Dec. 3, 1957 J. E. NYROP 2,815,246

ROTATING VANE WHEEL ATOMIZER

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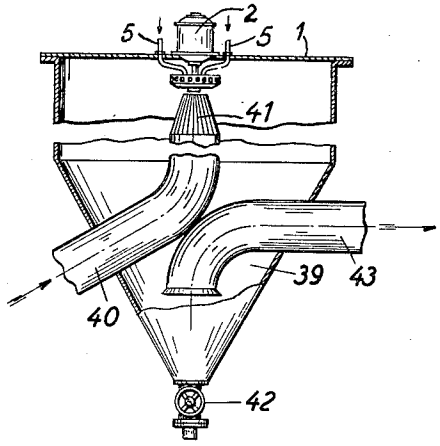

Fig.1

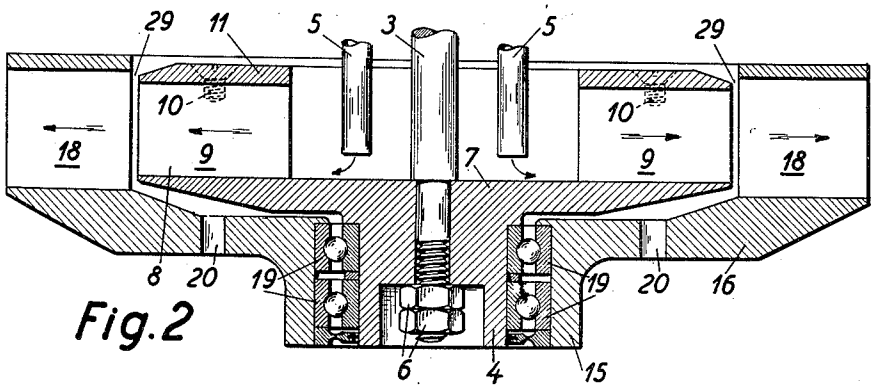

Fig.2

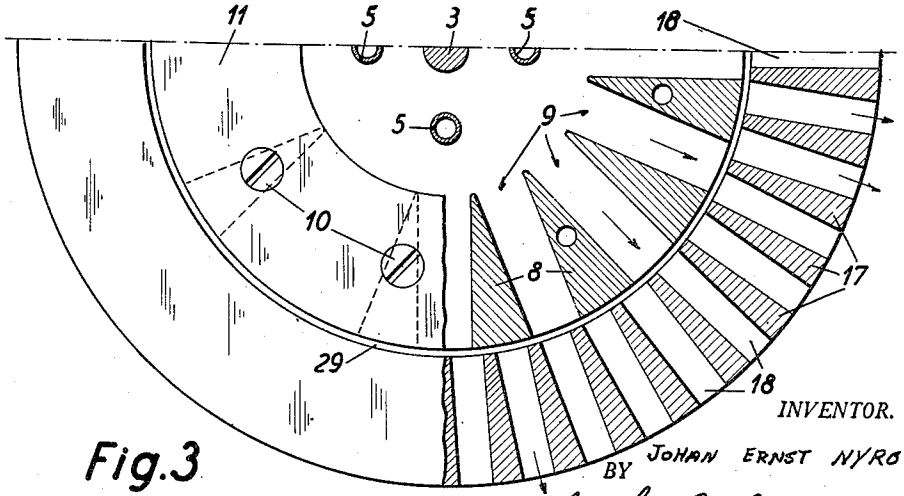

Fig.3

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Fig.4

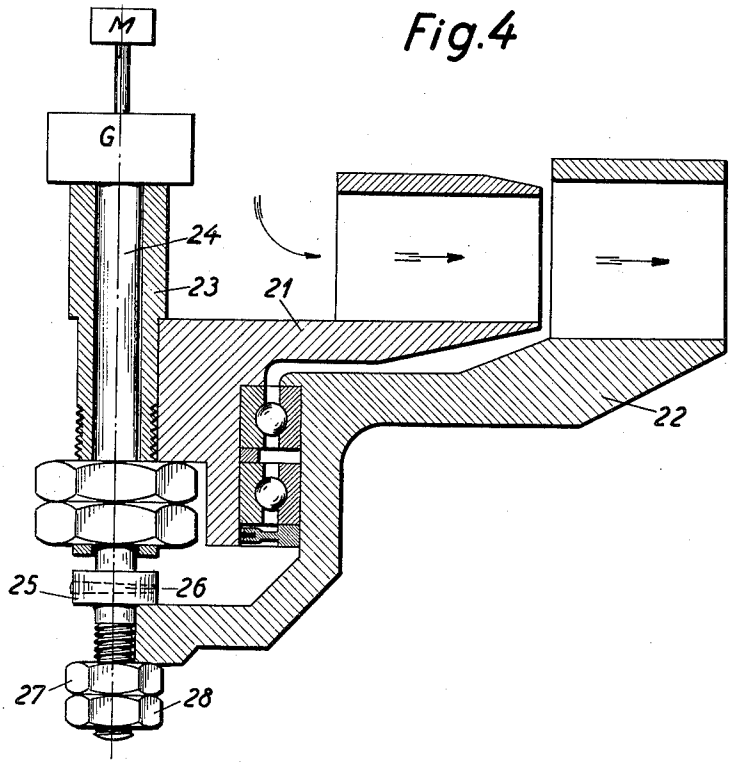
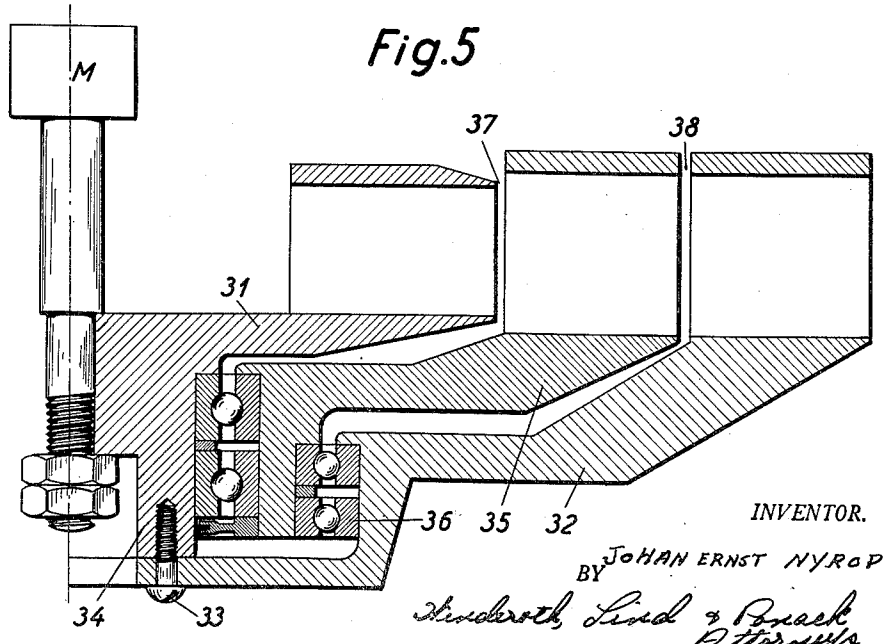


Fig.5



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ROTATING VANE WHEEL ATOMIZER

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The invention relates to a rotating vane wheel atomizer comprising at least two vane wheels concentrically rotating in the same or in opposite directions relative to each other at differing relative velocities, each of the vane wheels independently mounted and driven from a common central shaft and radial channels in each of the vane wheels through which a liquid or fluid with a content of solids is fed from a fluid supply means and is flung out in atomized form into the chamber of a spray drier or the like in which the particles are dried by means of a drying medium such as hot air or in other ways treated for obtaining a finely comminuted dry powder.

Atomizers with rotatable vane wheels having a space intended to receive the medium to be atomized inside of the inner edges of the vanes of the vane wheel are known. Such atomizers are well suited for atomizing liquids of a viscosity which is not too great, e. g. aqueous solutions, and they are used for instance for the production of powders of various substances by atomizing a solution of the substance into a drying chamber wherein a heated air current causes the evaporation of the solvent so that the solid is recovered in the form of solid particles of the substance dissolved in the liquid supplied.

These known atomizers cannot, however, be used for atomizing too highly viscous liquids or for powder agglomerates of a slight liquid content, as it appears that the viscous liquids are flung off from the outer edges of the vanes, as threads coherent whereas the powder agglomerates are flung off in lumps.

The main purpose of the invention is to provide an atomizer by which such highly viscous liquids or agglomerates may be effectively atomized.

The atomizer of the present invention is provided with a rotating vane wheel with an annular space between the shaft of the vane wheel and the inner edge of its vanes. The annular space is adapted to receive the medium to be atomized. A further vane wheel is provided co-axially with said vane wheel and surrounding the same. A narrow space between the inner edges of the vanes of the latter wheel and the outer edges of the vanes of the former wheel is thereby provided. The vane wheels are driven by driving means in such a way that two successive wheels have mutually different rotational speeds.

In the atomizer according to the invention, there is used a further vane wheel rotating concentrically around the former with a narrow space between the outer edge of the former and the inner edge of the further vane wheel and so that the two wheels adjacent the same narrow space move at different velocities, and atomization is obtained of such highly viscous liquids or powder agglomerates of a slight moisture content which most probably is due to the fact that a crushing or a kind of grinding of the material takes place.

