APPARATUS FOR DRYING FLUENT MATERIALS

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ABSTRACT

An apparatus for drying fluent materials with an approximately horizontally arranged cylindrical conduit as well as a rotor rotating internally of such conduit. The rotor supports vane-like elements operatively associated with the inner wall of the conduit. The rotor carries a number of such elements which are successively arranged in the direction of rotation thereof and serve for wiping, circulating, comminuting and scraping of the fluent material. One of the elements is constructed at least as a wiper element and a further element is constructed at least as a scraper element, the free edge of which travels closer to the inner wall of the conduit than the free edge of the wiper element. The scraper element has throughpassage openings for scraped-off material.

21 Claims, 9 Drawing Figures
APPARATUS FOR DRYING FLUENT MATERIALS

BACKGROUND OF THE INVENTION

The present invention relates to a new and improved apparatus for drying fluent materials. A dryer construction is already known to the art which embodies an approximately horizontally arranged heatable treatment compartment or chamber. A rotor is coaxially arranged within this treatment compartment. Star-shaped arms are secured to the rotor, at the ends of which there are provided blades or bucket elements. The blade elements extend up to the direct neighborhood of the wall of the treatment compartment. The arms supporting the blade elements are arranged at the rotor along a helical line, it being important that one blade partially overlaps the preceding blade viewed in the peripheral direction of the rotor. During operation of this dryer the material to be processed arrives in the treatment compartment through the agency of an inlet connection or stud. Within this compartment the material is engaged by the blade elements and conveyed in the form of a spiral-shaped band as a thin layer towards an outlet connection or stud. Along its path from the inlet connection to the outlet connection the material is subjected to thermal treatment, the liquid part of the material being vaporized, that is to say, the material is dried.

A drawback of this dryer resides in the fact that owing to the selected blade arrangement the material to be treated is conveyed in a band-like configuration over the treatment wall, and therefore, there is not possible optimum utilization of the available treatment surface.

Furthermore, during operation of this state-of-the-art dryer, especially during treatment of paste-like materials, there are formed agglomerations or lumps from which moisture is difficult to expel or cannot be expelled to the desired degree. Owing to this insufficient treatment of the material a final product departs from the dryer having an irregular or non-uniform moisture content. This drawback can be partially overcome in that the delivery of heat to the treatment compartment is controlled by a control mechanism. However, such control mechanism can only partially fulfill the desired objectives owing to the inertia of the control circuit, and additionally makes the final product more expensive.

SUMMARY OF THE INVENTION

Thus, from what has been explained above it should be apparent that this particular technology is still in need of apparatus for drying fluent materials which is not associated with the aforementioned drawbacks and limitations of the prior art proposals discussed above. Hence, it is a primary object of the present invention to provide an improved construction of apparatus for drying fluent materials which is not associated with these drawbacks and which effectively and reliably fulfills the existing need in the art.

Still a further significant object of the present invention relates to an improved drying apparatus or dryer for fluent materials which is relatively simple in construction, extremely reliable in operation, not readily subject to malfunction, requires a minimum of servicing and maintenance and is economical to manufacture.

Yet a further object of the present invention relates to an improved drying apparatus for fluent materials which is designed to make maximum use of the available treatment surface of the treatment compartment, affords a uniform treatment of the material in an efficient and reliable manner, and does not require complicated and expensive controls to achieve the desired treatment effect.

Now in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the inventive apparatus for drying fluent materials embodies an approximately horizontally arranged substantially cylindrical thermal treatment compartment as well as a rotor rotating internally of the thermal treatment compartment. The rotor carries vane-like elements operatively associated with or proximate to the inner wall of the treatment compartment. In particular, the rotor carries a number of such elements which are arranged in succession in the direction of rotation of the rotor and serve for wiping, circulating, comminuting and scraping of the material undergoing treatment. One of the elements is at least constructed as a wiper element and another one of the elements is at least constructed as a scraper element. The free edge of the scraper element is situated more closely to the inner wall of the treatment compartment than the free edge of the wiper element. The scraper element is provided with through-flow openings for the scraped material.

