

Jan. 31, 1967

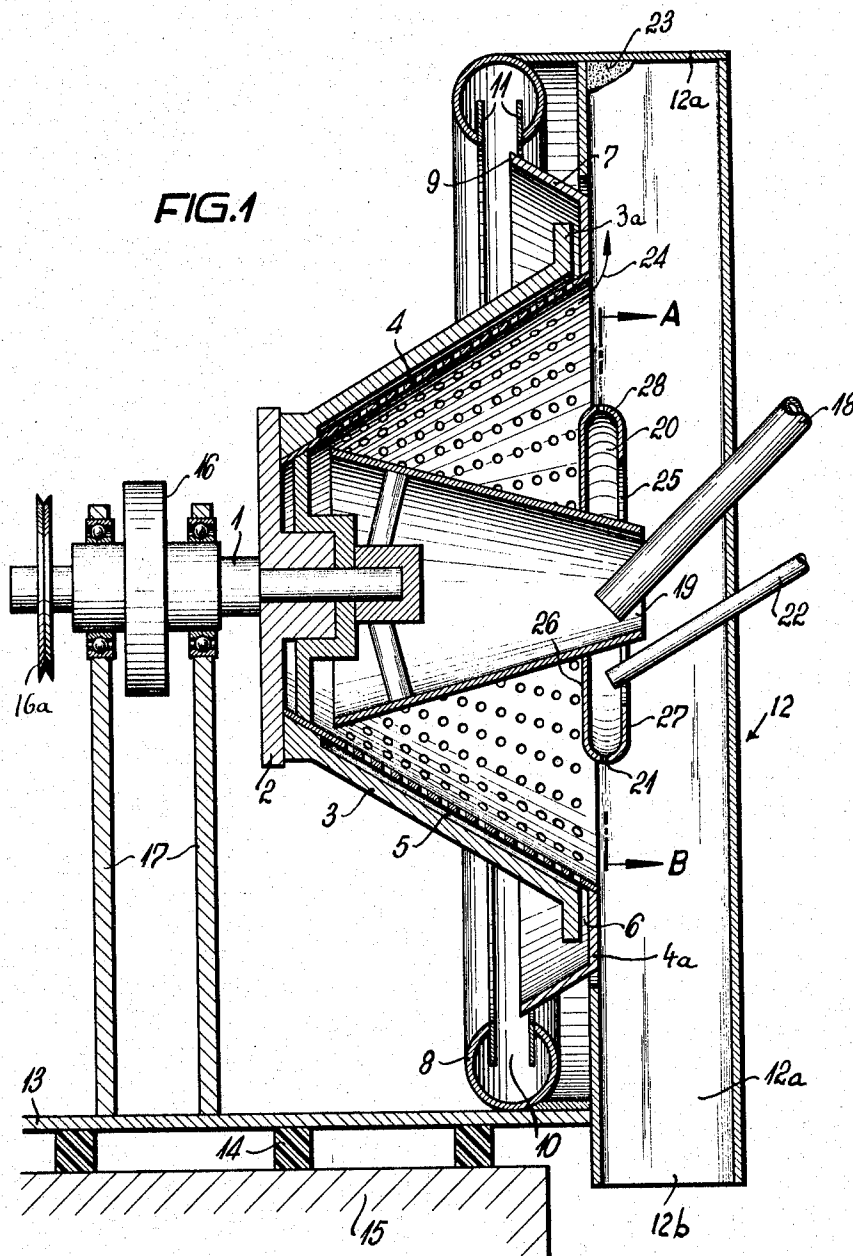
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3,301,708

