Dec. 4, 1951 E. LOWE ET AL 2,576,952

APPARATUS FOR SPRAY COATING PARTICLES

Filed April 24, 1950

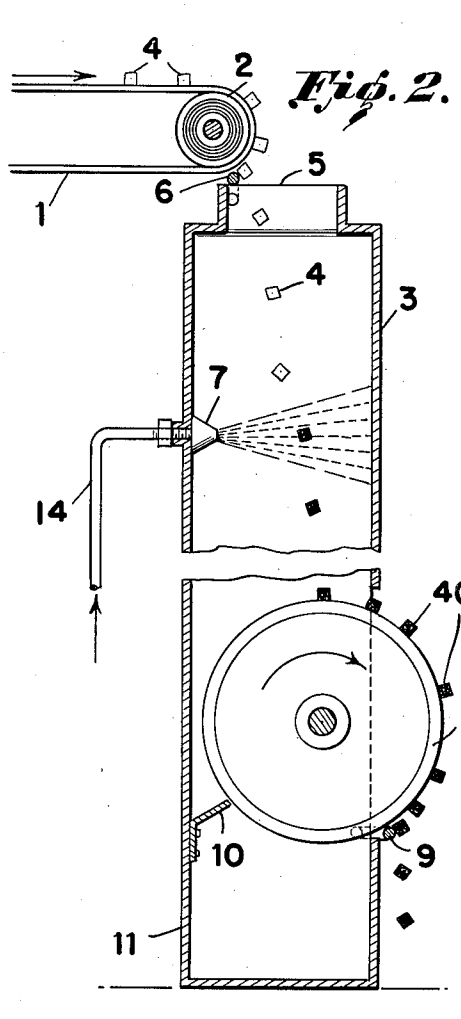


Fig. 2.

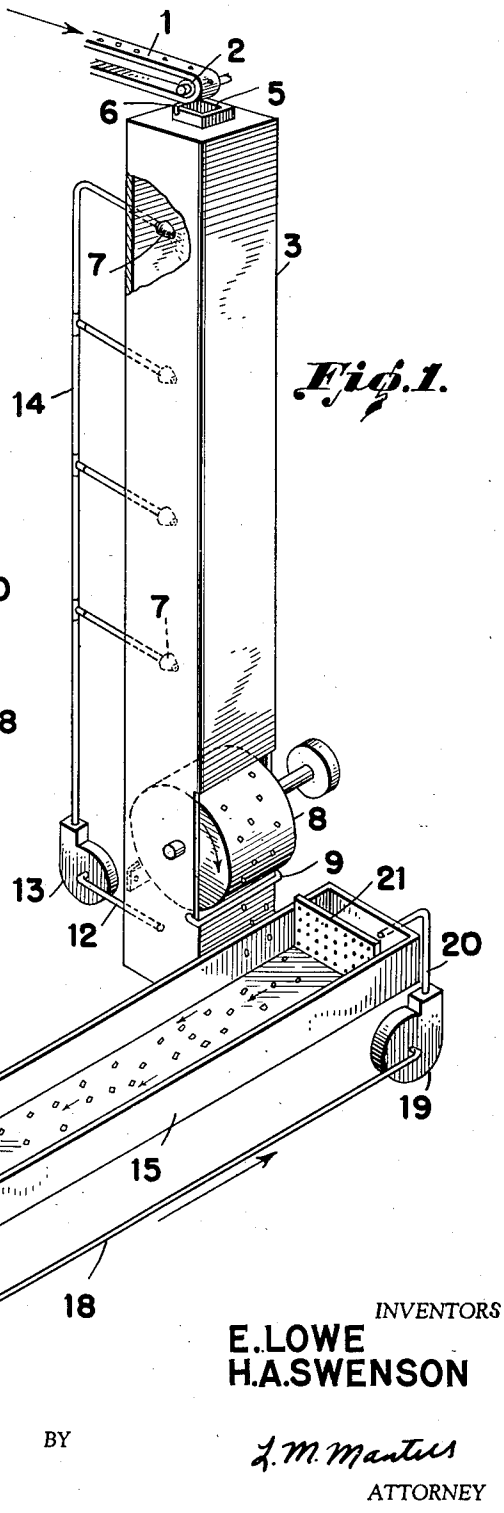


Fig. 1.

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Patented Dec. 4, 1951 2,576,952

UNITED STATES PATENT OFFICE

2,576,952

APPARATUS FOR SPRAY COATING PARTICLES

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Application April 24, 1950, Serial No. 157,838

4 Claims. (Cl. 91—45)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes throughout the world, without the payment to us of any royalty thereon.

