June 19, 1956 E. H. LESLIE ET AL 2,751,301

SYSTEM FOR THE AGGLOMERATION OF SOLVENT-EXTRACTED FINE SOLID ORGANIC PARTICLES

Filed Oct. 8, 1949

Fig. 1.

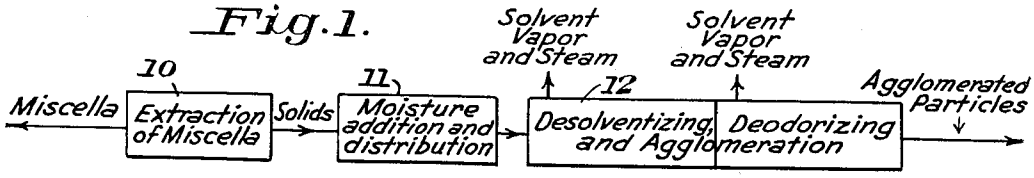


Fig 2

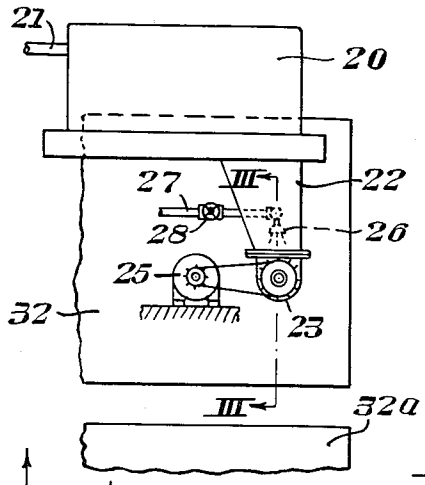


Fig. 3.

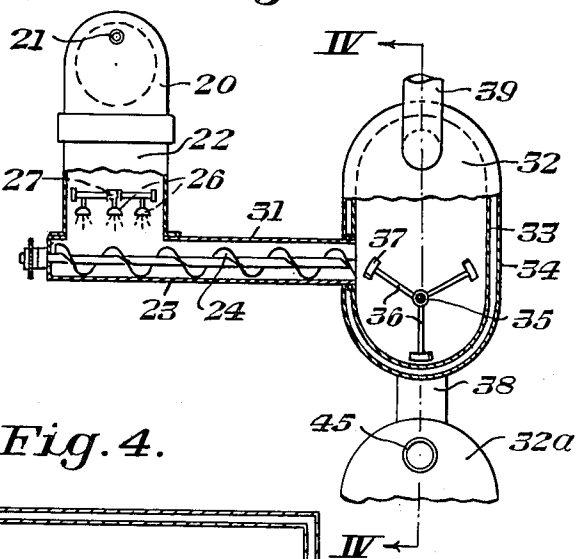


Fig. 4.