APPARATUS FOR SEPARATING CRYSTALS FROM SUGAR SYRUP

Filed May 5, 1964

2 Sheets-Sheet 1



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FIG. 2

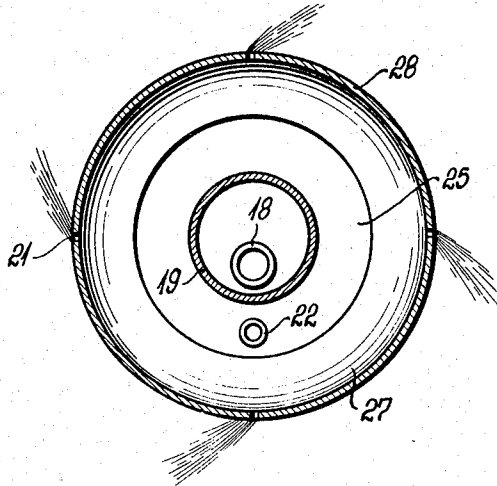
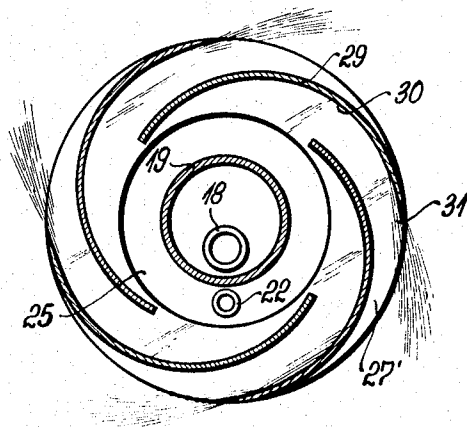


FIG. 3



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APPARATUS FOR SEPARATING CRYSTALS  
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Grevenbroich, GermanyFiled May 5, 1964, Ser. No. 365,020  
11 Claims. (Cl. 127-19)

The present invention relates to a method and apparatus for treating concentrated syrup in the manufacture of sugar, and more particularly to a method and apparatus for preventing or for reducing comminution and disintegration of crystals during separation of sugar syrup into a liquid fraction and a solid crystalline fraction.

It is an important object of the present invention to provide an improved method of separating a solid crystalline fraction from highly concentrated sugar syrup in such a way that the crystals can undergo no comminution or disintegration even though the method is carried out in modern high-speed centrifugal machines.

Another object of the invention is to provide a method of the just outlined characteristics according to which the purity of the solid crystalline fraction exceeds the purity of solid fractions which are obtained by conventional separating methods of which I have knowledge at this time.

A further object of the invention is to provide an improved centrifugal machine which may be utilized in the practice of the above method and which is constructed and assembled in such a way that a solid fraction of very high purity and consisting of very large crystals may be obtained in a continuous operation and at the same rate as in any modern centrifugal separator.

An additional object of the invention is to provide a centrifugal machine of the just outlined characteristics which may be rapidly and conveniently adjusted to deliver a solid crystalline fraction of desired consistency, wherein the consistency of the solid crystalline fraction may be regulated at one, two or more points, and which may be used with great advantage in all or nearly all presently known sugar processing plants.

Still another object of the invention is to provide an improved centrifuge for use in a machine of the above outlined characteristics and to equip the centrifuge with means for preventing comminution or disintegration of sugar crystals which form the solid fraction of sugar syrup.

With the above objects in view, one feature of my invention resides in the provision of an improved method of separating crystals from sugar syrup wherein the syrup is subjected to the action of centrifugal force to yield a solid crystalline fraction which is separated from the liquid fraction and accumulates along the walls of a suitable collector. In accordance with the invention, the method comprises the additional steps of directing at high speed a stream of crystals which form the solid fraction in a direction toward the walls of the collector, and admitting into the stream of such crystals a stream of liquid material so that the two streams form a cushion which coats the walls of the collector and protects the crystals from disintegration by preventing full-speed impact of crystals against the collector. The liquid material which is admitted to the stream of crystals preferably consists of syrup whose purity at least equals but preferably exceeds the purity of centrifuged syrup, and the material of such high-purity syrup forms a protective film about the crystals to protect them from disintegration on impact against the walls of the collector.

As a rule, the liquid material will be admitted in the form of fine sprays and the mass obtained on admixture of such liquid material to the stream of crystals will form

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a cushion coating the walls of the collector so that any crystals impinging against such cushion are braked sufficiently to prevent undesirable comminution or disintegration even if the crystals are hurled at very high speeds, for example, at speeds in the range of 100 meters per second.

