A. P. ANDERSON.

ART OF TREATING STARCH.

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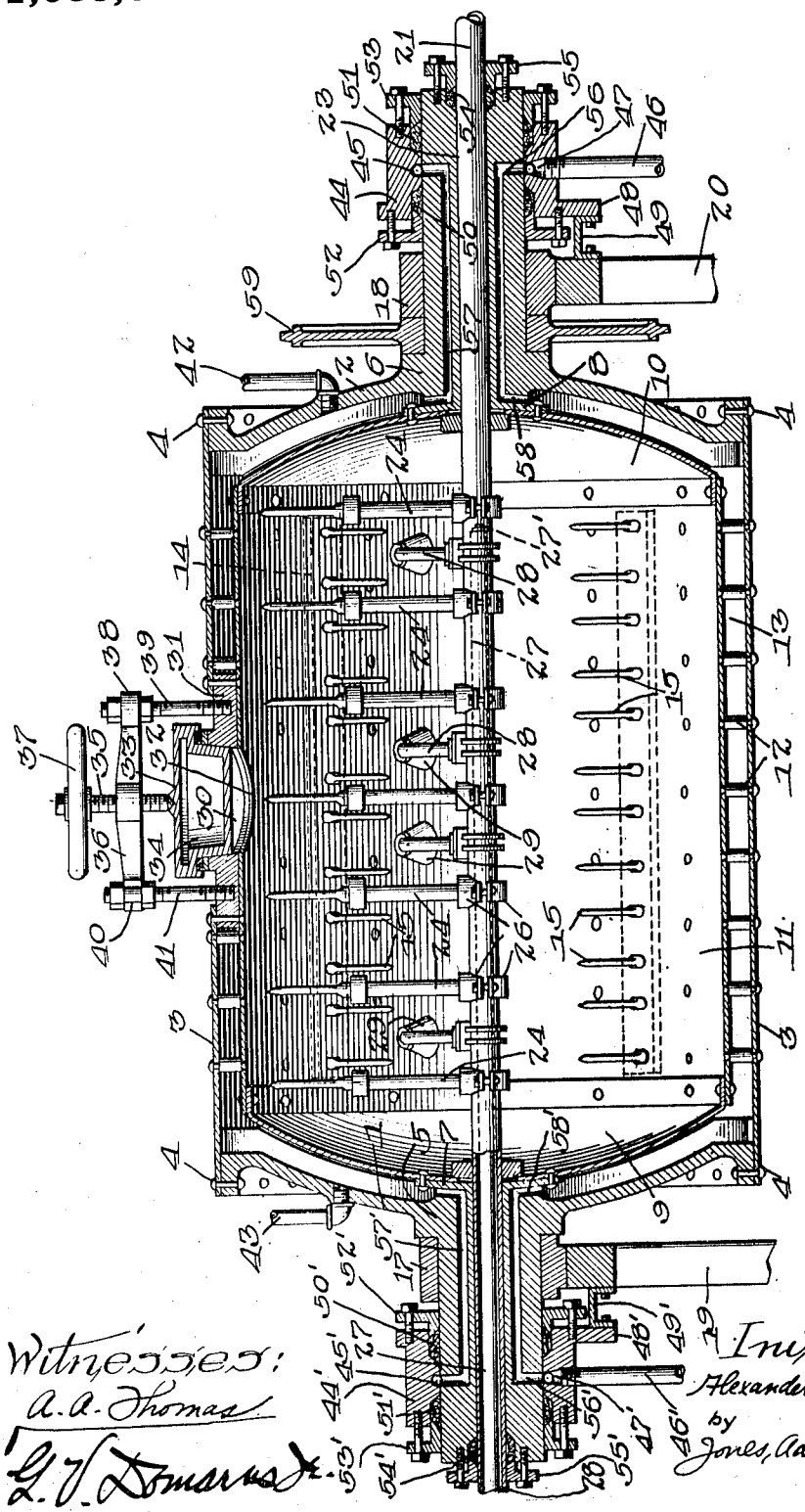
1,035,834.

Patented Aug. 20, 1912.



Witnesses:
A. A. Thomas
L. V. Thomas

Inventor:
Alexander P. Anderson
by Jones, Addington, Hawes, Att'ys

UNITED STATES PATENT OFFICE.

ALEXANDER P. ANDERSON, OF CHICAGO, ILLINOIS.

ART OF TREATING STARCH.

1,035,834. Specification of Letters Patent. Patented Aug. 20, 1912.