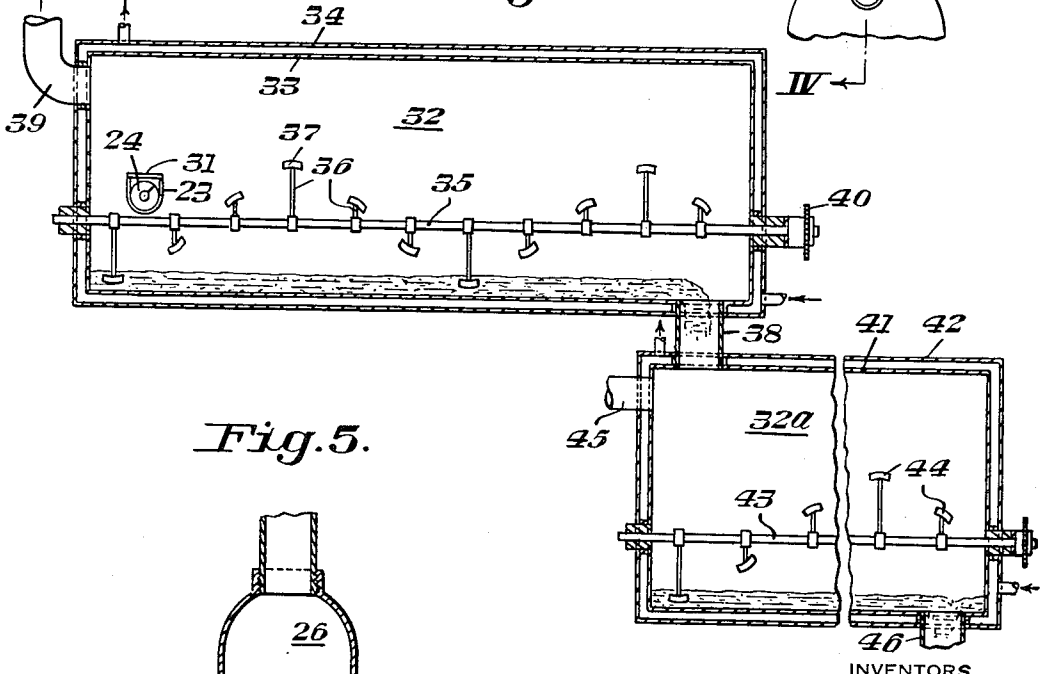


Fig. 5.

INVENTORS

Eugene H. Leslie and Jerome M. Crockin

by Hoopes, Leonard & Glenn their attorneys

United States Patent Office 2,751,301 Patented June 19, 1956

2,751,301

SYSTEM FOR THE AGGLOMERATION OF SOLVENT-EXTRACTED FINE SOLID ORGANIC PARTICLES

Eugene H. Leslie, Ann Arbor, Mich., and Jerome M. Crockin, Pittsburgh, Pa., assignors, by mesne assignments, to Blaw-Knox Company, Pittsburgh, Pa., a corporation of Delaware

Application October 8, 1949, Serial No. 120,392

3 Claims. (Cl. 99—2)

This invention relates to the controlled agglomeration of fine solid organic particles from a solvent extraction operation. More particularly, it pertains to the continuous formation of usefully sized nodules by the agglomeration of the very finely divided solid residues resulting from the solvent extraction processing of the relatively more fragile vegetable materials such as flaxseed, peanuts, castor beans and the like.

In the solvent extraction of vegetable oils to produce a final oil-rich solution of oil and solvent, which may be termed "miscella," the solids residue from such vegetable materials is an important product. This solids residue is frequently used in the feed ration for domestic animals, for which purpose the residue is preferred in the form of a meal having particles of substantial size rather than being composed of fine flour-like particles. While materials such as soybeans have a stronger cellular structure which is resistant to the extensive disintegration thereof into fine particles during solvent extraction, the same is not true of certain other vegetable materials such as flaxseed, peanuts, castor beans and many others. These last-mentioned vegetable materials are structurally relatively more fragile and during the preparation for and in the course of solvent extraction tend to extensively disintegrate.

After treatment of the oil bearing vegetable material with solvent to remove the oil, the solid material is conventionally mechanically separated from the liquid and is thereafter heated to completely remove the residual solvent which has not been removed mechanically. This step of evaporating residual solvent from the extracted particles is generally called desolventizing and deodorizing the particles. When these particles are very fine, difficulties arise in the desolventizing step due to the entrainment of dust in the solvent vapor evaporated and removed in that stage of the operation. This entrained dust tends to collect wherever any condensation occurs and causes difficulty, the difficulty being especially acute at the condensers in which the solvent vapors are condensed to liquid. Pasty masses and objectionable adherence to equipment may also result when such fines are present. In addition, as was previously noted, the fine solvent-free flour which results is not in a desirable condition for use in preparing feed rations for domestic animals. Even when other known processes are used adapted to the separation of liquid from solid material from the more fragile vegetable substances yielding a high content of fines, the resulting meal still contains objectionable quantities of flour-like particles.

The present invention constitutes a system of desolventizing such disintegrated materials in such a way that they are agglomerated into relatively coarse useful nodules or grains simultaneously with the evaporation of residual solvent therefrom. The resulting product is thus much improved and the difficulties hereto experienced in processing such fines-containing materials are eliminated. This novel result may be obtained without any interruption of or material change in any conventional processing operations and conditions to which such solid materials are also subjected. Further, the apparatus changes involved are extremely inexpensive.

Other objects and advantages of this invention will be apparent from the following description and from the drawings, which are illustrative only, in which

Figure 1 is a schematic layout of a preferred embodiment of the system of this invention;

Figure 2 is a diagrammatic view of an apparatus for carrying out the moisture addition and mixing stage of the system of this invention;

Figure 3 is a view in cross section taken along line III—III of Figure 2;

Figure 4 is a view in cross section taken along line IV—IV of Figure 3 through conventional solids desolventizer and deodorizer equipment in which the agglomeration stage of the system of this invention takes place; and

Figure 5 is an enlarged detail view of a suitable spray nozzle for use in the apparatus shown in Figures 2 and 3.

