

DESCRIPTION

Technical field of the Invention

The invention concerns an equipment and a method for the mixing and/or granulating of a stock, namely an equipment according to the classifying clause of the claim 1 or a method according to the classifying clause of the claim 14.

The equipment and the method are envisaged particularly for the charge-wise granulation of a stock, which comprises a mixture of solid particulate components, is moistened for granulation by a fluid, for example water, an aqueous solution or an organic solvent, is granulated in the moist state and thereafter withdrawn from the chamber as well as dried. During the granulation, a so-called cumulative granulation is concerned, in which originally present particles are deposited one against the other and in that case agglomerated into larger particles.

The equipment and the method can for example serve for the manufacture of products for the formation of medicaments, foodstuffs, agro-chemicals or seed stock pellets. For the manufacture of a granulate envisaged for example as medicament or as component of such, one can for example mix together at least one carrier or basic substance and frequently two or more carrier or basic substances, a binding agent and at least one pharmaceutically effective material in the dry state and then moisten the mixture for granulation.

State of the Art

A commercially known mixing and/or granulating equipment provided for the charge-wise operation displays an elongate chamber, the wall of which has a cylindrical casing with horizontal axis and end walls arranged at both ends of the casing. A rotor has a shaft co-axial with the axis of the chamber and several stirring organs consisting of vanes or blades distributed along the shaft as well as around it. For granulation of a stock, a charge is introduced by this rotor through an inlet into the interior space of the

chamber. The rotor can be rotated by a motor, whereby the stock present in the chamber is granulated. After the granulating process, for example, the one end wall can be removed as well as the rotor withdrawn from the chamber and the granulate can thereafter be taken out of the chamber.

The rotor of these known equipments is constructed in such a manner that although it distributes a stock, which is to be mixed and granulated and introduced through the inlet into the elongate chamber, more or less uniformly over the length of the chamber in the course of time, the stock then however moves predominantly only within the same length region of the chamber and the stock is thus no longer moved substantially in the longitudinal direction of the chamber. If one now for example introduces different particulate components, which are to be mixed together, of the stock one after the other into the chamber through the inlet disposed in about the centre thereof, it can take a relatively long time until about the same proportion of each of the components to be mixed is present in all length regions of the chamber and until the different components have been mixed together homogeneously to some extent. This acts in a particularly disadvantageous manner during the manufacture of medicaments, because the added effective substance quantity in such is often very much smaller than the quantity of the other components to be mixed and because each formed granulate grain should comprise the provided effective substance proportion as accurately as possible.

When the rotation of the rotor is terminated at the end of the granulating process in one of the known equipments, the formed granulate is distributed more or less uniformly over the entire length of the internal space of the cylindrical chamber. When the chamber is opened at one end after the granulating process, one must therefore use some auxiliary tools in order to take the granulate out of the chamber. In case the granulate shall still be dried, it must on the withdrawal first be introduced into a transport container, be transported in this to a drier and thereafter filled into this. The withdrawal of the granulate from the chamber of the granulating equipment and the drying of the granulate thus require relatively many awkward and time-consuming working steps which are performable practically only with the co-operation of at least one person and can thus not be automated or be automated at most with great expenditure on apparatus.

Moreover, the described manner of the withdrawal of the stock from the chamber of the granulating equipment increases the danger that the granulate or the internal space of the chamber becomes contaminated, which is very disadvantageous in the manufacture of medicaments and also of foodstuffs.

When known equipments of the described kind are provided for the mixing and/or granulating of greater quantities of stock, the chambers are usually dimensioned to be relatively large in order that a reasonably economical production is possible in spite of the measures required for the withdrawal of a product charge. When large charges of stock are granulated, the driers provided for the drying of the granulate charges must then also be dimensioned to be very large and are correspondingly expensive.

In case organic solvents are used for the granulation, solvent vapours, the escape of which into the ambient air shall be avoided as completely as possible, arise during the granulation and the subsequent drying. When the produced granulate must be withdrawn from the chamber in the described manner, the escape of solvent vapour lets itself be prevented only with difficulty during the withdrawal of the granulate. When large charges of the stock are to be processed, great quantities of solvent vapour also arise per unit of time in certain phases of the manufacturing process. A complete recovery of solvents is however technically difficult in the case of large quantities of solvent vapour arising per unit of time and moreover require also large and expensive recovery devices.

Different properties of a manufactured granulate, for example the mean particle size, the scatter of the particle sizes and the shape, porosity, abrasion strength as well as other strength of the particles depend strongly on the total liquid content of the particles on the termination of the granulating process. When water or an aqueous solution is fed to the stock disposed in the chamber for granulation and is atomised with air, the liquid content of the particles, which is present at the end of the granulating process, depends on the quantity of liquid supplied during the process, however also still on the initial moisture of the stock and the moisture of the air. Moreover, in the case of industrial manufacture of greater quantities of granulate, the particle sizes and other properties of the used starting products can vary from charge to charge, which can likewise influence the quantity of the liquid to be supplied for the

attainment of optimum product properties. The known equipments of the described kind however comprise no means for ascertaining the quantity of liquid present altogether in the stock during the granulating process, which impairs the product quality and is likewise disadvantageous.

It is to be noted in this context that it is indeed known for equipments of other kind, namely for example from the WO-A-88/01904 for fluidised bed granulating equipments, to measure the torque or the power required for the rotation of a disc-shaped rotor, to obtain information therefrom about the liquid content of the stock and the state of the granulating process and then to control this on the basis of the measured magnitude. These known equipments and their manners of operation are however very different just from the subject of the present invention. Moreover, the measurement of the torque is quite expensive because of the torque-measuring organ required for this purpose. Although the power required for the rotation of the rotor can be measured in the form of the electrical power, which is consumed by the electrical motor driving the rotor, by measuring means at favourable costs, the problem then however arises on a measurement of the electrical power consumed by the electrical motor that this power, in addition to the power serving effectively for the movement of the stock, also still contains power losses which are consumed in the motor and above all in a gear present between this and the rotor. In that case, the power losses are dependent on the temperatures, which change in time, of the bearings as well as of the gear and possibly on other parameters varying in time and can therefore change during the operation of the equipment so that the power, which is actually consumed by the rotor for the movement of the stock, can be ascertained only inaccurately.

It is also known to mix, moisten and granulate pourable stocks continuously. Known equipments serving this purpose comprise an elongate chamber. This is provided with a stock inlet for the particulate stock as well as with a liquid inlet in the proximity of the one end and with an outlet at the other end. A worm-like rotor is arranged in the chamber. During the operation of an equipment of that kind, the stock is conveyed from the stock inlet opening to the outlet opening during the rotation of the worm-like rotor and then issues from the chamber at the outlet opening. The number of the rotations of the rotor, which take place during the dwell of

the stock in the chambers, and thereby the dwell time of the stock in the chamber in the case of a fixedly preset rotational speed of the rotor is determined by the geometric dimensions of the chamber as well as the construction of the rotor. An equipment of the last-described kind therefore has the disadvantage that it is practically constrainedly required for the granulation of a pourable stock consisting of several components to mix these pourable stock components already before the introduction into the chamber, since the chamber and the rotor must otherwise be dimensioned to be extremely long. In that case, a certain danger however exists that the stock separates out again between the mixing and the granulating. Furthermore, it is practically impossible or possible at most with a narrow limit in an equipment of that kind, when this is built with certain dimensions, to vary the number of rotations of the rotor taking place during the dwell of the stock in the chamber and the dwell time of the stock in the chambers and to adapt them to different products. Furthermore, the chamber has a step-shaped constriction, which can hold back a part of the stock, between an initial portion comprising the stock inlet and a narrower main portion comprising the outlet. Moreover, the stock can in some circumstances be compacted in certain regions and heated in that case, which is likewise disadvantageous in the case of stocks sensitive to increases in temperature. Since the rotor during operation touches particles disposed in very different treatment stages at each instant in the different regions of both the chambers, it is also not possible with these equipments to obtain information about the liquid content of the stock and the instantaneous state of the granulating processing through measurement of the torque or the power required for rotation of the rotor.

Explanation of the Invention

The invention is therefore based on the task of creating an equipment and a method for the mixing and/or granulating of a stock, wherein the equipment of the method is to eliminate disadvantages of the known equipments or methods. In that case, the initially described, known equipment and its operating method shall be improved particularly with the

object that the stock can be mixed and/or granulated rapidly and well, that the formed product correspondingly has a homogeneous composition independently of the kind and composition of the processed stock and can be withdrawn from the chamber in simple manner at the end of the mixing and/or granulating process.

This problem is solved according to the invention by an equipment and a method with the features of the claim 1 or 14. Advantageous refinements of the equipment and the method are evident from the dependent claims.