By virtue of the inventive design and arrangement of the treatment elements at the rotor of the dryer there is achieved the effect that with variable starting moisture content of the material there is obtained a final product of practically constant moisture content. This constant final moisture of the material can be attained in that the material is mechanically prepared in such a manner, i.e. worked into the smallest or smaller material particles and is agitated, so that these small material particles are always again brought, at brief intervals, into contact with the treatment compartment wall, and thus, there is achieved an optimum heat transfer from the wall of the treatment compartment to the material undergoing processing.

The fact that the final moisture content of the material is independent of the rotational speed of the rotor is believed to be apparently based upon the fact that the material particles are propelled under the influence of the centrifugal force against the wall of the treatment compartment. As a result, the liquid adhering to the surface of the material particles is pushed along such surface of the material particles towards the contact point of such particles with the wall of the treatment compartment. This increased liquid concentration at the contact point improves the heat transfer from the wall of the treatment compartment to the material particles, again resulting in an increase in the vaporization efficiency. On the other hand, with an increase in the rotational speed of the rotor the residence time of the material at the treatment compartment is shortened, so that the material is only subjected to the thermal treatment for a short time. These two effects tend to cancel one another over a wide range of changes in the rotational speed and in such a manner that the final moisture content is not influenced by the rotational speed of the rotor.

That the final moisture content is independent of the mass stream can be explained from the following oc-
currences. The individual material particles, independently of the supplied quantity per unit of time, are prepared by the treatment elements in such a manner and circulated in the treatment compartment such that the quantity of material per unit of time does not exert any influence upon the frequency of contact of the individual material particles with the treatment compartment wall throughout a wide range of the infed quantity of material. Now, since with constant contact frequency of the material particles at the treatment compartment wall per material particle the vaporization of the quantity of liquid remains constant there is obtained, independently of the mass stream, a product with approximately constant final moisture content.

These different improvements in the treatment of the material are based upon the effect of an increased heat transfer between the treatment compartment wall and the material to be treated and could not be readily expected. Apart from the obtained improvement of the material as concerns the constant final moisture content it is also possible to dispense with the previously required control systems when utilizing the inventive dryer. As a result, there is obtained a noticeable reduction in the maintenance costs of the dryer as well as the production costs of the dried substances or materials.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. 1 is a schematic view of a thin-film dryer designed according to the teachings of the present invention;

FIG. 2 is a cross-sectional view of the dryer depicted in FIG. 1, taken substantially along the line II—I thereof, and showing a first embodiment of rotator construction employed therein;

FIG. 3 is a cross-sectional view similar to the showing of FIG. 2, illustrating a second embodiment of construction of rotator;

FIG. 4 is a schematic view of a further embodiment of thin-film dryer similar to the showing of FIG. 1;

FIG. 5 is a cross-sectional view of the dryer depicted in FIG. 4, taken substantially along the line V—V thereof;

FIGS. 6 to 9 inclusive schematically illustrate, on an enlarged scale, different constructional embodiments of treatment elements arranged at the rotator depicted in FIG. 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, the exemplary embodiment of apparatus for drying fluent materials as depicted in FIG. 1 has been generally indicated by reference character 10. This drying apparatus 10, a so-called thin-film dryer, possesses an approximately horizontally arranged conduit or pipe 12 connected at one end to a supply compartment or space 14 and at the other end to a discharge compartment or space 16. At the free end of the supply compartment 14 there is additionally arranged a vapor compartment or space 18, the free end of which is closed by a cover 19 or equivalent structure. The free end of the discharge compartment 16 is closed by a cover 17.

The conduit portion forming the supply compartment 14 is equipped with a radially extending connection or stud 20. The discharge compartment 16 possesses a connection or stud 22 at its associated conduit surface or jacket. Consequently, the conduit 12, i.e., the inner wall of the jacket 26, constitutes a heat exchange surface upon which fluent material is processed. Similarly the jacket of the vapor compartment 18 has associated therewith a connection or stud 24.

The conduit 12, the supply compartment 14 as well as the discharge compartment 16 are surrounded by a heating or cooling jacket 26, sometimes conveniently referred to as a heat transfer jacket, which is provided with an inlet connection 28 and an outlet connection 30. Similarly a heat transfer jacket, either a heating or cooling jacket 32 surrounds the vapor compartment 18, wherein the jacket 32 possesses an inlet connection 36 and an outlet connection 34.