The improved centrifugal machine is preferably constructed in such a way that the stream of finely dispersed high-purity syrup is concentric and coplanar with the stream of crystals whereby the stream of high-purity syrup forms an annulus which is surrounded by and which merges into the annulus of crystals.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved centrifugal machine itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawings, in which:

FIG. 1 is a central vertical section through a centrifugal machine which embodies one form of the invention;

FIG. 2 is a transverse section as seen in the direction of arrows from the line A-B of FIG. 1; and

FIG. 3 is a similar transverse section through a portion of a modified centrifugal machine.

Referring to FIG. 1, there is shown a centrifugal machine including a frame or housing 13 which rests on elastic cushioning members 14 placed onto a fixed main support including a base structure 15. The centrifuge of the machine is mounted in overhang position and comprises a horizontal drive shaft 1 which is rotatable in bearing plates 17 and which may be driven by one element of a suitable clutch 16. The other element of this clutch is driven by a belt transmission including a sheave 16a. The drive shaft 1 carries the hub 2 of an outer vessel here shown as including a conical jacket 3 which diverges in a direction away from the hub and which surrounds with some clearance an inner vessel including a perforated conical basket 4 so that the two vessels define between themselves a conical space 5. The smaller-diameter end portion of the basket 4 is fixed to the hub 2 so that the two vessels rotate at the same speed. The larger-diameter end of the space 5 communicates with an annular passage 6 disposed in a radial plane which is perpendicular to the axis of the drive shaft 1. The passage 6 serves to direct the liquid fraction against a conical baffle plate 7 which directs such liquid fraction into the annular channel 10 of a hollow ring-shaped collector 8. This collector has a ring-shaped mantle with an annular slot in the zone where its diameter is the smallest, and the edge portions of its mantle are connected with substantially radially extending washer-like guide walls 11 which direct the liquid fraction into the channel 10. It will be noted that the concavity of the baffle plate 7 is just the opposite of that of the vessels, and that the edge 9 at the larger-diameter end of the baffle plate 7 registers with the space between the guide walls 11 so that the liquid fraction may enter the channel 10 without even touching these walls. The baffle plate 7 rotates with the basket 4 but the collector 8 is stationary. The passage 6 is defined by a pair of closely adjacent annular washer-like portions 3a, 4a secured to and extending outwardly from the open larger-diameter ends of the vessels.

The solid crystalline fraction of syrup which is admitted into the basket 4 travels along the internal surface of this basket and is discharged at the open end of the inner vessel to form an annular stream which flows radially outwardly (arrow 24) to accumulate along the walls 12a of a box-shaped second collector 12. The

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customary washing device is not shown in the drawings because it forms no part of this invention.

The mass of syrup to be separated into a solid and a liquid fraction is admitted through a first conveyor device including an inclined conduit 18 which discharges into the smaller-diameter end of a hollow frustoconical funnel 19. The larger-diameter end of this funnel is adjacent to but spaced from the smaller-diameter end of the basket 4 so that the syrup may flow about the larger-diameter end of the funnel 19 and is then separated into a liquid fraction and a solid crystalline fraction. The funnel 19 is connected with the hub 2 so as to rotate with the drive shaft 1. The conduit 18 is stationary.

In accordance with my invention, the centrifugal machine of FIG. 1 further comprises a second conveyor device which preferably serves to admit syrup of greater purity than that which is admitted through the conduit 18. This second conveyor device comprises an inclined conduit 22 which discharges into a revolving distributor or header 20 of U-shaped cross section comprising a pair of spaced annular flanges 26, 27 having their peripheral portions connected to each other by an annular web 28 of concavo-convex shape. The flange 26 is coaxially secured to and rotates with the funnel 19; the flange 27 defines a circular aperture 25 which receives with play the smaller-diameter end of the funnel 19 and which also receives the discharge end of the conduit 22; and the web 28 is provided with a series of equidistant openings here shown as orifices 21 which communicate with the internal chamber of the header 20 and which discharge sprays of pure or nearly pure syrup into the stream of sugar crystals (arrow 24). It will be noted that the header 20 rotates with the funnel 19. In other words, the parts 3, 4, 7, 19 and 20 rotate with the drive shaft 1 and with reference to the conduits 18, 22 and collectors 8, 12. FIG. 2 shows that the web 28 may be provided with four equidistant orifices 21 which discharge sprays of pure or nearly pure syrup in directions substantially tangentially of the header 20 when the shaft 1 rotates. Such sprays together form a substantially annular stream which is coplanar with and surrounded by the stream of crystals flowing in the direction indicated by arrow 24.