The equipment can comprise a single chamber or two or possibly still more chambers. The inward surface of the casing of the or each chamber of the equipment is preferably at least substantially rotationally symmetrical to the axis, about which the rotor is rotatable. The inward casing surface is moreover advantageously at least substantially cylindrical. The axis is normally horizontal, could however also possibly be inclined a little, for example by at most 20°. In case the equipment comprises two or still more chambers each with an associated rotor, the axes of the rotors are preferably arranged one parallelly to the other and for example one beside the other. The selectably closable and freeable outlet of the or each chamber for example displays an outlet opening penetrating one end wall thereof, could however also have an opening which penetrates the casing in the proximity of one of both the ends walls. The outlet opening is preferably disposed at the lowest circumferential place of the internal chamber space. Furthermore, the outlet and the shut-off organ serving for the closing thereof are advantageously constructed in such a manner that the shut-off organ in the closed setting is at least approximately and for example exactly flush with that internal surface of the wall of the chamber, into which the opening of the outlet opens, so that at the outlet, there is as far as possible no "dead space", in which the stock to be processed could remain lying unmoved during the mixing and/or granulating process.

For the processing of a stock comprising two or more solid particulate components, a charge of particulate components can be introduced initially in the dry or at most slightly moist state into the or one chamber of the equipment, be conveyed to and fro along the axis in the chamber through rotation of the rotor in alternating directions of rotation without feed of

fluid and intermixed in that case. During the subsequent granulating process, a fluid can be fed continuously or possibly intermittently to the stock disposed in the chamber and continued to be conveyed to and fro by the rotor. This fluid can comprise a liquid - in particular, as already mentioned, water and/or an organic solvent - and/or vapour, which condenses in the chamber at the latest on contact with the solid particles, for example of water vapour and/or an organic solvent and/or another material, the boiling point of which amounts to at least 30°C in the case of a pressure amounting to approximately 100 kilopascals. The fluid is preferably introduced into the interior chamber space in such a manner that it gets in the shape of fine droplets onto the solid particles of the stock and wets these. When the fluid is liquid already before the entry into the interior chamber space, it can for example be sprayed by a nozzle - in particular a two-substance nozzle - in the upper region of the interior chamber space in the direction towards the stock in such a manner that a largest possible part of the liquid droplets impinges directly onto the stock. In case the fluid consists of vapour, this can likewise be introduced and/or sprayed into the upper region of the interior chamber space in such a manner that it forms at least one jet directed towards the stock and distributes itself before impinging onto the stock. It is still to be noted here that the mixed stock, which is dry before the granulating process, i.e. without feed of liquid or vapour, is of course also still intermixed during the granulating process. This assures that the stock does not separate out between the actual mixing process and the granulating process as well as during the latter and that the granulate particles arising during the granulation have practically identical compositions.

The equipment can of course serve not only for the dry mixing of a stock comprising several components and for the subsequent granulation thereof, but also for the granulation of a stock, the solid particles of which all consist of the same material or which was introduced into the chamber already in the form of an adequately homogeneously intermixed mixture. In such a case, a fluid can be introduced into the chamber at once on the setting of the rotor into operation after the introduction of a charge of the stock.

For the remainder, the equipment can of course also be used to merely mix a stock comprising several solid particulate components or a more or less moist pasty stock without wetting and granulating the stock.

A product, which is formed from a stock through mixing and/or granulating in the or one chamber, can be taken simply and rapidly out of this in that the outlet is opened and the product is conveyed to the outlet and out of this through rotation of the rotor in the appropriate direction of rotation. Residues of the stock, which during an emptying of that kind possibly still remain behind in the chamber and in the opening of the outlet, can in case of need still be blown out of the chamber and the outlet by compressed air or a gas.

A product, which is formed in a chamber and consists of a moist granulate, can after the withdrawal from the chamber be fed to a drier and be dried in this. In a particularly advantageous refinement of the subject of the invention, the equipment comprises two granulating units, each of which comprises a chamber as well as a rotor. Furthermore, a stock feed installation can be present, which is connected with a respective stock inlet of each of both the chambers. The exits at the chambers can then be connected with the entry of one and the same drier. In operation of the equipment, charges of stock can be introduced into both the chambers in alternation by the stock feed installation and be granulated in these displaced one from the other in time. The granulate charges then produced with time displacement in both the chambers can then be fed in alternation from one of both the chambers to the drier and be dried in this.

Possibly, one can provide even three or still more granulating units each with a respective chamber and connect the outlets of the chamber with the same drier. Since the time needed for drying is frequently less than the time required for mixing and granulating, an operation, in which granulate charges from two or more different chambers are fed in alternation to one and the same drier, enables a good utilisation of the equipment and a to some extent quasi-continuous processing of the stock.

In a preferred refinement, the equipment comprises drive means for the driving of the or each rotor and control means periodically and alternately to change the direction of rotation of the or each rotor, wherein the time spacings of the successively following changes in direction of rotation are preferably adjustable. The control means are in that case preferably constructed to change the direction of rotation automatically at least for a time and, for example, selectably automatically or manually.

Since the product formed in the or one chamber can be withdrawn from this without disassembly of parts of the wall of the chamber, the equipment according to the invention is also very well suited for an operation, in which the stock feed into the chamber as well as also the stock withdrawal from the chamber can be controlled by control means automatically at least for a time. The latter can for example be constructed in such a manner that they selectably enable a manual or an automatic control of the stock feed and the stock withdrawal.

Short Description of the Drawing

The invention is now explained more closely with the aid of examples of embodiment illustrated in the drawing. In the drawing, there show:

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| The Figure 1 | a largely schematic illustration of an equipment for the mixing and granulating of a stock, |
| The Figure 2 | a simplified and schematic axial section through the chamber of the first granulating unit of the equipment, |
| The Figure 3 | an oblique view of the rotor of the first granulating unit, |
| The Figure 4 | a schematic plan view onto the chamber and the rotor of the first granulating unit in the direction of view denoted by the arrow IV in the Figure 2, but to larger scale than the Figure 2 and without the end wall of the chamber facing the observer, |
| The Figure 5 | a schematic horizontal section through the chamber of the first granulating unit to the same scale as the Figure 4, |

- The Figure 6 a schematic view of the rotor in the direction of view denoted by the arrow VI in the Figure 4, wherein some vanes of the rotor were omitted in the Figures 5 and 6,
- The Figure 7 an oblique view of a differently constructed rotor,
- The Figure 8 a view of a part of the rotor according to the Figure 7 in the direction of view denoted by the arrow VIII in the latter Figure,
- The Figure 9 a view of the rotor according to the Figure 7 in the direction of view denoted in this by the arrow IX and the
- The Figure 10 a section along the line X-X of the Figure 8 through the rotor evident in this.

Preferred examples of embodiment of the invention

The equipment, which is evident in the Figure 1, for the mixing and granulating of a particulate stock displays two granulating units, namely a first granulating unit 1 and a second granulating unit 3 arranged beside this. Each of these comprises a chamber 5 with a wall 7. A rotor 11 is arranged in the interior space 9 of each chamber 5. Both the granulating units 1 and 3, in particular, their chambers 5 as well as rotors 11 are constructed to be at least substantially the same. For the remainder, the parts belonging to the first granulating unit 1 are denoted in the following also possibly as first chamber, first interior space, first rotor and so forth and the parts belonging to the second granulating unit 3 are correspondingly denoted as second chamber, second interior space, second rotor and so forth.

One of both the granulating units, namely the first granulating unit 1, is drawn separately in the Figure 2. The wall 7 comprises a circularly cylindrical casing 15 and an end wall 17 or 19 at both ends thereof. Both the ends walls 17 and 19 each consist of a respective substantially planar plate with four-cornered, for example square outline and project beyond the

casing 15 over the entire periphery thereof. The casing 15 and, in particular, the inward casing surface 15a is at least generally, and namely apart from the openings provided in it, exactly rotationally symmetrical to an axis 21 which forms an angle with the vertical. The axis 21 is at least approximately and namely exactly horizontal. The casing 15 and both the end walls 17 and 19 are firmly as well as detachably connected one with the other by connecting means. The connecting means for example comprise four rods 23, which are distributed about the casing 15 and provided at both ends with threads, the one ends of which are screwed into threaded bores of the end wall 17 and secured there by nuts 25. The other ends of the rods 23 penetrate bores of the end wall 19 and are provided there with nuts 27, namely wing nuts. The casing 15 projects by its one end into an annular groove of the end wall 17 and by its other end into a cylindrical recess of the end wall 19 and is thereby secured co-axially with the axis 21. For the remainder, the casing 15 is connected to at least some extent tightly with both the end walls 17 and 19. In case of need, sealing rings can still be provided in order to seal the connections between the casing and both the end walls to be completely gas-tight. The end walls 17 of both the granulating units 1 and 3 are fastened at a common frame 29, which is indicated in part in the Figure 2, in such a manner that the axes 21 each extend parallelly beside the other at the same height.