Referring to Figure 1, a prior method of extracting oil in the form of a miscella from vegetable seeds and beans of fragile structure is illustrated in United States Patent No. 2,467,404 to M. W. Pascal. The Pascal process is characterized by the fine state of division of the vegetable material and the use of centrifuges to separate it from the solvent. When the solids residue, named "pulp" in that patent, which normally contains from 33% to 45% by weight of solvent, is removed from the extraction zone for further processing to remove residual solvent therefrom and to recover the solid material therein in usable form, common practice is to pass such solids through desolventizing and deodorizing vessels before final toasting and finishing. This solvent-wet solids residue, or "pulp," resembles slightly moist fine sawdust in appearance and texture. Besides solvent, the fine solids, which consist largely of protein materials, contain water in varying amount. For example an extracted flaxseed pulp was found to contain about 12% moisture on a solvent-free basis and other solids from peanuts or castor beans may normally contain other percentages of moisture.

The phenomenon of agglomeration of extracted solid vegetable materials due to the presence of large amounts of liquid water during the desolventizing of such materials, so as to cause the formation of large sticky masses and "dough balls," is known and has been the source of much trouble particularly in processes which employ steam directly for desolventizing. The lumpy product so produced is not only undesirable, but the mechanical operating difficulties encountered have been so serious that such steam desolventizing systems have to be conducted under conditions under which agglomeration does not occur. Elimination of this trouble is one of the chief virtues of desolventizing in the absence of direct steam while the particles are solvent-wet.

In the system of this invention a controlled sizing agglomeration which has heretofore been unattainable is achieved without generating any equipment or operational difficulties. We have discovered a system whereby by adding still more water in a predetermined amount, as water or in aqueous solutions or dispersions, to the solvent-wet particles having such high contents of fines and distributing such water relatively uniformly throughout the solvent-wet particles as they are delivered to conventional evaporating apparatus, and then agitating or shallowly tumbling the particles so as to impart a turning motion to them while heating, the fine particles are caused to agglomerate to form small nodules while the liquid solvent and added water is being evaporated. Any such aqueous solution or dispersion may contain impurities to the extent which can be tolerated as is known to those in

the biochemical art. Moreover, such aqueous solution or dispersions may have salt, sugar, gelatin or other substances dissolved or suspended therein when a particular substance of such a character is desired in the final solid product. Thus for example, flavoring, preservatives or vitamins may be added to the water to be added if desired.

It is essential that such water or aqueous solution or dispersion be so added to the particles while they are still solvent-wet; that is, before the desolventizing has proceeded to any substantial extent, in part at least to eliminate difficulties which may arise due to the sticking of wetted particles to the mechanical apparatus in which they are being treated. The agglomerated desolventized material produced in this manner is found to be comprised of firm usefully sized agglomerated particles somewhat darker in color than the fine flour-like product which would otherwise be produced.

Thus as shown in Figure 1, solvent-wet extracted particles removed from an extraction zone **10** are conveyed through a zone **11** in which water is admitted, preferably in the form of a liquid spray, and thus distributed throughout such fine particles. The mass of moistened fine particles now passes through a conventional evaporating zone **12** where it is heated and agitated to evaporate residual solvent and at least most, usually, of the added water. The resulting meal has increased commercial attractiveness and value, being somewhat darker and more uniform in color, than ordinary solvent-extracted meal, and having a granular particle form.

Figures 2 and 3 diagrammatically illustrate one example of apparatus which has been used in the practice of this invention. Therein, a centrifuge **20** is shown which separates the solids and liquids after solvent extraction, the liquids leaving through an outlet **21** and the solids, which in the given instance were in the form of very fine particles, pass from the centrifuge through a chute **22** into a screw conveyor comprising a trough **23** and a helical screw **24** rotatably mounted therein. A helical ribbon may be used in place of the helical screw. The screw or ribbon is rotated by means of a motor **25** to convey the solids falling through chute **22** to the desolventizer and deodorizing stage where the solvent therein is to be evaporated. Within chute **22** a plurality of nozzles **26** are arranged to spray water upon solvent-wet particles in trough **23**. Water is supplied to nozzles **26** by means of pipes **27** and a valve **28**. The conveyor trough **23** and screw **24** extend beyond chute **22** and are covered at **31** to form a closed tubular conduit between chute **22** and its connection opening into a conventional desolventizer **33** at the discharge end of the screw conveyor. Such tubular conduit is usually filled with the particles passing therethrough. The mixing and stirring action of the rotating screw **24** further distributes the added liquid water throughout the solvent-wet particles.