Application filed October 14, 1907. Serial No. 397,322.

To all whom it may concern:

Be it known that I, ALEXANDER P. ANDERSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in the Art of Treating Starch, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to the art of treating starch and has for its object the provision of a quick method of puffing starch whereby the same increases greatly in volume, at the same time becoming very porous and cellular.

Broadly considered, the process comprises two steps, the first of which consists in rendering the starch into resistant nodular or pebble-like lumps; the second step consists in rapidly heating the starch-pebbles or nodules to a high temperature whereby the same become puffed. By the term "resistant" as above applied is meant that the starch-mass or pebble-like lump is resistant to the rapid escape from its interior of fluid under pressure,—as when moisture in the lump has been changed into steam. The various characteristics of these resistant starch-pebbles, as well as the process of making them are set forth in detail in my copending application, Serial No. 332,807, filed August 31, 1906.

In the drawing accompanying this specification is illustrated a longitudinal sectional view of a suitable form of cooker, showing the interior construction of the same, as well as the connections for passing a heating or cooling fluid through the cooker-jacket.

The drum or cylinder (conveniently termed the "cooker") comprises a pair of end heads 1 and 2, preferably of heavy cast metal, to which is secured the outer cylindrical section 3 by means of rivets 4. The section 3 and the end heads 1 and 2 constitute the outer shell. The end head 1 is provided with a hub 5, while the end head 2 is provided with a similar hub 6. The inner ends of these hubs have peripheral flanges or shoulders 7 and 8, to which are riveted the end members 9 and 10, respectively. To these end members is secured the inner cylindrical section 11 spaced from the outer section by stay-bolts 12. The section 11 and its end members 9 and 10 constitute the inner shell. There is thus formed a space or jacket 13 which surrounds the inner shell of the cooker. The inner shell has attached thereto upon its outer surface a series of ribs or strips 14 to which are secured the cutter- or stirrer-pipes 15 to communicate with the jacket. It will be noticed that the free ends of these pipes are closed, so that any heating or cooling fluid admitted into the jacket will enter said pipes without passing therethrough. These pipes may be flattened in a plane transverse to the longitudinal axis of the cooker for the purpose of cutting or breaking large lumps of the material that may be rolled against said flattened edges during the rotation of the cooker. Of course, the configuration of these pipes may be varied at will; ordinary round pipes may be used, in which case they might do little or no cutting, but they would stir the material during rotation of the cooker just as effectively as the flattened pipes. The number of these pipes in a row, as well as the number of rows, is purely a matter of choice.

The cooker is rotatably supported by the hubs 5 and 6 in suitable bearing-blocks 17 and 18 mounted on standards 19 and 20. Passing longitudinally through the cooker is a stationary central pipe 21 which rests snugly in bores 22 and 23 in the hubs 5 and 6, without interfering with the free rotation of the hubs. To the central pipe 21 within the cooker is attached a series of pipes 24 which I call the breaker-pipes. These breaker-pipes are, like the stirrer-pipes 13, closed at their free ends and may be of any suitable construction,—such as cylindrical throughout their entire length. Suitable clamps 26 may be employed for rigidly securing the breaker-pipes to the central pipe, into the upper parts of which clamps the pipes are screwed to communicate with the interior of the central pipe. In this way any heating or cooling fluid admitted into the said central pipe will enter the breaker-pipes without passing therethrough. A second pipe 27 is concentrically arranged within the central pipe 21, being fastened thereto so as to rotate therewith, and is sufficiently smaller in diameter to leave a space 28 between the pipes. Communicating with the interior of the pipe 27 are the exhaust pipes 28, rigidly secured in position on the central pipe 21 in any pre-

ferred way. These exhaust pipes are open at their outer ends to establish connection between the interior of the cooker and the interior of the pipe 27. The inner end of the pipe 27 is closed beyond the last exhaust pipe, as indicated at 27', while the other end is adapted to be connected to a vacuum and condensing pump, whereby the interior of the cooker may be exhausted to the desired degree of vacuum. It will be noticed that the pipes 28 are set back at an angle relative to the breaker-pipes 24. The object of this angular displacement of the pipes 24 and 28 on the central pipe 21 is to keep the free ends of the pipes 28 clear of the material under treatment when the breaker-pipes 24 are turned down into the material in a direction toward the observer, for breaking up any masses that are too large to pass between the pipes 15 and 24. When the breaker-pipes 24 are thus turned down into the material, the pipes 28 will remain clear of the same, and will not, therefore, be in danger of having the openings in their free ends clogged. As a further prevention of such clogging it may be desirable to provide the free ends of these pipes with hoods 29.