The drive means 31 of both the granulating units 1 and 3 comprise a respective drive device 33 for each of these. Each drive device comprises an electrical motor 35 and a gear 37. The motor 35 is constructed in such a manner that the direction of rotation of its shaft is controllable electrically, i.e. reversible. The gear 37 has a manually adjustable setting organ 37a, by which the transmission ratio, i.e. the step-down and/or step-up ratio of the gear is steplessly adjustable. The housings of the drive devices 33 of both the granulating equipments 1 and 3 are fastened at the common frame 29. The rotor 11, which is drawn separately in the Figure 3 and also still evident in the Figures 4, 5 and 6, comprises a shaft 41, which is co-axial with the axis 21 and the one end of which penetrates a hole, which consists of a stepped bore, in the end wall 17 and is borne radially and axially in this by at least one bearing 39 comprising for example rolling bodies. The shaft 41 has a continuous hole 41a which is co-

axial with the axis 21 and the central main part of which consists of a bore and which is provided at both ends with an enlargement. The output shaft 37b of the gear 37 projects into the enlargement, which is disposed in the region of the bearing 39, of the hole 41a of the shaft 41 and is connected there secure against relative rotation with the shaft 41 of the rotor 11 by a not visible fitting key. A screw 43, which connects the shaft 41 detachably with the output shaft 37b of the gear 37, has a head recessed in that enlargement of the hole 41a, which is remote from the gear 37, a shaft penetrating the middle main portion of the hole 41a and a gear part which is screwed into a threaded bore of the output shaft 37b. That end of the shaft 41, which is remote from the gear 37, projects nearly to the end wall 19 and is separated from this by a gap-shaped intermediate space. This end of the shaft 41 disposed in the proximity of the end wall 19 is free, i.e. not borne, according to the Figures 2 and 5. In case of need, a bushing, which together with a spigot which is either fastened rigidly at the end wall 19 or in its turn is borne in this by a rolling body, can however still be inserted into that enlargement of the hole 41a, which is present at this end of the shaft 41, between the head of the screw 43 and the opening of the hole 41a. This possibly still present bearing shall preferably be constructed in such a manner that the spigot can be drawn out of the bushing and again be plugged into this without anything having to be detached from and fastened again to the bearing itself. The hole serving in the end wall 17 for the feedthrough and bearing of the shaft 41 and the hole possibly present for the bearing of the other end of the shaft 41 in the end wall 19 is at least to some extent tight and in case of need sealed off to be completely gas-tight.

The rotor 11 comprises a number of stirring organs distributed about its shaft 41 and thereby about the axis 21 and along this. The stirring organs all serve for the moving and stirring of the stock, are however differently constructed and can therefore be subdivided into conveying stirring organs 47 and 49, distributing and/or chopping stirring organs 53 and scraping stirring organs 57 in dependence on their special functions provided in addition to the stirring. Each stirring organ comprises at least one arm which generally projects radially outwards and is rigidly connected with the shaft 41, for example welded thereto. These arms are

constructed differently in dependence on their function. As is evident particularly clearly in the Figure 3, for example five arm groups or arm rings are present, which stand at a spacing one from the other in axial direction and comprise several, namely three arms each. The three arms belonging to the same arm group are distributed uniformly along the rotor circumference and also displaced one relative to the other along this by arcs which correspond to an angle of 120° . The arm groups one following the other are turned one relative to the other about the axis 21 through an angle of 60° . The three arms belonging to the same group one overlap the other in radial projections onto the axis 21.

Each conveying stirring organ 47 and 49 comprises two arms which belong to arm groups each following the other along the axis 21 and are each displaced relative to the other through an arc, which corresponds to at most 180° and namely for example 60° , along the circumference of the rotor. Two of the four conveying stirring organs 47 and 49 have two conveying arms 51, which belong to the inner, i.e. not end arm groups, and therefore form inner conveying stirring organs 47. Both the other outer conveying stirring organs 49 each have a conveying arm 51 belonging to one of the inner arm groups and an end scraping arm 55. Both the arms belonging to the same conveying stirring organ are at their free ends each connected with the other by a conveying web 59. The extents of the four conveying organs parallel to the axis 21 are approximately equally great and each amount to less than 50%, namely at most or approximately 30% of the axial extent of the interior space 9. The comminuting and/or chopping stirring organs 53 and the scraping stirring organs 57 each consist of a single arm and are therefore denoted in the following also as comminuting and/or chopping arm 53 or scraping arm 57. Each stirring organ projects away from the axis 21 and the shaft 41 to at least nearly to the inward casing surface 15a, wherein narrow gaps are namely present between this and those edges of the stirring organs, which are furthest away from the axis 21.

Each of the arms 51 belonging to a conveying stirring organ 47 or 49 consists of a thin platelet, which is elongate in the direction extending away from the shaft 41 and becomes narrower outwardly, with a longitudinal centre line radially off and at right angles to the axis 21. Each platelet forming an arm 51 has two surfaces 51a and 51b each parallel to the other.

These are inclined to a plane at right angles to the axis 21 in a radial projection parallel to the longitudinal centre line of the arm concerned and thus in a section parallel to the axis 21 and to the longitudinal centre line concerned. In that case, the directions and angles of inclination of the surfaces 51a and 51b are equal for all arms 51 in the named projection. The surfaces 51a and 51b can be planar or twisted a little. The conveying arms 51 are thus arranged and constructed more or less similarly as the blades of a propeller or the vanes of the impeller wheel of an axial pump.

The arms forming the comminuting and/or chopping stirring organs 53 are likewise elongate in the direction extending away from the axis 21 and have longitudinal centre lines, which are radial off and at right angles to the axis 21, as well as an at least approximately rhombic outline shape in a section parallel to the axis 21 and at right angles to the longitudinal centre line concerned, wherein the rhombus edges are straight or slightly bent concavely. The one first shorter rhombus diagonal extends parallelly to the axis 21 and the other second longer rhombus diagonal is at right angles to the axis 21. Each comminuting and/or chopping stirring organ 53 is symmetrical with respect to a plane of symmetry extending through its longitudinal centre line and through the axis 21 as well as also with respect to a plane of symmetry extending through its longitudinal centre line and at right angles to the axis 21. Each comminuting and/or chopping stirring organ 53 consisting of an arm therefore forms a pair of wedges 53a and 53b, which are contiguous as their broader ends, i.e. at the rhombus diagonal parallel to the axis 21. Both the wedges 53a and 53b have, at both the ends of the longer rhombus diagonals and thus on mutually remote sides of a plane extending through the longitudinal centre line of the arm 53 concerned and the axis 21, each a respective sharp edge which forms the apex or the cutting edge of the wedge 53a or 53b concerned. Both the side surfaces belonging to the same wedge 53a or 53b are inclined away from the apex thereof on mutually remote sides of the plane of symmetry extending through this apex and at right angles to the axis 21 and form an angle amounting to at most 30° and for example 25° with this plane in a section at right angles to the longitudinal centre line of the stirring organ or arm concerned. The angle between the side surfaces, which in pairs together form a wedge 53a and 53b, of each comminuting and/or chopping stirring organ 53

then correspondingly amounts to at most 60° and for example 50° . Both the rhombus diagonals are longer at the free end of each stirring organ 53 than at the root thereof connected with the shaft 41. The apex or cutting edges of both the wedges 53a and 53b are therefore inclined one away from the other outwardly at least in places and namely bent concavely at least at their outer end region. Each stirring organ 53 is bounded at the free end by an arcuate surface co-axial with the axis 21, i.e. a portion of a cylindrical surface.

The arm group, which is situated in the proximity of the left-hand end of the shaft 41 in the Figures 2 and 3, comprises a scraper arm 55 belonging to one of the inner conveying stirring organs 49 and two scraper arms 57 each forming a respective scraper stirring organ 57. These three arms are arranged in such a manner that they nearly touch that inward surface of the end wall 57, which is at right angles to the axis 21, and are separated from this only by a respective narrow gap. The corresponding applies in respect of the end wall 19 for the arms situated at the other end of the shaft 41. Each arm 55 and 57 has a surface 55a or 57a, which is at right angles to the axis 21 and faces that end wall 17 or 19, in the proximity of which it is disposed. Each arm 55 and each arm 57 furthermore has two surfaces 55b and 55c or 57b and 57c inclined each towards the other and away from the edges of the surface 55a and 57a respectively. The end arms thus have a triangular outline in a section at right angles to their radial longitudinal centre line. The surface 55a of each arm 55 becomes narrower in the direction extending away from the shaft 51 and together with both the planar surfaces 55b and 55c forms straight edges 55d and 55e each inclined to the other away from the shaft 41. The surface 55b of each arm 55 is inclined, in a section at right angles to the radial longitudinal centre line of the arm, by about the same angle to a plane at right angles to the axis 21 as the surfaces 51a and 51b of the arms 51. As is evident in the Figure 6, the surface 55c is for example asymmetric to the surface 55b, could however also be in mirror symmetry to this. The arms 57 differ from the arms 55 in that their width becomes greater outwardly away from the shaft 41 and that their surfaces 57b and 57c are each symmetrical to the other with respect to a plane of symmetry extending through the axis 21. The edges 57d or 57e formed by the surface 57a together with the surfaces 57b and 57c for example

have about the same shape in axial projection as the edges of the wedges 53a or 53b serving as cutting edges. Furthermore, the surfaces 57b and 57c can, in a section at right angles to the longitudinal centre line of the arm concerned, form about the same angle with the surface 57a as the side surfaces of the comminuting and/or chopping arms 53 with a plane at right angles to the axis 21. Each edge 55d, 55e, 57d and 57e can be regarded as an apex of a wedge formed by the arm concerned. These apices are acute-angled in a cross-section at right angles to the radial longitudinal centre line of the arm concerned and project one away from the other on mutually remote sides of a plane extending through the axis 21 and the arm concerned.