This invention relates to an apparatus and process for the coating of articles. In particular it relates to an apparatus wherein the coating is applied to food particles by means of sprays.

The apparatus of this invention is particularly adapted to the preparation of pectinate-coated articles. The preparation of such articles involves first coating the articles with an aqueous solution of an alkali pectinate. The alkali pectinated coated articles are then contacted with a hardening solution, such as a solution of a polyvalent-metal salt, for example, calcium chloride. The hardening solution has the effect of causing a metathesis whereby the alkali pectinate is converted into a polyvalent metal pectinate which immediately gels; thus the article is then coated with a gel of the polyvalent metal pectinate.

A coating operation of this type involves considerable difficulty. The alkali pectinate solution is sticky, hence the articles coated therewith are sticky and tend to cohere in masses, resulting in clumps rather than individual coated pieces. Coherence of the coated articles must be prevented; otherwise in the hardening step the hardening solution will not contact all surfaces of the coated articles.

Another important point where articles of food are being coated is that actual immersion of the articles in the alkali pectinate solution must be avoided because the solution tends to leach soluble constituents from the articles of food; for example, where candied fruit is being coated the solution tends to leach sugar from the candied fruit. Immersion coating has the further disadvantage that, because of the sticky, viscous nature of the alkali pectinate solution, the coated articles tend to carry with them large droplets of the solution which go along with the coated articles to the hardening step and form lumps of polyvalent metal pectinate gel, which are undesirable in the finished product.

We have devised an apparatus and method which surmounts the difficulties enumerated above. In the apparatus the articles to be coated are allowed to descend through space in free fall. As they fall they pass through a zone provided with a spray of alkali pectinate solution and are thus coated with this material. The coated articles are then caught on a moving surface, such

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as a revolving drum or belt conveyor. This moving surface is situated below the spray zone so that it is also coated with the alkali pectinate solution and thus has a sticky surface. The coated articles, which are also sticky, adhere to the sticky moving surface. As the surface moves, the articles adhering thereto are moved out of the tower and dislodged by a rod placed parallel to and close to the surface of the drum or conveyor belt roller. The dislodged articles then fall into a current of hardening solution which renders them non-sticky and flushes them to a conveyor belt which in turn carries them to a dryer.

The surface of the drum, or belt, after dislodgment of the articles is then scraped to remove excess pectinate solution, the clean surface being then ready to receive the next allotment of coated articles.

In our apparatus the articles are coated uniformly as they pass in random free fall through the spray zone. Little opportunity is provided for the coated articles to stick together because they are removed from the coating zone at the same rate at which succeeding articles are introduced. No substantial immersion in pectinate solution takes place, hence no leaching of soluble constituents occurs.

In Figure 1 is shown the device of this invention in isometric projection.

In Figure 2 is shown an enlarged view of the top portion of tower 3.

In the accompanying drawing is shown a preferred form of apparatus in accordance with this invention. The apparatus includes an endless conveyor belt 1 supported on rollers, one of which, 2, is illustrated. One or both rollers are rotated by suitable device, such as an electric motor, in such direction that the upper flight of the conveyor belt, moves toward tower 3. The articles to be coated, 4, which have been deposited on belt 1 are thus dropped through port 5 into tower 3. A scraper rod 6 is provided to remove articles 4 which may tend to stick to the belt. Scraper rod 6 may be vibrated by suitable mechanism so as to prevent articles 4 from tending to adhere to it. The articles 4 which have entered tower 3 descend therethrough in free fall. During their passage through the tower they are subjected to sprays of coating material provided by nozzles 7. For the sake of simplifying the drawing, only four nozzles are illustrated, positioned on one wall of the tower. In actual practice it is preferred to have more nozzles and to position them on opposing walls or even on all four walls