Access to the interior of the cooker is afforded through an opening or man-hole 30 in the casting 31, said man-hole being in alinement with the opening 32 in the inner shell. An effective way of securing the casting to the cooker is to rivet or bolt the same to the shells in the space or jacket therebetween. In the instance shown the lid 33 is hollow as indicated at 34,—that is to say, it is provided with a passage whereby a suitable heating or cooling fluid may be admitted into the lid for the purpose of heating or cooling the same (as the case may be). The lid is pivotally mounted on the cooker and is held in closed or sealed position by a central member 35 adjustably carried (as, by screw-threading) in the cross-bar 36. A hand-wheel 37 permits ready adjustment of the member 35 either for moving it toward the lid to seal the same, or for raising it out of engagement with the lid to permit opening of the same. The cross-bar 36 is pivoted at one end 38 to the upright member 39 screwed into the casting 31. The other end 40 of the cross bar 36 is slotted to engage the upright member 41 likewise screwed into the casting. When it is desired to open the lid it is only necessary to raise the central member 37 out of engagement with the lid, whereupon the cross-bar 36 may be swung aside on its pivot out of the path of the lid. By connecting the pipes 42 and 43 (which communicate with opposite sides of the jacket) with the passage in the lid, some of the heating or cooling fluid may be bypassed around the jacket through the lid.

I shall now describe the connections whereby any suitable heating or cooling fluid may be passed through the jacket.

The stuffing-box 44 is provided with a circular groove 45, forming what might be termed a steam-space. To the lower portion of the stuffing-box is secured a pipe 46 adapted to be connected with a source of fluid-supply, such as steam. The radial opening 47, into which this pipe is secured in the stuffing-box, communicates with said steam-space. Although the pipe 46 and its connections might be sufficient to prevent rotation of the stuffing-box, I positively forestall any such possible rotation by connecting the flange 48 on the stuffing-box with the standard 20 by means of a brace or bracket 49. The packings 50 and 51 are held in place by the glands 52 and 53, respectively, secured to the stuffing-box. The packing 54 at the extreme end of the hub 6 is held in place by the gland 55 secured to the hub. The radial passages 56 in the hub are in alinement with the space 45 so as to communicate therewith. At their inner ends these radial passages communicate with the longitudinal openings 57 in the hub. These longitudinal openings in turn connect with the radial passages 58 formed in that portion of the end head 2 which projects into the jacket.

The above described arrangement at the right of the figure for the admission of a suitable heating or cooling fluid through the hub 6 into the jacket 13, is substantially duplicated at the left of the figure to permit the exit of the heating or cooling fluid from the jacket through the hub 5. For this reason I deem it quite unnecessary and superfluous to reiterate in detail the said arrangement at the left of the figure, whereby the heating or cooling fluid is allowed to escape from the jacket. All that need be said with reference to the description of said arrangement at the left of the figure is that the parts numbered 44 to 58, inclusive, as set forth in the immediately preceding paragraph, are for convenience shown in duplicate at the left of the figure and numbered, respectively, 44' to 58' inclusive.

Having thus described the structure of the cooker together with the arrangement for passing a heating or cooling fluid through the jacket I shall now direct attention to the operation of the device.

A sufficient amount of the material desired for treatment is put into the cooker, whereupon the latter is sealed air-tight. The cooker is then set in rotation by connecting it with a source of power through the gear-wheel 59 rigidly secured to one of the hubs. At the same time a heating fluid, such as steam, is turned into the jacket, entering hub 6 through pipe 46, and passing out of the jacket through hub 5 into the drain or return pipe 46'. The steam is

also fed into the central pipe 21 from the right through suitable connections leading to the source of supply. Bearing in mind the arrangement of the stirrer-pipes 15 and the breaker-pipes 24, it will be apparent that the steam in the jacket enters the stirrer-pipes to heat the same uniformly with the entire inner surface of the cooker, and that the steam passing through the central pipe 21 enters the breaker-pipes, whereby the same become heated uniformly with the stirrer-pipes and the inner surface of the cooker. During the rotation of the cooker the material is continually rolled and tumbled about, the presence of the stirrer-pipes 15 increasing the agitation of the material. In case it is desired to positively break up large lumps, the central pipe 21 is rotated in a direction toward the observer. Such rotation may be effected by a lever of some kind clamped to the central pipe. Although I have shown the stirrer-pipes 15 in pairs with the breaker-pipes arranged to enter the space between each pair of stirrer-pipes, any desired arrangement of the two sets of pipes may be employed. Therefore, with the breaker-pipes turned down into the tumbling material, any masses or lumps too large to pass in between the movable stirrer-pipes and the stationary breaker-pipes, will be crushed or broken. By this means the material is broken up into pieces more or less uniform in size. Should it be desired to subject the interior of the cooker to pressure below atmospheric, it is only necessary to open communication between pipe 27 and a vacuum pump.