Each web 59 consists of a strip and has two mutually parallel surfaces 59a and 59b, which in cross-section are at least nearly at right angles to the axis 21. The webs 59 for the remainder have the same thickness as the arms 51. Furthermore, their surfaces 59a and 59b adjoin at the connecting points of the webs 59 with the arms 51 more or less steadily and flush at their surfaces 51a or 51b. The outer edges, i.e. those remote from the shaft 41, of the webs 59 project nearly to the inward casing surfaces 51a and are each separated from this by a narrow gap. The radially measured width of the webs 59 is substantially smaller than the radial dimension of the arms 51 so that free intermediate spaces are present between the shaft 41 and the inner web edges facing this.

It is evident from the preceding description of the conveying stirring organs 47 and 49 that the outer edges, which are furthest away from the axis 21, of the conveying parts belonging to the conveying stirring organs, i.e. the conveying arms 51 and the conveying webs 59, extend at least approximately along helical lines and form a pitch angle ϕ with a plane at right angles to the axis 21.

This pitch angle ϕ measured in a development of the circularly cylindrical envelope surface, which is spanned by the named edges and co-axial with the axis 21, of the conveying stirring organs 47 and 49 amounts to at least 30° and for example about 35° to 55° . It is to be remarked here that a radial projection of the outer edge of a web 59 onto the circumferential surface of the shaft 41 of course results in a pitch angle which is greater than the pitch angle ϕ measured on the rotor envelope surface. When the conveying arms 51 consist of planar platelets, these are

expediently arranged in such a manner that the angle formed by them with a plane at right angles to the axis 21 is at least equal to the pitch angle resulting at the outer edge of the conveying web and at most equal to the pitch angle resulting at the inner edge of the conveying web. The surfaces 51a and 59a belonging to one and the same conveying stirring organ 47 or 49 together form a conveying surface of the conveying stirring organ concerned. The corresponding applies to the surfaces 51b and 59b. The different partial regions of these conveying surfaces form an angle, namely an at least approximate right angle, with those regions of the inward casing surfaces 15a respectively situated nearest to them and form helical surfaces at least approximately. According to the arrangement and width of the arms 51, each conveying surface extends along the rotor circumference over an arc which corresponds to a subtended angle amounting to at most 180° and namely approximately or somewhat more than 60°.

The wall 7 of the first and second chamber 5 is provided on the upperside of its casing 15, for example in the part thereof situated closer to the end wall 17, with an inlet opening, at which a stock inlet 65 consisting of a vertical connecting piece, which is four-cornered or round in cross-section, opens into the interior space 9. The stock inlet 65 at its upper end has a connection 65a for a stock feed duct and on one side a hole 65b, which serves as exhaust gas connection. The stock inlet 65 is provided at its opening into the interior space 9 or a little above this with an exhaust gas filter 67, which for example comprises at least one frame and a grid or mesh retained by this. The stock inlet 65 is furthermore provided with a pneumatic and/or electrical setting device 69 in order to move the exhaust gas filter 67 or the parts thereof from a covering position into a freeing position and back into the covering position, for example to displace or pivot it, wherein the filter in the covering position covers and in the freeing position frees the opening of the stock inlet into the interior space 9.

The end wall 19 is provided at its lowest region with an opening, at which an outlet 73 is detachably fastened by an horizontal, hollow-cylindrical sleeve at the end wall 19, namely screwed fast by an annular flange welded to the sleeve. The sleeve of the outlet 73 has an interior space, which is in alignment with the opening of the end wall and together with the opening of the end wall bounds the outlet opening. The sleeve of the outlet could instead thereof project into the opening of the end wall as far as the inner end wall surface and then bound the actual outlet opening alone. A downwardly projecting connecting piece 75 is fastened at the sleeve of the outlet. A piston serving as shut-off organ 77 is guided to be displaceable in the interior of the outlet 73 and can be displaced to and fro by a pneumatic setting device 81 between two end settings, which are fixed by an abutment 79 and in which it blocks or frees the passage of the outlet, which is formed by the outlet opening and connects the interior chamber space 9 with the opening of the connecting piece 75. When the shut-off organ 77 is disposed in its end setting, which is drawn in the Figure 2 and serves as closing setting, its end face facing the interior chamber space 9 is flush with the inward surface of the end wall 19.

That end wall 17 of each granulating unit, which is situated near to the drive device 33, is provided in the proximity of the lowest point of the interior space with a continuous hole, at which a gas inlet 83 opens into the interior space 9.

The casing 15, both the end walls 17 and 19 and the rotor 11 consist of a metallic material, possibly stainless steel. The end wall 19 is provided above the outlet 73 with an opening, in which a transparent pane, which serves as window 85, of mineral or organic glass is inserted in such a manner that its inward surface is flush with the inward surface of the remaining end wall.

An inclined, upwardly projecting connecting piece 89, which is evident in the Figure 4, is fastened, possibly welded to the casing 15 in the upper half thereof and approximately in its centre with respect to the axial extent of the casing. The casing 15 is provided with an opening in the region enclosed by the connecting piece 89. A spray nozzle serving as fluid inlet 19 is fastened detachably in the connecting piece 89 by a not shown clamping screw or the like in such a manner that its mouth is disposed

approximately in the said opening of the casing or a little to the side remote from the interior space. The spray nozzle is directed in such a manner that its spray centre line 93, i.e. the central axis of the liquid jet formed during spraying, is at right angles to the axis 21 and to the shaft 41, but runs past the shaft 41 beside this and thus does not cross the shaft. The spray nozzle forming the fluid inlet 91 has two connections 95 and 97 for connecting a compressed gas feed duct, namely a compressed air feed duct, and a liquid feed duct.

A gas feed installation 101, which is evident in the Figure 1, displays at least one and namely several, for example four stock stores 103, the outputs of which are each connected with a respective metering device 105, which is constructed for volumetric or gravimetric metering and which for example comprises a conveying worm and a motor serving for its drive. In case a gravimetric metering is provided, each stock store together with the associated metering device can be carried by a weighing machine. The exits of the metering devices 105 are connected with a collector 107, which is indicated schematically by a funnel and which can possibly be equipped with a rotating mixing tool serving for the preliminary mixing and/or with a filter device. A deflecting device 109 has an entry connected with the exit of the collector 107 as well as two exits, each of which is connected by way of a duct or directly with the stock inlet 65 of one of both the granulating units 1 and 3. The deflecting device 109 for example displays at least one flap which is pivotable by a pneumatic or electrical setting organ in order to feed the stock guided to it by the collector 107 selectably to the first or the second granulating unit 1 or 3.

The outlets 73 of both the granulating units 1 and 3 are connected with the entry of one and the same drier 111. This can for example consist of a multicell fluidised bed drier which comprises several, possibly six cells each with a respective fluidised bed chamber, in which the granulate charge to be dried can be fluidised by a gas, normally by heated air. The drier furthermore comprises conveying means in order to convey each granulate charge to be dried first into the first fluidised bed chamber, thereafter successively from one fluidised bed chamber into the respective next fluidised bed chamber and finally out of the last fluidised bed chamber. These conveying means for example comprise a vibratory conveyor

arranged at the entry of the first fluidised bed chamber, openings connecting the different fluidised bed chambers one with the other, an opening serving as outlet of the last fluidised bed chamber and flaps for the selectable closing or freeing of these openings. A granulate charge can be conveyed by appropriate control of the flaps and the air serving for the fluidising during the drying from one fluidised bed chamber into the respective next fluidised bed chamber. The drier 111 can however in place of a multicell fluidised bed drier also consist of any other kind of drier which enables granulates fed to it charge by charge to be dried automatically and transported further. The drier can for example be constructed for drying by means of infrared radiation and/or microwaves. The drier can be constructed for example for drying by means of infra-red radiation and/or microwaves. The exit of the drier 111 can still be connected with a filter device 113.

The equipment furthermore comprises a fluid feed device 121 with a fluid reservoir, namely a liquid reservoir 123, the exit of which is connected by way of a first valve 125 with the connection 97 of the spray nozzle of the first granulating unit 1 and by way of another second valve 125 with the connection 97 of the spray nozzle of the second granulating unit 3. Both the valves 125 are provided with an electrically actuatable setting device.

The stock feed installation 101, the collector 107, the fluid feed device 121, both the granulating units 1 and 3, the drier 111 and the filter device 113 can, as indicated schematically in the Figure 1, be arranged in such a manner that the stock to be granulated as well as the fluid, which consists of a liquid and is to be fed to the granulation, get to the stock and fluid inlets of both the granulating units in consequence of gravity and that the granulates produced in these then likewise get to the drier 111 and from this into the filter device 113 likewise in consequence of gravity. These devices and parts of the equipments must of course however not be arranged one above the other. In case of need, conveying means, such as conveyor belts, worm conveyors, lifting devices of any kind and/or at least one pump can then be provided in order to convey the stock to be granulated, the produced granulate and the liquid to the desired places.

A gas source, namely a compressed air source with a pump 131 and a compressed air reservoir 133, furthermore belong to the equipment.