The machine of FIGS. 1 and 2 operates as follows:

The conduit 18 delivers a continuous stream of syrup which flows through and is discharged along the larger-diameter end of the funnel 19 to enter the smaller-diameter end of the basket 4. As it flows along the inner side of the basket, the syrup yields a liquid fraction which penetrates through the perforated wall of the basket to enter the space 5, and a solid crystalline fraction which travels along the inner side of the basket and thereupon radially outwardly, see the arrow 24, so as to impinge against the walls 12a of the collector 12. A cushion consisting in part of such crystalline fraction is shown at 23 in FIG. 1. The liquid fraction flows through the annular passage 6 and along the edge 9 of the baffle plate 7 to pass between the walls 11 and to accumulate in the channel 10 of the collector 8 from which the liquid fraction is removed continuously or at regular intervals in a manner well known in the art.

At the same time, the conduit 22 discharges a continuous stream of pure or nearly pure syrup which flows into the interior of the revolving header 20 to be discharged through the orifices 21 and to form sprays which are admitted to the solid crystalline fraction (arrow 24) and which form with such crystalline fraction a doughy or pasty mass accumulating on the walls 12a of the collector 12 to provide a cushion for the crystals and to prevent comminution or disintegration of the solid crystalline fraction. In other words, the header 20 serves as a means for admitting a liquid or liquefied material to the solid crystalline fraction which is discharged from the basket 4 so that the crystals which form the solid fraction cannot disintegrate on contact with the wall structure 12a of the collector 12. Also, the pasty mass which accumu-

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lates at 23 will tend to become separated from the wall structure 12a as soon as its weight reaches a certain value so that the solid fraction (mixed with syrup admitted at 22) will automatically descend through the open lower end 12b of the collector 12 to be thereupon subjected to further centrifuging or purifying treatment. Once the solid fraction leaving the interior of the basket 4 and the sprays of syrup leaving the interior of the header 20 form a cushion 23 which is deposited on the wall structure 12a of the collector 12, the crystalline fraction leaving the basket 4 will impinge against this cushion and its particles will be protected from comminution or disintegration. Thus, the mass forming the cushion 23 serves to brake the crystals of the solid fraction and to prevent direct full-speed impact of such crystals against the solid wall structure 12a of the collector 12. In fact, the globules of the sprays issuing at 21 will form protecting films around the crystals of the solid fraction to further reduce the likelihood of disintegration.