I shall now proceed to describe the preferred manner of carrying my process into effect.

A sufficient quantity of starch (preferably ground starch) containing about 40% of total moisture, is run through a sieve having holes about one eighth of an inch in diameter, for the purpose of evenly distributing the moisture throughout the starch. Furthermore, this preparatory detail of sieving serves to separate foreign matter, such as gluten lumps which will not pass through the sieve. When dry starch is used enough water is added to bring its total moisture up to about 40%. On the other hand, should it be desired to use wet starch from the runs or gutters, (which, as is well known, contains about 50% of total moisture), it requires a preliminary drying in order to reduce the total moisture to about 40%. In either case the starch is run through a sieve as just mentioned. Enough of this starch, now fluffy and porous, is put into the cooker, and a low pressure of steam is fed into the jacket. At the same time the rotation of the cooker is begun, so that the starch may be tumbled and rolled about. As soon as the temperature has reached the gelatinization point of the starch, the latter begins to form innumerable starch-masses which, being continuously tumbled and rolled about over each other, soon become rounded and worn, very much like pebbles. The surfaces, being more or less sticky, gather up any starch particles or powder not already formed into pebble-like lumps. In this way, the starch, which was in the form of a fluffy powder when put into the cooker, has now formed itself into innumerable rounded and more or less gelatinized masses of varying sizes, say from the size of a pin-head to that of a pea of bean. The treatment is continued until a pressure of about 15 pounds to the square inch has developed within the cooker, and until all of the pebble-like lumps are hardened and gelatinized to such an extent that the starch-granules of each lump have coalesced together by the fusion of their contact-planes. These lumps, when dry, are horny, glassy and resistant. The formation of the starch into pebble-like lumps, as explained, occurs at a comparatively low temperature of the starch, and is completed by the time its temperature reaches 100 degrees C. At this temperature, or soon thereafter, the gage begins to show pressure, due to the conversion into steam of a part of the moisture of the starch. The steam increases in temperature and quantity with the increasing temperature of the starch, which by this time has all been formed into pebble-like lumps. The steam atmosphere formed within the cooker is essentially saturated steam. It follows therefore, that the starch-lump, containing as it does about 40% of moisture, cannot hold all of this moisture within itself at this temperature. Consequently, the moisture which has not been converted into steam forms on the surface of the lumps as free water or sweat. This surface-water not only prevents the pebble-like lumps from sticking or pasting together but also causes a formation of a very smooth, polished and hard surface, which completely covers the periphery of each lump. As soon as a pressure of about 15 pounds per square inch has developed within the cooker, all of the pressure is blown off through the air or through the condenser of the vacuum pump. In some cases it may be found desirable to create within the cooker a pressure below atmospheric for the purpose of rapidly drying the pebbled starch-lumps down to an air-dry condition. During the blowing off of the pressure, as well as during the drying by means of a vacuum, the apparatus is preferably kept in continual rotation so as to cause an even drying; also, during the drying the pressure of the jacket-steam may be increased to effect quicker drying. This operation of pebbling being now completed, the pebbled starch is

ready for the step of puffing. This step may be carried out immediately upon the completion of the pebbling operation, or at any time thereafter. Thus, the pebbles may be taken out of the cylinder and stored for any length of time.