The equipment comprises a control installation 141 arranged schematically in the Figure 1. Belonging to this is a control circuit 143 illustrated by a block and with electrical and/or electronic components for the measuring, controlling and regulating. The control circuit 143 is connected by electrical connections indicated by arrows with the motors 35, the motors of the metering devices 105, the setting devices of the valves 125 and the other electrically drivable and/or controllable parts of the equipment. The control circuit 143 is inter alia provided with an electrically controllable switch-over device in order to switch over the currents fed to the motors 35 in such a manner that the motors change their directions of rotation. The control circuit 143 furthermore comprises a clock pulse generator, which serves for the control of the switch-over device and the pulse frequency of which is preferably variable and adjustable. The control circuit 143 furthermore comprises measuring and controlling means in order to measure the electrical powers fed to both the motors 35 and to control the granulating process in dependence on magnitudes linked with these measured values in a manner still to be explained later. Furthermore, manually operable operating elements 145, possibly press-key switches or the like, are present. The control installation 141 furthermore comprises analog and/or digital indicating and/or recording devices 147, luminescent elements 149, which are possibly formed by small bulbs and/or luminescent diodes and serve for the indication of operational states and the like, and electrically controllable pneumatic valves 151 each possibly provided with at least one electromagnet or motor. It is expressly pointed out here that the control installation 141 can comprise greater numbers of the operating elements 145, indicating and/or recording devices 147, luminescent elements 149 as well as pneumatic valves 151 than is indicated in the Figure 1. The valves 151 are connected on the one hand with the compressed air reservoir 133 and on the other hand, as indicated in the Figure 1 partly by lines or by arrows, with the setting devices 81, the connections 95 of the spray nozzles forming the fluid inlets 91, the gas inlets 99 and possibly other pneumatically controllable setting devices. The control installation 141 can furthermore comprise a control box or the

like, in which at least some or all described parts of the control installation 141 are arranged. The control installation 141 is furthermore constructed in such a manner that the course of the method described in the following for the production of a granulate can be controlled selectably through manual actuation of operating elements 145 either entirely or partially step by step by one person or completely automatically by the control installation 141 and in particular its control circuit 143. It is provided in that case to control the fabrication-like granulate production automatically as permanently as possible and to control the method "manually" by one person merely temporarily for trial purposes, for example for the optimisation of process parameters.

The production of a granulate, which for example is envisaged for the formation of a medicament, shall now be explained. The stock stores 103 contain the components of the particulate stock to be granulated in the form of dry pourable stock. These can for example consist of lactose, maize starch, polyvinylpyrrolidone (PVP) and a pharmaceutically effective substance, wherein the lactose and starch serve as base substances and/or carrier substances and the polyvinylpyrrolidone serves as binding agent. The liquid reservoir 123 can contain a liquid possibly consisting of pure water as fluid.

In operation of the equipment, a charge of the stock to be granulated is fed in alternation to both the granulating units. For the feeding of a stock charge, the metering devices 105 are set into operation temporarily until they convey the provided quantities of the different stock components into the collector 107. The deflecting device 109 is controlled by means of the control device 141 for example in such a manner that it feeds the first stock charge to the first granulating unit 1. The control installation 141 controls the setting device 69 of the exhaust gas filter 67 of the first granulating unit 1 in such a manner that the exhaust gas filter temporarily frees the inlet opening of the first stock inlet 65 into the first chamber 5 for the introduction of the stock and thereafter covers it again. The quantity of the stock charge is in that case metered in such a manner that the stock fills only a part of the interior chamber space 9, wherein the volume taken up by the stock can amount to at least 20%, at most about 90% and for example about 30% to 70% of the volume of the entire interior space 9.

After the introduction of a charge of the stock into the first chamber, the components thereof are initially intermixed dry, i.e. without feed of liquid, for a certain mixing time duration through rotation of the first rotor 11. Thereafter, liquid is fed intermittently or continuously to the now intermixed stock during a granulating operation and the stock is granulated with the rotor rotating. For the feeding of the liquid, the first valve 125 connected with the first fluid inlet 91 is opened and compressed air is fed to the spray nozzle forming the first fluid inlet 91 so that fluid is atomised and sprayed onto the stock contained in the first chamber. The outlet 73 is closed by the shut-off organ during the mixing operation and during the granulating operation.

The rotor 11 is rotated during the mixing operation as well as also during the granulating operation at a rotational speed which suffices to accelerate at least a part of the particles of the stock into that region of the interior space 9, which is free of stock each time the rotor is stationary. The rotational speed of the rotor 11 can for this purpose be set by means of the setting organ 37a of the gear 37 to a value favourable for the stock concerned. The peripheral speed of the rotor 11 can then at its point furthest away from the axis 41 amount to 50 to 300 metres per minute. Furthermore, the direction of the rotation of the rotor is changed in alternation and periodically during the dry mixing as well as also during the granulating of the moist stock. The time intervals between successive changes in the direction of rotation can for example amount to at least 1 second and at most 1 minute in dependence on the dimensions of the chamber, the construction of the rotor and the properties of the stock. In the case of a volume of the interior space amounting to approximately 8 litres, it proved to be expedient to change the direction of rotation at time intervals of 3 to 30 seconds, wherein time intervals of 10 to 20 seconds gave particularly good results.

When the rotor 11 is rotating, the stock present in the chamber is moved, stirred and inter alia - as already mentioned - thrown upwards by the stirring organs 47, 49, 53 and 57. The throwing of the stock is in that case effected above all by the arms 51 as well as the webs 59, wherein however the other arms of the rotor 11 also contribute to the moving of the stock. The conveying stirring organs 47 and 49 and in particular their arms

51 as well the webs 59 furthermore have the tendency of conveying the stock along the axis 21 in the one or other direction in dependence on the direction of rotation of the rotor. When the rotor rotates in clockwise sense as seen from the end wall 19, the conveying organs 47 and 49 convey the stock from the end wall 17 to the end wall 19. In the case of the opposite direction of rotation of the rotor, the stock is conveyed from the end wall 19 to the end wall 17. Due to the fact that the conveying parts resulting in an axial conveying in dependence on direction of rotation, i.e. the conveying arms 51 and the conveying webs 59 of the conveying stirring organs 47 and 49, one overlap the other in radial projections onto the axis 21 at the inner arm rings, it is assured that the entire stock present in the chamber 5 is conveyed to and fro in alternation between both the ends of the chamber along the axis 21. The comminuting and/or chopping arms 53 above all have the purpose of splitting up the stock situated in their path as well as to chop and comminute clumps of stock that may have formed. In that case, the comminuting and/or chopping stirring organs 53 comminute and/or chop the stock in those length regions of the interior chamber space 9, in which the stock is in a certain sense transferred from one conveying stirring organ to the conveying stirring organ following in the momentary conveying direction. The arms 53 altogether do not result in any axially directed conveying effect. The scraper arms 55, which during the rotation of the rotor rotate at small spacings along the end walls 17 and 19, of the outer conveying stirring organs 49 and the scraping stirring organs 57 consisting exclusively of one arm 57 above all have the purpose of moving stock, which lies against the end walls and possibly is adhering to these, away from the end walls independently of the direction of rotation of the rotor and if need be first to detach these as well as scrape them off, can however also still chop up clumps of stock possibly lying against the end walls. The conveying webs 59 shall in addition to the already mentioned throwing and conveying effect above all detach and scrape off any stock adhering at the casing 15. It is here still to be remarked for clarification of the terms of "scraper arms" and "scraping" that the arms 55 and 57 in question and the webs 59 of the rotor 11 do not touch the inward surfaces of both the end walls 17 and 19 and of the casing 15, but are during rotation of the rotor moved so closely past these inward surfaces that they can detach stock lying against the inward surfaces almost completely from these.

The stock is thus accelerated upwardly during the mixing and granulating, conveyed to and fro along the axis 21 and comminuted by the comminuting and/or chopping stirring organs 53. These superimposed movements yield a very intensive mixing effect during the dry mixing as well as also during the granulation of the moist stock. Since each conveying organ extends only over a part of the length of the interior space 9, the stock is strongly intermixed during the axial conveying, in particular on the transfers from one conveying stirring organ to the conveying stirring organ following in the direction of conveying. The air, which flows into the interior space 9 and serves for the atomising of the liquid during the granulating operation, can again flow out of the interior chamber space 9 through the exhaust gas filter 67, the stock inlet 65 and the hole 65b thereof and then be conducted away into the environment by way of an exhaust gas duct which for example still comprises an additional filter.

When a granulate has been formed from the stock, the previously closed outlet 73 is opened. The rotor 11 is for the emptying of the chamber 5 rotated in that rotational direction, in which it conveys the granulate present in the interior space 9 towards the end wall 19 and towards the outlet 73. Gas, namely compressed air, can furthermore in case of need be blown into the chamber at the gas inlet 83. This compressed air together with the rotating rotor 11 has the effect that the formed granulate is conveyed rapidly out of the interior space 9 into the outlet 73 and towards the drier 111. Thereafter, a stock charge can again be introduced into the first chamber. The granulate fed to the drier 111 is of course dried in this, thereafter sieved in the sieve device and in that case sorted out according to size. The sieved granulate can then be filled into formations as well as transported away in these by a person or by a conveying device. The granulate can however also be conveyed further by a conveying device without being filled into formations. It is to be remarked here that one can possibly dispense with a sieving of the granulate and correspondingly with a sieving device 113 and to fill the granulate into formations already after the exit from the drier or convey it further by a conveying device without formations.