A rotor designated by reference character 40 is suitably rotatably arranged in the thin-film dryer 10. This rotor 40 possesses a rotator core 42 which extends over the entire length of the discharge compartment 16, the conduit 12, the supply compartment 14 and the vapor compartment 18, and such rotor 40 and its rotator core 42 are arranged coaxially within conduit 12. A multipurpose element 44 for wiping, circulating and comminuting the material to be treated is arranged at a partial section 42 of the rotator core and which is retained at a spacing from the partial core section 42 by a multiplicity of webs 46.

Under the expression "comminuting" as employed in the context of this disclosure there is to be understood an operation in which material agglomerations or the like, as such arise during drying of wet or semi-moist materials, are again redistributed into the original material particles or grains.

The element 44 extends up to the direct region of or proximate to the wall of the conduit 12. It has been found to be especially advantageous if the width of the multiple-purpose element 44 which is in the form of a multiple-purpose blade corresponds approximately to 0.01 to 0.05—times the diameter d of the conduit 12 (cf. reference character g of FIG. 2). Viewed in the direction of rotation of the rotator 40 the multiple-purpose element 44 is rearwardly flexed, as best seen by referring to such FIG. 2. As also best recognized by referring to FIGS. 2 and 8 the angle which the radial web 46 encloses with the element 44 is in the order of between 40° and 80°, preferably 60°. The gap, such as the gap h of FIG. 2, provided between the inner wall of the conduit 12 and the confronting lengthwise edge of the multiple-purpose element 44 corresponds approximately to 2 to 3—fold the grain or granulation size of the material to be treated.

Arranged diametrically opposite the multiple-purpose element 44 upon the core portion 42 of the rotator is a scraper element 48 which is connected via a blade or leaf spring 50 with the core portion 42. In this regard it should be mentioned that it has been found to be advantageous if the blade spring 50 is arranged such that, viewed in the direction of rotation of the rotator 40, it extends rearwardly from the connection location of the blade spring 50 with the core portion 42. The advantages of this measure shall be explained more fully hereinafter. The scraper element 48 is connected by
rivets 51 with the blade spring 50. A gap \( f \) (FIG. 9) having a play corresponding approximately to that of a running shaft i.e. running clearance is provided between the inner wall of the conduit 12 and the confronting edge of the scraper element 48.

At the region of the supply compartment 14 the corresponding core portion of the rotor 40 has been designated by reference character 52. In this region a helically-shaped and wound band 54 is secured to the rotor core portion 52, the outermost edge of which extends up to the region of the wall of the supply compartment 14, as shown.

The rotor core portion penetrating into the vapor compartment has been designated by reference character 60. Also at this region there is arranged at such rotor core portion 60 a helically-shaped and wound band 62 which is provided over its entire length with throughpassage holes or apertures 64. The significance of such throughpassage holes 64 will be explained more fully hereinafter.

The rotor 40 is rotatably mounted at both of its ends in bearings 68 and 70 arranged at the covers 17 and 19 respectively and is operatively connected with any suitable drive 72.

During operation of the thin-film dryer the rotor 40 is placed into rotation by drive 72. At the same time a heat carrier, for instance in the form of water vapor, is delivered to the jackets 26 and 32, in this case constituting heating jackets via the connections 28 and 36 for heating the conduit 12. The temperature of the heat carrier is regulated in accordance with the desired final moisture content of the material to be treated. In this regard care need only be taken to ensure that the heat carrier is delivered at a constant temperature to the heating jackets 26 and 32.

The fluent material to be processed, and under which there is to be understood a liquid material (for instance a salt solution), or a pasty-like material (for instance a clay-like or muddy-like material), or a pulverulent material (for instance a granulate or centrifuged product) is inled via the connection 20 into the supply compartment 14. The wound band 54 engages the material and displaces such in the direction of and towards the discharge connection 22. As soon as the material has arrived at the operable zone of the multi-purpose or multiple-purpose element 44 it is engaged thereby and distributed in the form of a thin-film. It so doing, the treated material forms at the front side of the element 44 a nose or bowed wave which increases in volume for such time until it can flow away over the inner edge of the multiple-purpose element 44. During this collection of material the material uniformly distributes at the front side of the multiple-purpose element 44 and thereafter, following the flowing thereof over the inner edge thereof, uniformly falls onto the inner wall of the conduit 12. The material remains resident at this location for such length of time until it is scraped away from the inner wall by the scraper element 48. Due to the rotational velocity of the scraper element 48 and the narrow gap between the scraper element 48 and the inner wall of the treatment compartment the adhering material is completely propelled away therefrom without the scraper element 48 coming into direct contact with the inner wall.