so that articles 4 will be uniformly coated on all sides. Drum 8 is positioned partly within tower 3 and is rotated by suitable means, such as an electric motor, in a clockwise direction. This drum serves to remove the coated articles 40 from the tower 3 and has the advantage that the articles are never allowed to contact a pool of the coating material whereby leaching of soluble constituents from the articles is prevented. The coated articles 40 fall on the top surface of the drum and as the drum rotates, the articles are carried out of the tower. The speed of rotation of drum 8 is correlated with the speed of conveyor belt 1 so that the coated articles are removed from the tower at the same rate at which they are introduced. Thus, the piling up of articles on drum 8 is prevented. A rod 9 is mounted parallel to the axis of the drum adjacent to the lower half of the drum and outside tower 3. This rod which is positioned close to the surface of drum 8 but not in contact therewith serves to remove the coated articles which stick to the surface of the drum. Rod 9 may be vibrated by suitable mechanism so as to aid in its scraping and dislodging action. Rod 9 or other disengaging device is necessary because the coated articles are sticky and moreover the drum is also sticky because of particles of coating material which fall on it from the spray nozzles. A scraper 10 is provided to remove excess coating material from drum 8. The excess coating material drops into sump 11 from which it flows through pipe 12 into pump 13 and then is forced upwardly through pipe 14 which serves to distribute the coating material to spray nozzles 7. The coated articles which have been dislodged by rod 9 fall into horizontally extending trough 15. A current of hardening solution is kept flowing through this trough whereby the coated articles are subjected to the action of the solution to harden the coating and also to sweep the coated and hardened articles 400 onto conveyor belt 16. This latter belt is made of wire mesh or other foraminous material whereby excess hardening liquid passes through the same into sump 17. The hardening solution is recirculated via pipe 18, pump 19, and pipe 20. Perforated plate 21 is provided at the entrance end of trough 15 to uniformly distribute the hardening liquid as it enters the trough. The articles 400 which are caught on conveyor 16 are then subjected to drying to finish the coating operation.

A conveyor belt can be used in place of drum 8. It may be mounted on rollers and provided with a rod 9 and a scraper 10.

Many types of foods can be so coated. Such treatment is especially advantageous for coating normally sticky foods such as candied fruit, dates, raisins, dried prunes, and figs, to render the surface of these foods non-sticky. The coating may also be for the purpose of protecting the foodstuff from contact with dirt, air, and micro-organisms. The pectinate coatings are particularly desirable because they are edible, tasteless, odorless, strong, flexible, transparent, and glossy. For this type of operation, the coating liquid supplied to the spray nozzles should be an aqueous solution of an alkali salt of a low-methoxyl pectinic acid. The pectinic acids which have a methoxyl content from 2% to 7% are suitable for this process. They are generally used in the form of their alkali salts, such as their sodium, potassium, or ammonium salts, because they are more soluble in their salt forms. The concentration of pectinate in the coating liquid is not critical. The higher concentrations are generally more viscous and form thicker films. A suitable range of concentration is from 1 to 5%.

If desired, a water-soluble plasticizer may be incorporated in the coating liquid, to obtain a more flexible film. For this purpose, methyl cellulose, ethyl cellulose, carboxymethyl cellulose, tartaric acid, glycol, glycerol, ethylene glycol, monoethyl ether, ethylene glycol monomethyl ether, and the reaction product of glycol, boric acid, and borax (sold under the name of glycol bori-borate) are suitable. In general, the proportion of plasticizer should not be more than about 35% based on the amount of pectinic acid. Dyestuffs or pigments may be included in the pectinate solution to obtain colored films. For food coating, non-toxic coloring materials should be used. For example, a red film may be obtained by incorporating a small amount of F. D. & C. Red #1 in the pectinate solution. Mold-inhibiting agents may be incorporated in the solution to give the film greater protective value. For this purpose, about 0.1% of ethyl parahydroxybenzoate may be incorporated in the spraying solution. Flavoring agents may be added to give the film a distinct odor or taste. For example, salt may be added to the pectinate solution in the coating of nuts or nut meats. The hardening solution required to gel the alkali pectinate and thus render it non-sticky is an aqueous solution of a salt of a polyvalent metal. For food use, salts of calcium such as calcium chloride, and calcium acetate are preferred, because the calcium is non-toxic. The concentration of the salt in the hardening liquid is not critical; in general, a solution of one normal concentration gives good results.

Although we have herein stressed the use of our apparatus for coating of articles of food with pectinate solution, it is obvious that the device can be used for coating any article with any coating liquid. Thus the device can be used for application of paints, varnishes, and lacquers.

It is obvious that many modifications are possible within the spirit of this invention. Thus although we disclose the use of a belt conveyor 1 to feed the articles to be coated into the tower, one can use other mechanical conveying devices. For example, one may use a conveyor belt equipped with spikes upon which the articles are impaled. Tower 3 instead of being square in cross-section, as illustrated, may be rectangular and may be equipped with a plurality of feeders, sets of sprays, and drums to remove the coated articles. Rods 6 and 9 are preferably of small and circular cross-section, about .02 to .05 in. in diameter, so that they do not afford any substantial surface upon which the articles might adhere.