As already mentioned, a charge of stock is fed in alternation to both granulating units, wherein also the stock fed to the second granulating unit is of course processed each time in the manner described in the preceding for the first granulating unit. The time duration required for the mixing and granulating of a stock charge of one of both the chambers 5 is equal to the sum of the mixing time duration and the granulating time duration and is denoted in the following as processing time duration. The alternating feed of stock to both the chambers preferably takes place with a phase displacement which is approximately equal to half the processing time duration. A change of charge thus then always takes place after approximately half a processing time duration. The drier 111 and the sieving device 113 are dimensioned in such a manner that they can respectively dry and sieve a granulate charge during half the processing time duration. The equipment can then mix, granulate, dry and sieve stock charges in cyclic manner and in a certain sense quasi-continuously, wherein these operations can in the case of automated operation take place exclusively by apparatus means, i.e. without the aid of persons.

The process sequence is preferably controlled in such a manner that the mixing time duration and the granulating time duration are approximately equally long and the one rotor granulates a moist stock at any one time, whilst the other rotor mixes a dry stock. When both the motors 35 rotate the rotors 11, the mentioned electronic measuring and control means of the control circuit 143 measure the electrical power fed to each motor 35. The power required for the moving and mixing of the dry stock is practically constant. The rotor power serving for the moving and granulating of the moist stock is dependent on the quantity of the supplied liquid and after a certain initial phase at first increases slowly with constant feed of liquid from an initial power required in the dry state, then remains more or less constant, thereafter increases rather steeply and then falls off steeply after reaching a maximum. For further details, the WO-A-88/01904 is referred to, which has already been cited in the introduction and which contains diagrams which actually concern granulating equipments of different kind and show changes in the rotor torque with respect to time. At constant rotational speed, this is proportional to the power so that the course of the temporal course of the torque illustrated in the diagrams corresponds

qualitatively to the temporal course of the powers which are required for the rotation of the rotors 11. The power, which during the granulation serves for the movement of the moist stock, of a rotor 11 and its change with respect to the time therefore gives a measure for the quantity of the liquid contained in the stock and the stage of the granulating process. Each of the electrical powers fed to a motor 35 however in addition to the power serving effectively for the movement of the stock still contains power losses which are consumed in the motor 35, above all in the gear 37 and also in the bearing 39 of the rotor and converted into heat. The power losses can moreover change in the course of time because for example the temperatures of the bearings of the motor, the gear as well as the rotor and the temperatures of the gear wheels and thereby the friction losses caused by these parts change. The measuring and control means of the control circuit 143 now however also still ascertain the power difference between the electrical powers consumed by both the motors by circuit means operating analog or digitally. This power difference then practically no longer contains any power loss components. In case the power losses change in the course of time possibly due to changes in temperature, these changes are normally approximately the same for both granulating units. The said power difference therefore gives a reliable measure for the quantity of liquid present in the moist stock and for the stage of the granulation even in the case of power losses changing with respect to time. The granulating process can therefore be controlled in dependence on the ascertained power difference. The feed of liquid can be terminated when the power difference and/or its change with respect to time fulfils a preset criterion. The electronic measuring and control means of the control circuit 143 can for example be constructed to terminate the liquid feed when the power difference reaches a preset and adjustable maximum value ascertained previously by some trials. It can instead thereof also be provided that the measuring and control means form the first derivative of the power difference with respect to time and fix the instant for the termination of the liquid feed in dependence on this derivative. This can then occur in analog manner as explained in the WO-A-88/01904 for the control with the use of the derivative of the torque with respect to time.

The good mixing effect of the rotors 11, which convey the stock to and fro along the axes 21, enable the time duration for the mixing as well as also the time duration for the granulating and thereby the time duration for the entire processing, which takes place in a granulating unit, to be kept small. Furthermore, the changes of charge also need very little time. For these reasons and because stock is processed by two granulating units at the same time, but with a cycle displaced in phase, one can achieve relatively large production rates with chambers of small dimensions. The described fixing of the instant for the termination of the liquid feed in that case assures a high quality of the produced granulate so that the granulate particles have an almost completely homogeneous composition and sizes lying in a relatively narrow range. For example, a granulate was produced, in which about 64% of the particles had grain sizes lying in the range of 0.25 to 0.5 millimetres. Moreover, the stock is subjected to only a small friction as well as compacted only little and correspondingly heated only little during the movement by the rotors of both the granulating units 1 and 3 so that also stocks sensitive to pressure and/or increased temperatures can be processed. As already explained, the equipment is also very well suited for the fully automatic processing of several stock charges fed one after the other so that the equipment consequently in a certain sense operates quasi-continuously. Furthermore, the end wall 19 and the casing 15 can for cleaning be separated rapidly and simply from the casing 15, which can then in its turn be removed from the end wall 17. After cleaning has taken place, the chamber also lets itself be assembled rapidly again.

The rotor 11 of each of both the granulating units 1 and 3 can be replaced by a rotor 211 illustrated in the Figures 7, 8, 9 and 10. This comprises a shaft 241, which is rotatable about an axis denoted by 221 and which is constructed identically with or similarly to the shaft 41. The rotor 211 analogously to the rotor 11 comprises several stirring organs extending approximately to the inward casing surface of the chamber. Belonging to these are several, namely four conveying stirring organs 247 distributed along the shaft 241. Each conveying stirring organ 247 comprises two arms 251, which are connected at one end firmly with the shaft 241, but which by contrast to the arms of the four conveying stirring organs 47 and 49 of the rotor 11 are all completely identical and, as will still be

explained later, are constructed as comminuting and/or chopping arms. Those ends of the two arms belonging to the same conveying stirring organ, which face away from the shaft, are firmly connected together by a conveying web 259. The rotor 211 still comprises comminuting and/or chopping stirring organs 253 and end scraping stirring organs 257, each of which is formed by only a single arm rigidly connected with the shaft and which are also denoted as comminuting and/or chopping arms 253 and scraping arms 257. The arms of the rotor 211 are all rigidly connected with its shaft 241, namely welded to this, and project radially away from this outwardly.

The arms 251, 253 and 257 of the rotor 211 can like the arms of the rotor 11 be associated with five groups or rings distributed along the shaft of the rotor. The inner arm groups each have three arms, namely each two arms 251 and one arm 253. Both the end groups, i.e. those situated nearest to the ends of the interior chamber space, each have two arms, namely one arm 251 and one arm 257.

Both the arms 251 of each conveying stirring organ 247 belong to arm groups following one upon the other along the axis 221 and are displaced one relative to the other along the circumference of the rotor 211 through an arc which corresponds to an angle of at most 15° and for example 5° to 10° . The four conveying stirring organs 247 have approximately or exactly equally large axial extents which as for the conveying stirring organs 47 and 49 each amount to less than 50% and namely approximately 30% of the length of the interior space 9. The conveying stirring organs following one upon the other along the shaft are displaced one relative to the other through an angle amounting approximately to 90° as measured along the rotor circumference. The arms 253 and 257 following one upon the other along the shaft are likewise displaced one relative to the other along the circumference through angles of for example each approximately 90° . Furthermore, the arm 257, which in the Figure 7 is situated at the right-hand end of the shaft, is displaced along the circumference through an angle of for example about 120° to 135° relative to the arm 251 situated nearest at the shaft end concerned.

The comminuting and/or chopping arms 251 belonging to the conveying stirring organs 247 each consist of a respective rod which is four-cornered in cross-section and namely of a square profile rod. The one first diagonal of the quadrilateral formed by the arm cross-section for example extends parallelly to the axis 221 and the other second diagonal extends at right angles to the axis 221. The first diagonal could instead thereof also extend parallelly to the longitudinal direction of the web 259 connected with the arm concerned or have a direction which lies between the direction of the axis 221 and the longitudinal direction of the web. The second diagonal could in the case of this variant again be at right angles to the first diagonal and thus at right angles to the longitudinal direction of the web or to a direction lying between this and the direction of the axis 221. Each comminuting and/or chopping arm 251 thus forms two wedges 251a and 251b, the sharp edged and more or less cutting-edge-like apices project on mutually opposite sides of a plane which extends through the axis 221 and the longitudinal centre line of the arm 251 concerned.

The comminuting and/or chopping conveying organs 253 or arms 253 are identical with or similar to the stirring organs 53 or arms 53 and in particular each have two wedges 253a and 253b, which correspond to the wedges 53a and 53b and display sharp edges at their apices or cutting edges.

Whereas a scraper arm 55 belonging to a conveying stirring organ 49 and two identically constructed scraping stirring organs 57 or scraping arms 57 are present at each of both the ends of the rotor 11, the rotor 211 has one arm 251 belonging to a conveying stirring organ 257 and only one scraping stirring organ 257, which consists of a scraper arm 257, at each of both its ends. The scraping stirring organs 257 or arms 257 have a similar shape as the scraping stirring organs or arms 57, can however have greater dimensions in axial direction and along the circumference of the rotor than the stirring organs 53 or arms 53. The scraping stirring organs 257 in particular have three surfaces 257a, 257b and 257c and two edges 257d and 257e, which correspond to the surfaces or edges, which display reference numbers smaller by 200, of the scraping stirring organs 57.