FIG. 3 illustrates a portion of a modified distributor or header which may be used in the centrifugal machine of FIG. 1 and which is constructed with a view to prevent clogging of openings through which syrup of high purity enters the path of the solid crystalline fraction. The modified header comprises a first flange (not shown in FIG. 3) corresponding to the flange 26 of FIG. 1, a second flange 27' which corresponds to the flange 27 of FIG. 2, and at least two but preferably more spiral vanes or blades 29 which are disposed between the flanges 26, 27' and which are arranged in such a way that the outer end portion of each vane 29 overlaps but is spaced from the inner end portion of an adjoining vane. The vanes 29 resemble logarithmic spirals and define between themselves a series of comparatively large arcuate openings 31 which discharge streams of pure or nearly pure syrup so that such streams flow along concave inner sides 30 of the vanes and thereupon substantially tangentially of the flange 27'. An important advantage of the header shown in FIG. 3 is that the openings 31 between the vanes 29 are comparatively large so that crystals which are invariably present in the stream of syrup entering through the conduit 22 are less likely to clog the header. The inclination of the vanes 29 with reference to lines which are tangential to the flanges 26 and 27' is about 10 degrees. These vanes accelerate the mass which is admitted through the conduit 22 so that the speed of sprays issuing from the header approximates or equals the speed of the solid crystalline fraction which overflows the open larger-diameter end of the basket 4. The crystalline matter which is admitted with the syrup entering through the conduit 22 will be admixed to crystals of the solid fraction and will form with the remainder of pure syrup a cushion which prevents comminution or disintegration of the bulk of crystals which are separated in the centrifuge. The thickness of the cushion 23 in the collector 12 increases gradually until it is ready to drop by gravity and to descend through the open lower end 12b and into a receptacle or onto a conveyor, not shown in the drawings. However, the mass of syrup discharged through the openings 21 or 31 continues to build new layers of cushioning material which protect the crystals of the solid fraction from comminution or disintegration as long as the conduit 22 continues to admit pure or nearly pure syrup. Since the syrup admitted at 22 moistens the very dry solid fraction which overflows the open end of the basket 4, the solid fraction is not likely to clog the collector 12 by forming bridges which will develop in many conventional separators.

The consistency of the cushion 23 may be varied by regulating the admission of material through the conduit 18 and/or 22, and/or by regulating the r.p.m. of the drive shaft 1.

I wish to mention here that it is already known to prevent disintegration of sugar crystals by operating a centrifugal machine in such a way that the solid fraction

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retains a certain percentage of moisture which is sufficient to prevent excessive comminution of crystals. In such machines, disintegration of crystals is prevented or reduced at the expense of purity. Thus, the liquid ingredient which remains in the solid fraction will prevent the formation of pulverulent sugar, but the purity of the solid fraction is less than that of a solid fraction which is substantially free of moisture.

The advantages of my method and apparatus will be more readily appreciated if one considers that a continuously operating centrifugal machine discharges a stream of solid crystalline fraction at speeds of up to 100 meters per second. A crystal travelling at such speed will disintegrate to form a pulverulent mass if it is allowed to impinge directly against a solid wall, i.e., if there is no braking or cushioning action which would reduce the speed of such crystals prior to actual contact with a solid wall. The likelihood of complete disintegration is increased if the solid fraction contains a very small percentage of liquid fraction and/or if the speed of the crystals is increased in response to higher r.p.m. of the drive shaft.

The mass which accumulates in the collector 12 may be used as a starting material for the production of high-purity sugar (for example, as the second intermediate product in the manufacture of commercial raw sugar), or as a high-purity mass for introduction into another continuously operating centrifugal machine which prepares sugar for the refining step. In both instances, the manufacturers prefer comparatively large crystals, i.e., it is desirable to reduce comminution and disintegration of crystals to a minimum or to eliminate any disintegration of crystals.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A centrifugal machine for separating crystals from sugar syrup, comprising a rotary vessel including a perforated basket having an open end; means for rotating said vessel; means for admitting into said basket a continuous stream of syrup whereby the liquid fraction of such syrup passes through said basket and the remaining solid crystalline fraction forms a stream of crystals which overflow and are discharged substantially radially from the open end of said basket; a collector having walls surrounding said open end so that the crystals travel in a direction toward and accumulate along said walls; and means for preventing disintegration of crystals on contact with said walls, including a hollow rotary distributor connected for rotation with said vessel and having a pair of spaced annular flanges and a web connecting the peripheral portions of said flanges and provided with openings disposed in the general plane of said open end and means for admitting high-purity sugar syrup into said distributor so that such high-purity syrup forms a stream of liquid material issuing from said openings and, in admixture to the stream of crystals, forming a cushion which coats said walls to prevent direct impact of crystals against said collector.

2. A centrifugal machine as set forth in claim 1, wherein one of said flanges is provided with an aperture and wherein the means for admitting high-purity syrup to said distributor comprises conduit means having a discharge end extending through said aperture and into said distributor.