During operation of the thin-film dryer material collects at the front of the scraper element 48. As a result pressure is exerted upon the scraper element 48. This pressure, owing to the resilient action of the blade spring 50 brings about a turning or pivoting-in of the scraper element 48 towards the rotor core portion 42, so that the material can flow through beneath the treatment edge of the scraper element 48.

The material which has been left by the scraper element 48 at the wall of the conduit 12 will be newly engaged by the multiple-purpose element 44 during the next half rotation of the rotor 40. Any possible agglomerations or conglomerates of dried material are engaged by the inclined arranged element 44 and pressed towards the gap \( f \) (FIG. 2). Owing to this action the occurring material-agglomerations are initially compacted, but nonetheless immediately thereafter comminuted. Consequently, the material to be treated is always maintained in a pulverulent or pasty condition.

In order to promote conveying away of the material collected in front of the scraper element 48 it is advantageous to diaphragm, at axial spacing, both the scraper element 48 as well as also the blade spring 50 as such has been best shown by referring to FIG. 1. Between the cut-out portions 53, of FIG. 1, the dammed-up material can flow away laterally and once again be engaged by the next successive element 44.

The advancing movement of the material from the connection 20 to the connection 22 is achieved by the conveying action of the wound band or strip 54, so that the material at the region of the conduit 12 is conveyed towards the discharge connection 22 by the continuously further advanced or displaced material.

In order to prevent that treated material remains at the compartment wall at the region of the discharge compartment 16 there is provided at such region the wound band or strip 58 which continuously conveys back from the closure wall 17 material present at the discharge compartment 16 towards the discharge connection 22.

The vapor formed during treatment of the material in the conduit 12 flows, in countercurrent flow with regard to the flow of the treated material, towards the supply compartment 14, flows therethrough and arrives at the region of the vapor compartment 18. The vapors which flow into the vapor compartment 18 impact against the wound band or strip 62 where they are freed of any possibly entrained droplets owing to the prevailing deflection action. The bores or apertures 64 facilitate passage of the droplet-free vapor stream to the region of the vapor connection or outlet 24, through the agency of which the vapors are delivered for instance to a non-illustrated condenser.

A further constructional form of dryer apparatus of the type described in FIGS. 1 and 2 has been shown in FIG. 3. In this embodiment there are provided two multiple-purpose or multi-purpose elements 44, these two elements 44 being arranged in diametrically opposed relationship at the rotor core portion 42. As illustrated, these elements 44 are held by webs 46 at a spacing from the rotor core portion 42. A pair of scraper elements are provided in a position displaced 90° with regard to the multiple-purpose elements 44. These scraper elements 48 are also arranged in diametrically opposed relationship with regard to one another at the rotor core portion 42. Scraper elements 48 are secured by rivets 51 or equivalent fastening devices to blade springs 50 which are connected with the rotor core portion 42. Owing to this combination there is achieved an
improvement in the treatment of the material in relation to the arrangement depicted in FIG. 2.

In FIG. 4 there is illustrated a further embodiment of inventive apparatus. Here, in the conduit 12 which is surrounded by a heat transfer jacket i.e. a heating or cooling jacket 26, there is coaxially arranged rotor 40. At the core portion 42 of the rotor 40 there are arranged four different elements 80, 82, 88 and 48, wherein each such elements are arranged offset by 90° with regard to one another.

The elements 48, 80, 82 and 88 depicted in FIGS. 4 and 5 have been individually shown in a larger view in FIGS. 6 to 9. The wiper element 80 extends axially over the entire length of the associated partial section or core portion 42 of the rotor core and radially up to the region of the wall of the conduit or pipe 12. A gap a, as best seen by referring to FIG. 6, is provided between the wall of the conduit 12 and the confronting edge of the wiper element 80, this gap corresponding in size to the desired film or layer thickness of the material to be treated.