The amount of water so added may vary somewhat. We have found in the processing of "pulp" of extracted fine flaxseed particles, that the addition of water to increase the total water content to about 25% by weight of water plus solids on a solvent-free basis (i. e., 25% water and 75% dry solids, the solvent being additional) gives excellent results. Analysis of a typical flaxseed particles "pulp" before such water is added, shows it to consist of about 40 parts solvent, 53 parts dry linseed solids, 7 parts water, all such parts by weight. Such pulp upon being conventionally desolventized and/or deodorized does not agglomerate. By adding about 7 additional such parts of water by means of the nozzles **26**, we have produced substantially dust-free agglomerated meal, which after desolventizing and deodorizing, consists of solvent-free nodules containing about 10% by weight of moisture on a total water plus solids basis. If less water is added, there is somewhat less agglomeration and somewhat more dust may be present. In this invention, the added water must increase the water content of the vegetable pulp, on a solvent-free basis, to between about 20% to about 30% by weight of both total water plus solids before evaporation of the solvent, to achieve the advance of this invention. Upon completion of the liquids evaporation pursuant to this invention the final water content of the solids is about the same as it was prior to the addition of water hereunder.

A conventional desolventizer **32** may comprise an enclosed cylindrical drum-like vessel **33** surrounded by a jacket **34** through which steam is adapted to be passed to heat vessel **33**. Conveyor trough **23** opens at its discharge end into the interior of drum **33** adjacent the forward end thereof and somewhat above the bottom of the vessel. An agitator shaft **35** carries a plurality of axially and circumferentially disposed paddle shafts **36**. Paddles **37** are respectively attached to the outer ends of shaft **36** and are so pitched that the solid particles discharged by a conveyor **23—24** into the bottom of drum **33** are moved with a turning or rolling motion over the bottom thereof toward an outlet **38**. During the course of this passage over the heated interior bottom surface of drum **33**, volatile liquids in the particles are vaporized and the solvent vapor and steam escape through a vapor outlet **39**. Shaft **35** is rotated by means of a driven sprocket **40** turned by conventional means which are not illustrated.

The agitated and heated mass of particles passing through desolventizer **32** fall into a conventional deodorizer **32*a*** through outlet **38**. In construction and operation deodorizer **32*a*** is generally similar to desolventizer **32** and removes substantially all solvent remaining in the solids discharged from desolventizer **32**. In some installations a single vessel may be used in place of the connected vessels **32** and **32*a***.

Deodorizer **32*a*** thus comprises a drum **41**, a heating jacket **42**, and an agitating shaft **43** having agitating and progressing paddles **44** thereon. Steam is supplied directly to the interior of drum **41** where the removal of solvent is completed and any volatile odorous materials which may be present are mitigated in effect or removed. The solvent vapor and steam within deodorizer **32*a*** are exhausted through an outlet **45**. The mass of particles from vessel **32** is agitated and heated during the passage along the bottom of deodorizer **32*a*** until such particles are discharged through a deodorizer outlet **46**. By this time the transformation of the fine solid organic particles into nodules has been completed. These nodules are relatively hard and mechanically strong nodules of somewhat different sizes without any material accompaniment of dust.

It is believed, without this invention being limited to any such belief, that the addition of water distributed throughout the particles, with relatively shallow layer agitation and heating induces the formation of nuclei among the fine particles to which adjacent particles increasingly adhere provided there is relatively even distribution of water throughout the mass of particles within the range taught by this invention. The agglomeration producing the larger agglomerated and dust-free particles around these nuclei appears to take place substantially entirely during the agitation and heating which occurs in the desolventizer and deodorizer. Further, such controlled agglomeration keeps the interior of the vessels free of adhering particles and local accumulation of large lumps or masses of solids while at the same time materially reducing the dust in the desolventizing and deodorizing system. While the water is preferably added in the conveyor between the centrifuge **20** and desolventizer **32**, it also appears that it may be added adjacent the entrance end of the desolventizer.