The position of rod 9 with relation to drum 8 is important. In the first place, the rod must be located sufficiently close to the surface of the drum to be able to dislodge the articles but not close enough to scrape off the coating liquid. The rod should also be located adjacent the lower, right-hand quadrant of the drum. The exact location within this quadrant depends on the size, shape, and density of articles being coated. Thus for articles of high density it may be moved counterclockwise from the midpoint of the quadrant while for articles of lighter density it should be moved clockwise from the midpoint of the quadrant. In any case the best position of the rod can easily be determined by moving it clockwise or counterclockwise and fixing it in the

position in which it causes good dislodgment of articles at a point separated from the point where the coating material tends to drip off the drum.

Having thus described our invention, we claim:

1. A coating apparatus comprising a tower, a series of spray nozzles positioned within and lengthwise of said tower, means for supplying said spray nozzles with a coating liquid, a liquid sump in the lower portion of the tower, means for introducing articles to be coated into said tower at the top thereof, a rotatable drum positioned beneath said spray nozzles, and above the liquid level in said sump, and disposed partly within and partly without said tower, the axis of said drum being transverse to the tower so as to expose the upper surface of the drum to the spray and articles falling through said tower, means for rotating said drum whereby coated articles falling thereon are conveyed out of the tower, a rod extending parallel to the axis of the drum and close to but not in contact with the surface thereof, outside the tower, said rod acting in cooperation with said drum for dislodging coated articles therefrom but not coating liquid, and scraper means within said tower to remove coating liquid from the drum.

2. A coating apparatus for food articles comprising a tower, a plurality of spray nozzles positioned within said tower, means for supplying said spray nozzles with a coating liquid, means for introducing food articles to be coated into said tower at the top thereof, a liquid reservoir in the lower end of the tower, a rotatable drum positioned beneath said spray nozzles and disposed partly within and partly without said tower, above the liquid level in said reservoir, the axis of said drum being in a horizontal plane so as to expose the surface of the drum to the spray and food articles falling through said tower, means for rotating said drum whereby coated articles falling thereon are conveyed out of the tower, a rod of circular cross-section extending parallel to the axis of said drum and close to, but not in contact with, the surface thereof and outside said tower, said rod acting in cooperation with said drum for dislodging coated articles therefrom, scraping means located within said tower for scraping excess coating liquid from said drum, and a vessel containing hardening liquid positioned beneath said drum to receive coated articles dislodged therefrom.

3. A coating apparatus comprising a tower, said tower providing a zone wherein articles may be spray-coated while in free fall and providing at its lower end a reservoir for excess coating liquid, a plurality of spray nozzles positioned within said tower, means for circulating coating liquid from the lower end of said tower to said spray nozzles, means for introducing articles to be coated into said tower at the top thereof, a rotatable drum positioned beneath said spray nozzles and disposed partly within and partly without said tower and above the liquid level in said reservoir, the axis of said drum being in a horizontal plane so as to expose the surface of said drum to the articles and spray falling through said tower, means

for rotating said drum whereby coated articles falling thereon are conveyed out of the tower, a rod of circular cross-section extending parallel to the axis of said drum and close to, but not in contact with, the surface thereof outside the tower, said rod acting in cooperation with said drum for dislodging coated articles therefrom, the rod being of 0.02 to 0.05 inch in diameter so that it does not afford any substantial surface upon which the articles might adhere, and means located in said tower for scraping excess coating liquid from said drum and directing it into the lower end of said tower.

4. An apparatus system for first coating food particles with a sticky solution to form individual, discrete coated pieces with a minimum of coherence, and for thereafter subjecting the discrete coated particles to treatment with a hardening solution, which system comprises: a non-immersion coating apparatus for food articles comprising an elongated vertical tower, a series of spray nozzles positioned within and longitudinally along said tower, means for supplying said spray nozzles with a coating liquid, means for dropping discrete food articles to be coated downwardly in said tower, whereby they fall vertically downward in said tower, a liquid reservoir in the lower end of the tower, a rotatable drum positioned beneath said spray nozzles and disposed partly within and partly without said tower, above the liquid level in said reservoir, the axis of said drum being transverse to the tower so as to expose the upper surface of the drum to the spray and food articles falling through said tower, means for rotating said drum whereby coated articles falling thereon are conveyed out of the tower, a rod of small cross-section extending parallel to the axis of said drum and close to, but not in contact with, the surface thereof and outside said tower, said rod acting in cooperation with said drum for dislodging coated articles, but a minimum of liquid, therefrom, scraping means located within said tower for scraping excess coating liquid from said drum, and returning it to said reservoir, the cleaned surface of the drum being then ready to receive the next allotment of coated particles, and a vessel containing hardening liquid positioned outside said tower and adjacent to said drum to receive coated articles dislodged therefrom.

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