, respectively, previously described. In addition, a loading port 94 is disposed adjacent the upper end of the housing 30. This port is provided with a manually adjustable valve 96, but can be opened for loading material into the drum or closed during operation of the device. To load material into the drum, the drum is rotated to bring the doors 22 and 24 into juxtaposition with the opening in the loading port 94. The doors are then opened, and material can be loaded into the bore of the drum.

OPERATION

To mix a batch of dehydrated vegetables, for the preparation of a mixture that can be dispensed into individual packets of dried soup mix, the valve 96 is moved to its open position. The drum 10 is then rotated, to bring the doors 22 and 24 into registry with the opening in the loading port. The appropriate quantities of the several dehydrated vegetables, that are to be mixed, are then loaded into the bore of the drum.

When all of the desired material, that is to be mixed, has been placed inside the drum, the doors 22 and 24 closed, and the valve 96 is moved to its closed position. At this point, the other valves in the system, namely the valve 62, the bleeder valve 68, and the discharge valve 46, are closed. The fan 63 is started and the drum is rotated in the direction shown by the arrow in the drawing. The heat exchanger 76 is adjusted to heat the air to the desired degree, and moisture, treating material, or an aqueous solution of treating material that both applies treating material and adjust the moisture content of the air, is injected into the flowing airstream through the nozzles 81.

The airstream passes from the plenum chamber, that is defined by the areas 32, 38, respectively, into the drum in a generally vertical direction. The velocity of the air is adjusted to a level at which the particles of dehydrated vegetable material, within the drum, are fluidized. The fluidizing action in itself causes some mixing of the contents of the drum. In addition, as the drum rotates, each of the blades 14—21 successively carries a portion of the bed of material from the lower regions of the drum up to the upper regions, where it tends to drop out by gravity into the fluidized bed. The airstream discharges from the drum through the duct 52 into the upper end of the cyclone separator 56. Solid particles of dust or small pieces of vegetable material drop out and collect at the lower end of the separator for subsequent removal. The air discharges in the usual manner from the central, upper region of the separator through the conduit 58, from which it is drawn back into the fan 63.

By regulating the rate of airflow and the speed of rotation of the drum, the mixing action can be completed quite quickly, but with a minimum of damage to the pieces of dehydrated vegetable material within the drum.

When it is desired to add an amount of fat or other treating material to the vegetables as they are mixed, a liquid fat can be injected through the nozzles 81 into the airstream that is flowing through the venturi. The airstream then carries the entrained droplets of liquid fat along and deposits the fat droplets on the vegetables.

When the mixing and treatment have been completed, the fan is stopped and the drum is rotated to bring the doors 22 and 24 into registry with the discharge chute 45. The doors are then opened, and the mixed material drops down into the chute, through the open valve 46, to empty the drum so that the drum can then be used for another mixing operation.

CONCLUSION

While a preferred embodiment of the apparatus of the invention has been described, it will be understood that many variations in the embodiment illustrated and described are possible that are within the scope of the present invention. For example, the degree of automation employed is a matter of the investment that is available and that can be made. A fully automated system is feasible and can be used where it is justified.

For simplicity, some aspects of the equipment have been described only briefly. Thus, the mechanisms for bringing the doors of the drum into registry with the loading and discharge chutes has not been shown or described in detail. It may be manual, or it may be automatic.

In operating the equipment, by carefully controlling the humidity and temperature of the airflow through the drum, the dehydrated vegetables may be transformed into a homogenous mixture without changing their moisture con-

tent. However, if desired, a part of the dehydration process may be carried out in the mixture quite easily, simply by using as the fluidized air an air supply that has been heated to a dehydrating temperature and that has had its moisture content adjusted, if necessary, so that the airflow is effective for dehydration.

Since the equipment may be used for heating and cooling along with mixing, and in order to minimize the noise level caused by the operation of the equipment, the equipment preferably is insulated. The insulation is particularly desirable since, in many cases, it is desirable to clean and disinfect the drum and other parts of the equipment that come in contact with the vegetables, by the use of steam or the equivalent, between batches. Such cleaning and disinfection is particularly desirable when fat treatments are used.