An object of the invention is to provide an atomizer having a rotating vane wheel with an annular space between the shaft of the vane wheel and the inner edge of its vanes, which space is intended to receive the medium to be atomized, wherein co-axially with said vane wheel

and surrounding the same a further vane wheel is provided with a narrow space between the inner edges of the vanes of the latter wheel and the outer edges of the vanes of the former wheel, means for driving the vane wheels in such a way that two successive wheels have mutually different rotational velocities, and wherein the outer vane wheel is positioned to be freely rotatable in relation to the inner vane wheel so that it may be driven by means of the medium flung out from the inner wheel during the operation of the atomizer.

Other and further objects of the present invention will appear from the more detailed description set forth below, it being understood that such detailed description is given by way of illustration and explanation only and not by way of limitation, since various changes therein may be made by those skilled in the art without departing from the scope and spirit of the present invention.

In connection with that more detailed description, there is shown in the drawings, in

Figure 1, a view partly in section and partly in elevation of the device of the invention,

Figure 2, an enlarged sectional elevation view of the vane wheels of Figure 1,

Figure 3, a plan view of a section of the structure of Figure 2, partly in elevation and partly in section,

Fig. 4, a sectional elevation view of a modified form of the vane wheels of Fig. 2; and

Fig. 5, a sectional elevation view of another modified form of the vane wheels of Fig. 2.

In Figure 1 there is shown the general relationship of parts of a spray drier provided with an atomizer in accordance with the invention and said atomizer comprises a motor 2 mounted upon the top wall 1 of the atomization chamber, a direct drive shaft 3 from the motor which drives the vane wheels and a series of supply pipes 5 which supply the viscous or concentrated liquid which is being atomized.

Through the conical bottom wall 39 of the chamber a supply pipe 40 is led into the chamber for supplying a drying medium such as hot air to the chamber. Said pipe has a bend so that it extends axially of the chamber for most of the height thereof and its mouth is disposed co-axially beneath the atomization wheel at an appropriate distance from the same in a well known manner. At the mouth the supply pipe may be provided with a guiding member 41 for guiding the drying medium so that it flows out into the chamber as a rotating flow for intimately intermingling with the atomized particles flung out from the wheel for drying the particles so as to obtain a dried powder.

The particles sink down together with the drying medium and part of the dried powder is deposited on the cone shaped bottom wall from which it may be removed through an outlet 42.

The part of the particles which do not settle on the bottom wall, as a rule the greater part, follows the stream of drying medium sucked off through an outlet 43, whereupon the particles may be separated from the drying medium by any appropriate means not shown.

The atomization chamber is shown in Figure 1 as being of cylindrical shape with a conical bottom part and the motor is mounted at the top and center of the upper part of the device to illustrate the invention in one of its simpler forms. However, it should be appreciated that the chamber may be modified as to shape, and that the mounting of the motor may be modified to provide a direct or indirect drive as is known in the art. The motor may thus be coupled with the shaft 3 by means of appropriate gearing for either greater or reduced rotational speeds of the shaft as is desired. Further, the inlet pipes 5 are shown as passing through the top wall 1 of the atomizer, but these pipes may, if desired, lead

through the sides of the atomizer at a position above the vane wheels and near the top wall 1.

It should be understood that the atomizer of the invention is not limited for use with spray drying but may also be used for other operations that may be performed by means of similar devices. For instance the apparatus or modifications thereof may be used in manufacturing powders by spray crystallization. In this case the drying medium should not be hot air but on the contrary it should be a cooling medium. Further it is possible to obtain chemical reactions between the atomized fluid and a gaseous agent supplied in lieu of or simultaneously with the above mentioned drying and/or cooling media.

The supply of the drying medium or the like may be obtained in other ways than shown and described above. For instance it may be supplied from above or on a level with the atomization wheel through appropriate channels or mouth pieces. It may alternatively be supplied from beneath the atomization wheel through one or more mouthpieces through the sidewall of the atomizer, tangentially to the wall or not, as desired.

The construction of the vane wheels is shown in Figures 2 and 3. On the shaft 3 an atomization wheel 4 is secured by means of a nut and a jam nut 6 which atomization wheel comprises a hub 7 and an annular member 8, which is shaped in one piece with the hub 7 or fixed thereto in any suitable way. In the annular member 8 channels 9 are milled out. The vanes of the wheel are constituted by the lagging walls of said channels, when the wheel is rotated. As indicated with a dotted screw 10 an annular cover plate 11 may be fastened to some of the partitions 12 separating the channels 9. This cover plate may also constitute part of the body of the wheel or it may, as the case may be, completely be dispensed with. The inner edges of the vanes are at some distance from the shaft 3 so that an annular space is formed between the vanes and the shaft, receiving the means for supply of the medium to be atomized. This means is in Figs. 2 and 3 diagrammatically shown as a single supply pipe 5 but it should be understood that the supply means is not so limited, any means for obtaining an appropriate distribution of the medium to the vanes could be used. When the wheel is rotated at a great speed by means of the motor, the medium supplied in the annular space will by means of the centrifugal force be flung out into the channels 9 and pass along their lagging walls, and be flung away from the outer edges of the latter.