3. A centrifugal machine for separating crystals from sugar syrup, comprising a pair of coaxial vessel each

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having a closed smaller-diameter end and an open larger-diameter end, one of said vessels being received in the other thereof and said one vessel comprising a perforated basket extending between said ends thereof and defining with the other vessel a conical space; drive means for rotating said vessels at high speed about a horizontal axis; means for admitting syrup into said basket comprising a conduit arranged to discharge a continuous stream of such syrup so that syrup entering said basket undergoes separation by centrifugal force and the thus obtained liquid fraction passes through said basket and enters said space whereas the solid crystalline fraction remains in said basket and advances toward the open end of said one vessel to form an annular stream of crystals overflowing and passing substantially radially outwardly from the open end of said one vessel; a collector comprising walls spaced from and surrounding the open end of said one vessel so that said stream of crystals advances at high speed toward and accumulates along said walls; and means for preventing disintegration of crystals on impact against said walls, including a hollow rotary distributor coaxially secured to one of said vessels and having openings disposed in a vertical plane closely adjacent to the plane of the open end of said one vessel, said distributor having a maximum diameter which is less than the diameter of the open end of said one vessel, and conduit means for admitting high-purity sugar syrup into said distributor so that such high-purity syrup forms a stream of dispersed liquid material which issues from said openings and is admixed to the stream of crystals whereby the two streams form a cushion which accumulates along said walls and prevents direct impact of crystals against said collector.

4. A centrifugal machine as set forth in claim 3, further comprising a pair of annular portions spaced from each other and each connected to the open end of one of said vessels so as to form an annular passage which communicates with said conical space, a hollow ring-shaped second collector having an annular slot in the smallest-diameter portion thereof, and conical baffle means connected with one of said annular portions and arranged to direct the liquid fraction through said slot and into the interior of said second collector.

5. A centrifugal machine as set forth in claim 3, further comprising a conical funnel secured to said drive means and extending into said basket, said funnel having a larger-diameter end adjacent to the smaller-diameter end of said one vessel and being spaced from said basket, said first mentioned conduit being arranged to deliver syrup into said funnel so that such syrup passes through said funnel and enters the basket at the smaller-diameter end of said one vessel.

6. A centrifugal machine as set forth in claim 3, wherein said first mentioned collector is provided with an open lower end so that fragments of the cushion which accumulates along said walls can descend by gravity to pass through the lower end of said first collector.

7. A centrifugal machine as set forth in claim 3, further comprising a frame for said collector and for said drive means, and cushioning means for said frame.

8. A centrifugal machine for separating crystals from sugar syrup, comprising a rotary vessel including a perforated basket having an open end; means for rotating said vessel; means for admitting into said basket a continuous stream of syrup whereby the liquid fraction of such syrup passes through said basket and the remaining solid crystalline fraction forms a stream of crystals which overflow and are discharged substantially radially from the open end of said basket; a collector having walls surrounding said open end so that the crystals travel in a direction toward and accumulate along said walls; and means for preventing disintegration of crystals on contact with said walls, including a hollow rotary distributor connected for rotation with said vessel and including a pair of annular flanges and a plurality of

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arcuate vanes extending between said flanges, said vanes defining between themselves a plurality of arcuate openings for escape of high-purity syrup from said distributor so that such high-purity syrup forms a stream of liquid material issuing from said openings and, in admixture to the stream of crystals, forming a cushion which coats said walls to prevent direct impact of crystals against said collector.

9. A centrifugal machine as set forth in claim 8, wherein one of said flanges is provided with an aperture and wherein the means for admitting high-purity syrup into said distributor comprises a fixed conduit having a discharge end extending through said aperture and into said distributor.

10. A centrifugal machine as set forth in claim 8, wherein each of said vanes comprises an outer end portion and an inner end portion, each of said outer end portions overlapping and being spaced from one of said inner end portions.

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11. A centrifugal machine as set forth in claim 8, wherein each of said vanes makes an angle of about 10 degrees with a line extending tangentially of said flanges.

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