One of the important advantages of mixing equipment constructed in accordance with the present invention is the very low level of loss because of breakage. Losses of less than 0.2 percent of the dried vegetables, that are being mixed, are commonly observed.

While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth, and as fall within the scope of the invention.

I claim:

1. An apparatus for mixing together relatively fragile particulate material, such as pieces of different dehydrated vegetables, comprising:

a foraminous drum that is mounted for rotation about a generally horizontal axis;

means for establishing and maintaining within the bore of said drum a fluid-suspended bed of the particulate material;

said foraminous drum formed with openings that permit the passage of suspending fluid therethrough but that retain the particulate material therein in said fluid-suspended bed to permit admixture thereof, and

mechanical means mounted to project within the bore of said drum and into said bed, and movable upon rotation of the drum, to transfer successive portions of the bed from one location in the bore of the drum to a remote location therein, thereby to effect mixing of the material.

2. Apparatus in accordance with claim 1, wherein said means for establishing and maintaining the fluid-suspended bed comprises:

means for delivering a flow of air to a lower section of the surface of the drum for upward flow through the bore of the drum, and

means for permitting discharge of the air from an upper section of the surface of the drum.

3. Apparatus in accordance with claim 1, wherein said mechanical means comprises a plurality of blades that are mounted on the interior surface of the drum to extend generally axially of the drum and that project generally radially inwardly of the drum for projection into said bed and that are disposed at angularly spaced locations respectively within the drum, and that are mounted for rotary movement with the drum upon rotation of the drum.

4. An apparatus for mixing together relatively fragile particulate material, such as pieces of several different dehydrated vegetables, comprising:

a chamber that is formed with an opening at its lower end and an opening at its upper end;

a drum that is mounted within said chamber for rotation about a generally horizontal axis and that is formed with closed ends and with a generally cylindrical wall that is formed with a plurality of perforations that are disposed in a pattern therein;

a plurality of bearing means mounted in said chamber and engaging said drum to permit rotation of said drum thereon and to prevent the passage of air about said drum;

means for supplying air to the lower opening of said chamber for passage upwardly through the perforations in the portion of the drum wall confronting said opening and through the bore of said drum, to establish and maintain within bore of said drum a fluid-suspended bed of the particulate material, and for discharge through perforations in an upper section of the drum wall, and through the upper opening of the chamber;

said drum being formed with perforations of such size and that are disposed in such a pattern as to permit the passage of suspending fluid therethrough but to retain the particulate material therein in said fluid-suspended bed to permit admixture thereof, and

at least one blade that is mounted on the interior surface of the drum to project into the bed and to undergo rotary movement with the drum upon rotation of the drum, to transfer successive portions of the bed from one location in the bore of the drum to a remote location therein, thereby to effect mixing of the material.

5. Apparatus in accordance with claim 4, including a plurality of blades that are mounted on the interior surface of the drum to extend axially of the drum and to project generally radially inwardly of the drum and into said bed, and that are disposed at angularly spaced locations respectively within the drum, and that are mounted for rotary movement with the drum upon rotation of the drum.

6. Apparatus in accordance with claim 4, wherein the perforations in the drum are of a size to permit the discharge from the drum, along with the discharged air, of solids of less than a preselected size that are entrained in the airflow.

7. A process for mixing fragile pieces of several different dehydrated vegetables to provide a substantially uniform mixture suitable for packaging in unit serving packages, comprising:

placing batches of pieces of the several different dehydrated vegetables in substantially the desired proportions in a confined mixing zone;

suspending the pieces in said zone in a fluid to form a fluid-suspended bed of said pieces;

mechanically separating successive portions of said bed from a lower region of the bed and transferring them to a remote upper portion of the bed, to effect mixing of the pieces of the different dehydrated vegetable while they remain in said zone and substantially protected against breakage by being suspended in said bed, and

recovering a substantially uniform mixture of the dehydrated vegetable pieces from said zone.