The circulating element 82 which follows the wiper element 80 looking in the counterclockwise direction, is designed in the form of a band or strip 82 and likewise extends axially over the entire length of the partial section 42 of the rotor core, and wherein the radial extent C of the band 82 corresponds approximately to 0.001 to 0.03-fold of the diameter d (FIG. 7). As also clearly seen by referring to FIG. 7 the gap b between the wall of the conduit 12 and the edge of the band 82, confronting the aforementioned conduit wall corresponds approximately to the play of a running shaft, i.e. running clearance. The band 82 is retained by webs 84 at a spacing from the rotor core 42.

The comminution element 88 which follows the material circulation element 82 extends with its flexed portion 86 up to and towards the inner wall of the conduit 12. The flexed end portion 86 of the comminution element 88 confronting the inner wall of the conduit 12, viewed in the direction of rotation of the rotor, is flexed or bowed towards the rear, and wherein this end portion 86 serves to comminute the material to be treated. On the other hand, and as already described in conjunction with the embodiment of FIG. 2, the said 88 is secured to a blade spring 50 or the like which, in turn, is connected with the rotor core portion 42. The scraper element 48 and the blade spring 50 are connected with one another by rivets 51 or other suitable attachment or fastening devices.

In this embodiment the material fed into the thin-film dryer is engaged by the wiper element 80, and wherein all of the material must flow through the gap a which is bounded, on the one hand, by the edge of the wiper element 80 confronting the inner wall of the conduit 12, and, on the other hand, by the inner wall of such conduit itself. The material 92 which is spread or wiped uniformly upon the inner wall of the conduit 12 is subsequently engaged by the band 82 and intensively admixed or agitated, the agitated material flowing over the inner edge of the band 82 and again falling onto the inner wall and there remaining in the form of markedly agglomerated portions 96. The comminuting element 88 following the band 82 now engages the agglomerated or conglomerated material 96 by means of its flexed end portion 86, and wherein there occurs between the end portion 86 and the inner wall of the conduit 12 a compaction of the materials with simultaneous comminution of the agglomerations or conglomerates. At the same time the material is again uniformly distributed upon the inner wall in the form of a thin layer 100. In order to assist the distribution action and to prevent possible collection of material at the end portion 86 of the comminution element 88 it is advantageous to interrupt the comminution element 88, as viewed in the axial direction of the rotor, at regular intervals or spacing. In this regard attention is invited to FIG. 4. Hence, as best recognized by referring to FIGS. 1 and 4 any collection of material between the thus present openings 53 can again deposit upon the inner wall of the conduit 12 and be engaged by the next successive scraper element 48. However, under certain circumstances it also can be advantageous to construct the comminution element 88 to be continuous or uninterrupted.

It has been found to be advantageous if the end portion 86 encloses with the radial remaining portion of such comminution element 88 and angle α between 40° and 80°, most preferably an angle of 60°. In this regard attention is invited to FIG. 8. By also referring to this Figure it should be recognized that the gap e between the inner wall of the conduit 12 and the free edge of the end portion 86 confronting such inner wall advantageously amounts to 2 to 10-fold the granulation or grain size of the material undergoing treatment.

The function of the scraper element 48 depicted in FIG. 8 corresponds to that of the scraper blade 48 described in conjunction with the embodiment of FIG. 2. With the arrangement of the scraper element 48 it is of particular significance that it is approximately radially arranged in the conduit 12, and wherein it forms with a tangent at the conduit a right angle β, as best seen by referring to FIG. 9. It should be also understood by referring to FIG. 9 that the gap f between the wall of the conduit 12 and the therewith confronting lengthwise edge of the scraper element 48 approximately corresponds to the running play or clearance of an appropriate shaft of the same diameter.