The step of puffing is accomplished as follows: The substantially air-dry starch-pebbles (containing about 15 to 25% of moisture) are subjected to a comparatively high heat,—say, about 200 to 400 degrees C., depending upon the particular heating medium, as indicated in the examples cited below. This sudden heating of the pebbles should be but for a short time; not too long to burn them, but just long enough to cause the moisture to change into steam which expands or puffs the pebble-like lumps, rendering them porous or cellular and much enlarged in size. The heating of the resistant starch lumps for puffing requires to be done quickly, that is to say, the pebbles must be suddenly raised to the required temperature, as distinguished from a gradual heating up to such temperature since otherwise the steam-vapor arising from the starch will diffuse so slowly that no pressure (or at least an insufficient pressure) results within the resistant lump. To provide for such quick or sudden heating no special kind or form of apparatus is necessary. Thus, an ordinary wire cage like a corn-popper with a mesh fine enough to prevent the resistant lumps from falling through will answer the purpose very well. It will be found that by agitating the pebbles in such a corn-popper inside of an oven at a temperature of about 400° C. for a short time, the resistant starch will puff as above explained. Also, when dropped into oil or fat at a temperature of about 260 degrees C., the resistant starch-lumps will explode, puffing up to many times their original volume. Another method is to drop the resistant starch into sand or salt which has been heated up to a temperature of about 300 or 400 degrees C. The starch-pebbles are mixed with this hot sand or salt for a few moments until their puffing takes place. The puffed balls, being of greater size than the granules of sand or salt, are easily separated by screening. Such mixing of the resistant starch-lumps with the sand or salt is readily done in a series of trays which are kept inside of an oven long enough to heat the sand or salt to the desired temperature. The trays containing the salt or sand are preferably taken out of the oven during the treatment of the starch, but the mixing may be readily done inside the oven. As soon as one tray has been used, it is put back into the oven with the sand or salt to be heated up again. Another way of puffing the resistant starch by means of heated salt or sand may be carried out by arranging a continuous stream of hot sand or salt; the resistant starch fed into this stream, will mix evenly with it long enough to be puffed. The separation of the puffed starch from the sand or salt by screening has been found to be a very satisfactory method, especially when large quantities are to be thus puffed. The sand or salt is conveyed back to the heating chamber and can thus be used over again many times.

The final product herein obtained is substantially identical with the product claimed in my Patent No. 769,289, dated September 6, 1904.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The process of making a puffed starch product which consists in heating and tumbling starch containing about 40% of moisture in a closed receptacle until sufficient pressure has developed therein to start gelatinization of the starch, then continuing the heating until, due to the tumbling action substantially all of the material has formed into practically completely gelatinized pebble-like lumps, then reducing the pressure to dry the starch-lumps thus formed down to a substantially air-dry condition, and then suddenly heating the air-dry starch-lumps to a temperature sufficiently high to puff the same.

2. The process of making a puffed starch product which consists in heating and tumbling starch containing about 40% of moisture in a closed receptacle until a pressure of about 15 pounds per square inch has developed therein, whereby the starch is gelatinized and due to the tumbling action the material forms into pebble-like lumps, then reducing the pressure to dry the starch-lumps thus formed down to a substantially air-dry condition, and then suddenly heating the air-dry starch-lumps to a temperature ranging from about 200 to 400° C., whereby the lumps become puffed.

3. The process of making a puffed starch product which consists in heating and tumbling starch containing about 40% of moisture in a closed receptacle until sufficient pressure has developed therein to start gelatinization of the starch, then continuing the heating and tumbling until substantially all of the material has formed into practically completely gelatinized pebble-like lumps, then exhausting the pressure below atmospheric to dry the starch-lumps thus formed down to a substantially air-dry condition, and then suddenly heating the air-dry starch-lumps to a temperature ranging from about 200 to 400° C., whereby the same become puffed.

4. The process of making a puffed starch product which consists in heating and tumbling starch containing about 40% of mois-

ture in a closed receptacle until a pressure of about 15 pounds per square inch has developed therein, the heating being continued until the starch is gelatinized and due to the tumbling action the material forms into pebble-like lumps, then exhausting the pressure below atmospheric to dry the starch-lumps thus formed down to a substantially air-dry condition, and then suddenly heating the air-dry starch-lumps to a temperature ranging from about 200 to 400° C., whereby the same become puffed.

5. The process of making puffed starch lumps which consists in heating and tumbling moistened starch so as to form the same into gelatinized pebble-like lumps, then suddenly heating the pebble-like lumps to puff the same.

6. The process of making puffed starch lumps which consists in heating and tumbling moistened starch in a closed receptacle until the same is formed into gelatinized pebble-like lumps, then drying the lumps to a substantially air-dry condition, and then suddenly heating the lumps to a temperature sufficiently high to change into steam the contained moisture, whereby the lumps become puffed.

7. The process of making puffed starch pebbles or lumps which consists in heating and tumbling moistened starch in a closed receptacle and simultaneously subjecting the starch to a breaking up or stirring action, until the same has formed into gelatinized pebble-like lumps, and then suddenly heating the lumps to a temperature sufficiently high to puff the same.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

ALEXANDER P. ANDERSON.

Witnesses:

J. JAY SMITH,

LOUISE RAND BASCOM.