As one can see particularly clearly in the Figure 10, each conveying web 259 is generally triangular in cross-section and has two planar surfaces 259a and 259b serving for the conveying of the stock as well as one surface 259c, which faces the inward surface 15a of the casing 15 and which in a cross-section at right angles to the axis 221 is arcuate co-axially with this as well as with the inward casing surface and separated by a gap from this. Both the surfaces 259a and 259b are inclined one towards the other away from the surface 259c in the direction of the axis 221 and together with the surface 259c each form an angle amounting for example to approximately 45° . Each region of a surface 259a and 259b is inclined by about the same angle relative to that region of the inward casing surface 15a, which is situated nearest to it. The conveying webs 259 extend at least approximately along helical lines which all extend in the same sense of winding, namely in the manner of right-hand threads. The outer edges of the conveying webs 259 are inclined through a pitch angle ϕ relative to planes at right angles to the axis 221 in a development of the envelope surface which is co-axial with the axis 221 and envelopes the conveying webs. This angle preferably amounts to at least 60° and for example to 70° to 85° . Each rod forming a conveying web 259 can be arcuate exactly in helical shape. Since the curvature of a piece of a helical line belonging to a conveying stirring organ is relatively small, a web can for the manufacture of a conveying stirring organ 247 however possibly be formed of a straight rod which for example originally like the arms 251 has a four-cornered profile and at which, after its firm connection with the arms 251 and the shaft 241, the surface 259c is formed by a metal-cutting treatment. This surface could for the remainder possibly be planar in cross-section instead of arcuate about the axis 221.

As is evident in the Figure 8, the longitudinal centre lines of the two arms 251 belonging to the same inner arm group are situated on mutually opposite sides of a plane which is at right angles to the axis 221 and extends through the longitudinal centre line of the arm 253 belonging to the same arm group. The axial displacement of the three arms one relative to the other is however, so small that both the arms 251 overlap the arm 253 or even each other themselves in radial projections onto the axis 221. In the case of the rotor 211, the conveying surfaces of the conveying stirring organs 247, which result in an axial conveying of the stock in dependence on the rotational direction of the rotor, are formed at least substantially by

the surfaces 259a and 259b of the webs 259. According to the Figure 8, those ends of the surfaces 259a and 259b, which are situated one nearest to the other along the axis, are one spaced a little from the other in axial direction from webs 259 following one the other along the axis, however overlap the arm 253 belonging to the arm group concerned in radial projections onto the axis 221. According to the Figures 8 and 9, both the arms 251 belonging to the outer end arm groups are displaced a little in axial direction away from the arms 257 towards the inner region of the rotor. Both the arms 251 and 257, which are situated at the same end of the rotor, however still overlap one another in radial projections onto the axis 221.

The equipment comprising two rotors 211 in place of the rotors 11 can be operated in similar manner as the equipment with the rotors 11. In the following, some operating properties distinguishing the rotor 211 from the rotor 11 are however pointed out. Since in the case of the rotor 211 in addition to the comminuting and/or chopping stirring organs 253 or arms 253 consisting exclusively of one arm also still the arms of the conveying stirring organs 247 are constructed as comminuting and/or chopping arms 251 and each have two wedges 251a and 251b, of which the one or the other comminutes the stock and can chop up possibly arising clumps in dependence on the direction of rotation of the rotor, the rotor 211 results in a somewhat stronger comminuting and/or chopping effect than the rotor 11. Because the arms 251 produce no axial conveying effect or at most a small one with a direction dependent on the direction of rotation of the rotor and because the pitch angle ϕ in the case of the conveying stirring organs 247 of the rotor 211 is greater than for the conveying stirring organs 47 and 49 of the rotor 11, the rotor 211 results in a smaller axial conveying effect than the rotor 11. This has inter alia the consequence that the stock, which accumulates each time at the one or other end wall 17 and 19 during the alternating conveying to and fro of stock by the rotor 211, is compacted and heated still less than on the use of a rotor 11. This can be particularly advantageous when a stock inclines strongly to the formation of clumps during compacting or suffers qualitative penalties during compacting and/or heating.

Since those ends of the conveying surfaces, i.e. of the surfaces 259a and 259b, which are one nearest to the other, of conveying stirring organs 247 following one upon the other along the axis 221 are separated by small intermediate spaces in axial direction, no direct axial conveying of the stock by the conveying webs takes place in these on rotation of the rotor. Stock present in the said intermediate spaces, is however divided into two parts each time by the comminuting and/or chopping arms 253 present in these and displaced along the axis 211 on mutually opposite sides of the wedges 253a and 253b into longitudinal regions of the interior chamber space, in which it can again be seized and conveyed by the surfaces 259a or 259b of the conveying webs 259. This results in a particularly intensive mixing effect in the longitudinal regions, at which the stock conveyed by the conveying stirring organs 247 is transferred from one conveying stirring organ to the next conveying stirring organ. It is to be remarked that the named "axial" intermediate spaces between the surfaces 259a and 259b of mutually neighbouring conveying webs 259 can reduce the conveying effect of the entire rotor a little, but not prevent a conveying of the entire stock, because stock remaining momentarily in the said intermediate spaces is after all again displaced towards the surfaces 259a and 259b by the comminuting and/or chopping stirring organs 253 or arms 253. It is therefore also possible with a rotor 211 to practically completely empty the interior chamber space containing this.

Because the surfaces 259a and 259b of the webs 259 are inclined one towards the other and away from the inward casing surface, they provide in addition to their axial conveying effect also a radial conveying effect directed towards the axis 221. Thereby, the intermixing of the stock and above all also the detaching of stock possibly adhering at the inward casing surface 15a is re-enforced.

The equipment and the method for the granulation can still be changed in different aspects.

For example, one can provide a rotor which has certain features of the rotor 11 and certain features of the rotor 211. Of course, the number, shapes and arrangements of the stirring organs of the rotor can be altered in many ways. One could for example provide T-shaped conveying stirring organs which comprise only a single arm and in which the T-beam replaces the

web 59 or 259. Furthermore, one could possibly provide the conveying stirring organs at their outer ends with elastically deformable, in particular flexible lips which touch the inward casing surface. Likewise, one could possibly provide the end scraping stirring organs with lips of the named kind, which touch the inward surfaces of the end walls.

The gas inlet 83 of each chamber 5 can in place of only a single opening have several openings which open into the interior space 9 of the chamber, for example a ring of axially directed openings distributed around the rotor in the end wall and/or some openings which are arranged in the casing 15, distributed over its length and/or its circumference and for example directed approximately radially.

The equipments also let themselves be adapted well for the granulation with organic solvents and with solvent recovery. For this purpose, the chambers should then be completely gas-tight. Each fluid inlet can then, instead of a so-called two-substance spray nozzle atomising the liquid with the aid of compressed air, be replaced by a so-called one-substance spray nozzle which enables an atomisation without compressed air. For this, the fluid feed device can then be provided with a pump which is constructed to feed the fluid to the spray nozzles at a relatively great pressure. The possibility however also exists of dispensing with an atomisation of the liquid and to form the fluid inlet for the dripping-in of the liquid. The hole 65b, which serves as exhaust gas connection, of the inlet of each granulating unit is then connected with a solvent recovery device instead of with an exhaust gas duct opening into the environment. Since organic solvents are mostly liable to explode, Nitrogen should in place of compressed air be blown into the chamber through the gas inlet 83 during the emptying of a chamber. For the remainder, each chamber can be flushed with Nitrogen as well as filled with such each time after the introduction of a charge of stock and/or before the emptying. Possibly, one can still provide a suction pump which is temporarily connectible with the interior spaces of the chambers by way of at least one valve. This enables the chambers to be evacuated temporarily after the introduction of a charge of stock and/or before the emptying, wherein these evacuations can be undertaken instead of the mentioned sprayings with Nitrogen or additionally to such. The mixing and granulating with two granulating units, which are controlled in phase-

displaced cycles, results in the advantage during the granulation with an organic solvent that the quantity of solvent vapour maximally arising per unit of time is relatively small in relation to the quantity of stock processed per unit of time when averaged over several charges. This facilitates the solvent recovery.

Of course, one can still provide a separate opening in the wall of a chamber for leading the exhaust gas out therefrom so that the exhaust gas need then not be conducted through the stock inlet. Furthermore, the outlet opening of the wall can, instead of in the end wall 19 in the casing, be provided at one of its ends.

Instead of measuring the powers of the motors 35, torque-measuring organs can furthermore be arranged between the output shafts of the gears 37 and the rotors 11. The instants for terminating the fluid feed can then be fixed in dependence on magnitudes which are linked with these torques, for example the differences between these.

Furthermore, in addition to the sieve device arranged at the exit of the drier 111 or instead thereof, a sieve device can be provided, which is disposed along the path of the processed stock between the outlets of the chambers and the entry of the drier.