As an illustrative example only, such nodules may be produced from a flaxseed particles pulp as heretofore described in an apparatus in which a screw conveyor 4½ feet long or longer extends between a centrifuge such as centrifuge **20** and the entrance to a desolventizer such as desolventizer **32**. The mass of particles within the bottom of such a desolventizer might vary from 8 to 12

inches in depth and the walls thereof might be heated from about 300° F. by a steam jacket.

As another example of a successful practice of this invention, but to which it is not limited, a heptane-extracted castor bean pulp may be agglomerated using such foregoing apparatus with the exception of the water spray nozzles 26. Instead of applying water in a spray, steam may be caused to condense upon the solvent-wetted particles as they are agitated and heated in the desolventizer, such as desolventizer 32. This may be accomplished merely by lowering the operating temperatures of the desolventizer and the deodorizer until sufficient steam for the deodorizer enters the desolventizer through an opening, such as outlet 38. This action would cause steam to condense to liquid water on the cooler solvent-wetted castor bean particles in the desolventizer and would be controlled to keep within the total water content range of the system of this invention. Such an addition of liquid water to the pulp by controlled condensation of steam while the pulp is being agitated will give a good distribution of water among the particles, apparently comparable to the direct addition possible through the spray nozzles 26. The particles may be caused thereby to agglomerate in larger nodules ranging in size from small shot to small marbles with a final moisture content of from possibly between about 8% and about 12% by weight of water plus solids.

Thus, the added water when introduced need not be in a liquid state and the expression "adding water" as used in this application includes the condensation of water vapor as well as direct water addition. Various other alternatives and modifications in the system of this invention may be made within the spirit thereof and the scope of the appended claims.

We claim:

1. In a system for the agglomeration of solvent-extracted solid organic flour-like particles, the steps comprising, feeding said particles to a desolventizing zone, spraying water upon said particles while solvent-wet at a rate to increase the total water content of said particles to between from about 20% to about 30% by weight based on the weight of water plus solvent-free solids, agitating and moving said particles through said desolventizing zone to form substantially dustfree agglomerated nodules thereof, and heating said particles during said moving to evaporate substantially all solvent and added water therefrom.

2. In a system for the agglomeration of solvent-extracted solid organic particles having flour-like fines therein, the steps comprising, continuously passing said particles through a heated zone to desolventize said particles, spraying water over said particles during said passage, said water being in a quantity sufficient to increase the total water content of said particles to an amount in excess of the desired final water content and to be absorbed by the mass of said particles but insufficient to run out of said mass, said quantity being between about 20% and about 30% by weight on a solvent-free particles basis, and tumbling said particles in a relatively shallow layer during said passage, whereby agglomerated nodules are formed from said particles while substantially all solvent and approximately all of the water so added is evaporated and removed.

3. In a system for the agglomeration of solvent-extracted fine solvent-wet solid organic particles, the steps comprising, conveying and agitating said particles from the extraction step of a solvent-extraction operation, spraying water over said particles at a predetermined rate during said conveying to substantially uniformly mix said water through said particles, said rate being adjusted to increase the total water content of said particles to approximately 25% by weight based on the weight of water plus solvent-free solids in said particles, heating said particles in a relatively shallow layer until substantially all solvent therein has been evaporated, whereby agglomerated particles in the form of nodules of useful size will be formed having a total water content substantially no higher than the total water content of said particles before the addition of water by said spraying.

References Cited in the file of this patent

UNITED STATES PATENTS

245,274	Byerley	Aug. 9, 1881
1,421,283	Meakin	June 27, 1922
1,489,702	Hare	Apr. 8, 1924
2,254,867	Bonotto	Sept. 2, 1941
2,334,015	Levine et al.	Nov. 9, 1943
2,386,052	Lundy	Oct. 2, 1945
2,423,309	Gary	July 1, 1947
2,452,249	Leiske	Oct. 26, 1948
2,497,367	Notevarp	Feb. 14, 1950
2,508,112	Haugh	May 16, 1950
2,557,993	Oliver	June 26, 1951
2,585,793	Kruse	Feb. 12, 1952
2,695,459	Hutchins	Nov. 30, 1954