Finally, it might be mentioned for the various embodiments disclosed herein that the blade spring 50 and the scraper element 48, viewed in the axial direction of the rotor, have a pointed tip.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims. Accordingly,

What is claimed is:
1. An apparatus for drying fluent material comprising an approximately horizontally arranged substantially cylindrical conduit defining therein an internal compartment and having a material inlet and material outlet, said conduit including a heat exchange surface confronting said compartment, means arranged within said conduit for conveying inlet material therethrough, a rotatable motor arranged within said internal compartment, a plurality of elements which follow one another in the circumferential direction of rotation of said rotor and angularly offset from one another and carried by said rotor, said plurality of elements serving for the wiping, circulating, comminution and scraping of the material, one of said elements being constructed at least as a wiper element and another of said elements being constructed at least as a scraper element, said
wiper element and said scraper element each having a respective free edge, the free edge of the scraper element being positioned closer to said heat exchange surface of said conduit than the free edge of the wiper element, said scraper element being provided with throughflow openings for scraped material.

2. The apparatus as defined in claim 1, wherein said scraper element defines a multi-purpose element which extends substantially over the entire length of said conduit and contains means for comminuting and circulating the material, said scraper element containing means for scraping the treated material from said heat exchange surface of said conduit.

3. The apparatus as defined in claim 2, wherein said multi-purpose element extends up to the region of said heat exchange surface of said conduit and extends radially only over a portion of the free space of said conduit, said multi-purpose element, viewed in the direction of rotation of the rotor, being flexed towards the rear.

4. The apparatus as defined in claim 3, wherein the width of the multi-purpose element approximately corresponds to 0.01 to 0.05-fold of the diameter of the conduit.

5. The apparatus as defined in claim 3, further including radially extending webs for securing said multi-purpose element to said conduit, said flexed multi-purpose element enclosing with said radially extending webs an angle which is in a range between 40° and 80°.

6. The apparatus as defined in claim 5, wherein said angle amounts to 60°.

7. The apparatus as defined in claim 2, further including blade spring means connected with the rotor, said scraper element being secured to said blade spring means.

8. The apparatus as defined in claim 7, wherein said scraper element is radially arranged within said conduit.

9. The apparatus as defined in claim 7, wherein said blade spring means and said scraper element, viewed in the axial direction of said rotor, possess the same length.

10. The apparatus as defined in claim 7, wherein said rotor has a rotor core to which there is secured said blade spring means, said blade spring means, viewed in the direction of rotation of said rotor, extending rearwardly from the connection location of the blade spring means with said rotor core.

11. The apparatus as defined in claim 7, wherein a running clearance is provided between said heat exchange surface of the conduit and the confronting lengthwise edge of the scraper element.

12. The apparatus as defined in claim 2, wherein there is provided a further multi-purpose element and a further scraper element, said respective two multi-purpose elements and two scraper elements being arranged as substantially oppositely situated pairs at said rotor.

13. The apparatus as defined in claim 1, wherein said elements define a respective element seated upon said rotor for wiping, circulating, comminuting and scraping of the material from said heat exchange surface of the conduit.

14. The apparatus as defined in claim 13, wherein the element provided for wiping comprises an axially extending wiper element which extends approximately over the entire length of the conduit.

15. The apparatus as defined in claim 13, wherein said element provided for circulating the material comprises a band extending approximately over the entire length of the conduit, said band, starting from the region of said heat exchange surface of the conduit, extending in radial direction only over a portion of the free space of the conduit.

16. The apparatus as defined in claim 15, wherein the band is arranged such that a running clearance is left free between said heat exchange surface of the conduit and the confronting lengthwise edge of the band.

17. The apparatus as defined in claim 15, wherein the radial extent of said band corresponds to 0.001 to 0.03-fold of the diameter of the conduit.

18. The apparatus as defined in claim 13, wherein the element serving to comminate agglomerations of material comprises a vane-like element with axial interruptions and extending over substantially the entire length of the conduit, the end portion of said comminuting element confronting said heat exchange surface of the conduit, viewed in the direction of rotation of the rotor, being flexed towards the rear.

19. The apparatus as defined in claim 18, wherein the flexed portion of the vane-like element encloses an angle between 40° and 80° with the remaining portion of the vane-like element.

20. The apparatus as defined in claim 19, wherein said angle amounts to 60°.

21. The apparatus as defined in claim 13, wherein the element for scraping the material from said heat exchange surface of the conduit comprises a scraper element which, viewed in the direction of rotation of the rotor, is secured to a resilient element which extends rearwardly from the connection location with the rotor core, said scraper element being arranged approximately radially within the conduit and having a running clearance between said heat exchange surface of the conduit and the confronting lengthwise edge of the scraper element.

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