Furthermore, one can possibly envisage to omit the drier 111 and to dry the granulate also still in the same chamber, in which it was granulated. In this case, the equipment can possibly be equipped with three granulating units, the operation of which is then for example controlled in such a manner that each time simultaneously a charge of the stock is mixed dry in one chamber, a charge of the stock is granulated in another chamber and a charge of produced granulate is dried in the remaining chamber. Moreover, the casing of each chamber can still be provided with a cooling and/or heating device. This can for example comprise an outer casing, which encloses the casing and together with this bounds a passage, or a pipe coil and a thermal insulation so that a cooling fluid or a heating fluid can selectably according to need be conducted through the passage present between both the casings or the pipe coil. Of course, an electrical heating device could also be provided, which can possibly be combined with a cooling device, which is constructed in one of the ways mentioned in the preceding so that the chamber can be cooled or heated selectably.



CLAIMS

1. Equipment for the mixing and/or granulating of a stock and with a chamber (5), the wall (7) of which displays a casing (15) and end walls (17, 19) arranged at both its ends, with a stock inlet (65) opening into the interior space (9) of the chamber (5) and with a rotor (11, 211), which is rotatable about an axis (21, 221) that is horizontal or inclined through at most 20°, with a shaft (41, 241) and stirring organs (47, 49, 53, 57, 247, 253, 257) distributed along this, characterised thereby, that the chamber (5) at one of both the end walls (17, 19) displays an outlet (73) selectably closable and freeable by a shut-off organ (77) and that the rotor (11, 211) is constructed to convey the stock along the axis (21, 211) in the one or the other direction in dependence on the direction of rotation of the rotor.
2. Equipment according to claim 1, wherein drive means (31) for the rotation of the rotor (11, 211) and control means (141) for the control of the drive means (31) are present, characterised thereby, that the drive means (31) as well as the control means (141) are constructed to change the direction of rotation of the rotor (11, 211) during the mixing and/or granulating.
3. Equipment according to claim 1 or 2, characterised thereby, that the outlet (73) is connected with a drier (111).
4. Equipment according to claim 3, characterised thereby, that the chamber (5), the rotor (11, 211), the stock inlet (65) and the outlet (73) belong to a granulating unit (1), that still at least one other granulating unit (3) with a chamber (5), a rotor (11, 211), a stock inlet (65), an outlet (73) as well as with a shut-off organ (77) of the named kind is present and that the outlets (73) of the chambers (5) of the granulating units (1, 3) are connected with one and the same drier (111).



5. . Equipment according to claim 2 and 4, characterised thereby, that a stock feed installation (101) with at least one stock store (103) is present and connected with the stock inlets (65) of the chambers (5) in such a manner that a charge of the stock can be fed to selectably different chambers (5) and that these control means (141) are constructed to control the stock feed installation (101), the drive means (31) and the shut-off organs (77) of the chambers (5) in such a manner that charges of the stock are introduced one displaced relative to the other in time into the different chambers (5), are processed one displaced relative to the other in time into a granulate in these chambers and then fed one displaced relative to the other in time to the drier (111).

6. Equipment according to one of the claims 1 to 5, characterised thereby, that a fluid feed device (121) with at least one fluid inlet (91) opening into the or each interior space (9) is present, wherein the fluid feed device (121) is constructed for the feeding of a fluid which comprises a liquid and/or a vapour of a material becoming fluid in the interior space (9).

7. Equipment according to one of the claims 6, characterised thereby, that control means (141) for the control of the fluid feed device (121) and measuring means are present to measure the power output and/or the torque which is required for the rotation of the or each rotor (11, 211) and that the control means (141) are present and constructed to determine the instant for the termination of the fluid feed in dependence on a magnitude interlinked with the power output and/or the torque.

8. Equipment according to claim 7, characterised thereby, that the chamber (5), the rotor (11, 211), the stock inlet (65) and the outlet (73) belong to one granulating unit (1), that still at least one other granulating unit (3) of like kind is present, that the control means (141) are constructed to ascertain the power output difference between two simultaneously measured power outputs, of which the one is needed



for the rotation of a rotor (11, 211), by which a dry particulate stock is moved without fluid feed, and the other serves for the rotation of the or one other rotor (11, 211), by which a moist particulate stock is granulated with intermittent or continuous fluid feed, and to determine the instant for the termination of the fluid feed in dependence on the value of this power output difference and/or its change with respect to time.

9. Equipment according to one of the claims 1 to 8, characterised thereby, that some of the stirring organs (47, 49, 53, 57, 247, 253, 257) are constructed as conveying stirring organs (47, 49, 247) and each comprise at least one conveying part (51, 59, 259), that the conveying parts (51, 59, 259) extend at least approximately along helical lines which extend about the axis (21, 221) in like sense of winding for all conveying stirring organs (47, 49, 247) of the or one rotor (11, 211), that some stirring organs (53, 247, 253) each display a respective pair of wedges (53a, 53b, 251a, 251b, 253a, 253b), the apices of which project on mutually remote sides of a plane extending through the axis (21, 221) and the stirring organ (53, 247, 253) concerned, and that each wedge (53a, 53b, 251a, 251b, 253a, 253b) has two surfaces which are inclined away from its apex on mutually remote sides of a plane which extends through this apex and is approximately at right angles to the axis (21, 221).

10. Equipment according to claim 9, characterised thereby, that each conveying stirring organ (47, 49, 247) has two arms (51, 55, 251), which are displaced one relative to the other not only along the axis (21, 221) but also along the circumference of the shaft (41, 241) and project away from this, and a conveying web (59, 259), which forms a conveying part, at least nearly touches the inward casing surface (15a) and which connects together those ends of the arms remote from the shaft (41, 241), wherein a free intermediate space is present between the shaft (41, 241) and the conveying webs (59, 259).



11. Equipment according to claim 10, characterised thereby, that each conveying web (259) has one surface (259c) facing the inward casing surface (15a) and two surfaces inclined away from the edges thereof each towards the other in a cross-section at right angles to the longitudinal direction of the conveying web (259).

12. Equipment according to one of the claims 9 to 11, characterised thereby, that the axial extent of each conveying stirring organ (47, 49, 247) amounts to less than 50% of the axial extent of the interior space (9) and that the conveying parts (51, 59, 259) of each two conveying stirring organs (47, 49, 247) following one upon the other along the shaft (41, 241) overlap wedges (53a, 53b, 253a, 253b) belonging to another stirring organ (53, 253) in radial projection onto the axis (21, 221).

13. Equipment according to one of the claims 1 to 12, characterised thereby, that the or each rotor (11, 211) at each end wall (17, 19) comprises at least one scraper arm (55, 57, 257), which belongs to a stirring organ (49, 57, 257) and projects away from the shaft (41, 241), with one surface (55a, 57a, 257a), which faces the end wall (17, 19) concerned and is parallel to its inward surface, and two other surfaces (55b, 55c, 57b, 57c, 257b, 257c), which are inclined each towards the other, away from the edges of the surface (55a, 57a, 257a) facing the end wall (17, 19), in a cross-section at right angles to the longitudinal direction of the scraper arm (55, 57, 257) and together with that surface form wedges.

14. Method for the mixing and/or granulating of a stock, in particular with the use of the equipment according to one of the claims 1 to 13, wherein the stock is introduced into the interior space (9) of a chamber (5), is moved in this by the rotation of a rotor (11, 211), which comprises a shaft (41, 241) and stirring organs (47, 49, 53, 57, 247, 253, 257) distributed along this, about an axis (21, 221) that is horizontal or inclined through at most 20°, characterised thereby, that the rotor (11, 211) during the mixing and/or granulating process is rotated alternately in different directions of rotation and the stock is conveyed along the axis (21, 211) in the one or the other direction in dependence on the direction of rotation and that the product formed in that case is thereafter conducted out of the interior space (9) at one end thereof.



15. Method according to claim 14, characterised thereby, that a charge of the stock is fed in alternation to different chambers (5) of the named kind and granulated in these and that granulate formed in one of the chambers (5) is conducted away out of this in alternation as well as introduced into a drier (111) and dried in this.

16. Method according to claim 14 or 15, characterised thereby, that a fluid, which comprises a liquid and/or a vapour becoming liquid at the latest on contact with particles of the stock, is introduced into the interior space (9) during at least a part of the time, in which the rotor (11, 211) is rotated, that the power output and/or the torque, which is required for the rotation of the rotor (11, 211), is measured and that the feed of fluid is terminated when the value and/or the change with respect to time of a magnitude, which is linked with the power output and/or the torque, fulfils a preset condition.

17. Method according to claim 16, characterised thereby, that a charge of the dry particulate stock is fed in alternation to two different chambers (7) of the named kind, is moved in the chamber (7) concerned initially without feed of fluid and thereafter with intermittent or continuous fluid feed through rotation of the rotor (11, 211) arranged in the chamber (5) concerned, that the power for the rotation of the rotor (11, 211) moving the dry stock and the power for the rotation of the rotor (11, 211), which moves the stock mixed with fluid, are measured at the same time and that the difference between both these powers is ascertained and the feed of fluid is terminated when the power output difference and/or its change with respect to time fulfils a preset condition.