In constructions of the prior art which contain but a single vane wheel provided with the annular space between the vanes of the wheel and the shaft in order to deliver the liquid medium being atomized to the periphery of the wheel where it is atomized under the action of centrifugal force through the channels provided in the wheel, the atomization devices were severely limited for the use of liquid of low viscosity and low solids content. The channels and spaces became clogged in these single vane wheel devices by the concentrating action obtained upon the viscous liquid during the centrifuging operation of the devices. At the outer edges of the vanes, the lower density liquid flung out and separated from the solids by the action of centrifugal force causes the formation of threads and lumps of pasty solids and the desired atomization is defeated.

This drawback in the construction and performance of the prior art devices is overcome in accordance with the invention by providing at least one additional atomization wheel comprising a hub 15, a plate-shaped part 16 and an annular part 17 with channels 18 forming vanes as is shown in Figures 2 and 3. This further atomization wheel is positioned on the hub 7 of the first atomization wheel by means of bearings which are, in the embodiment shown, in the form of ball bearings 19. Between the annular parts 8 and 17 of the inner and outer wheel respectively a narrow space 29 has been maintained.

In the hub 15 of said further atomization wheel a number of openings are arranged only one of said openings being shown in the drawings and identified by the reference 20. These openings are for sucking in air when the wheel is rotated, and this sucking in of air, shown in Figs. 2 and 3, improves the atomization.

The mode of action of the atomizer is as follows: The shaft 3 is rotated by means of a suitable motor, so that the vanes, formed by means of the channels 9 will rotate at a number of revolutions of e. g. 10,000 revolutions per minute. The medium to be atomized is supplied through the supply pipe 5, of which there may possibly be more than one, and/or further distribution members as already mentioned, and thus the medium flows into the space 14 from where it is by means of the centrifugal force flung out and, also by means of the centrifugal force, driven out along the lagging walls of the channels 9 from the outer edges of which the medium is then flung out to impel the walls of the channels 18 of the outer vane wheel, which walls are facing backwards relative to the direction of rotation of the first wheel. The outer wheel is thus caused to rotate by turbine action. The medium flows out along said walls of channels 18 and is finally flung off their outer edges. Experiments prove that even in case of very highly viscous liquids or conglomerates of solid particles, said flinging off results in comminution and atomization, which it is presumed is due to the fact that a breaking or a kind of grinding of the medium flung off in coherent strings or lumps from the outer edges of the channels 9 takes place in the space 29 on account of the relative velocity between the two vane wheels.

It can easily be ascertained that such a relative velocity occurs between the two vane wheels, since apart from friction, the medium will leave the channels 18 with the same kinetic energy as that with which it was supplied to said vanes so that $m_1v_1^2=m_2v_2^2$ where m_1 and m_2 are the masses of the medium supplied and led away, respectively, per unit of time, and v_1 and v_2 are the speed of the medium supplied and led away respectively. m_1 and m_2 are equal and consequently also v_1 and v_2 are equals.

These two velocities are equal to the peripheral velocity of the inner wheel and the outer wheel, respectively, and accordingly the product of revolution number and outer diameter of either wheel is the same, so that the number of revolutions of the outer wheel is smaller than that of the inner wheel, whereby a relative movement is provided between the edges of the inner wheel and the edge of the outer wheel adjacent the narrow annular space 29.

In the above friction is disregarded, but it will easily be understood that the friction as well as any other imaginable influence from outside will entail a reduced number of revolutions of the outer wheel and thus an increased relative velocity.

If, accordingly, it is supposed that the inner wheel has a diameter of 20 cm. and the outer wheel one of 28 cm., the number of revolutions of the outer wheel will be about 7000 revolutions per minute, the presumed number of revolutions of the inner wheel being 10,000 revolutions per minute.

The embodiment described should only be regarded as an example as its details may undergo various modifications within the scope of the invention. Thus, the shape of the channels forming the vanes of the two wheels may have any suitable form, and the number of them may also vary within wide limits and also with a view to the mutual relation between the number of vanes of the two wheels.

The bearing may be shaped in different ways. For instance other types than the bearings 19 shown may be used, and further the bearing of the outer wheel does not necessarily have to be mounted directly on the hub of the inner wheel, but may be mounted on the shaft 3 or a projection of this shaft. Further, it might be pos-

sible that the outer wheel be positioned in a bowl with mercury.

While in the described embodiment it is supposed that the outer wheel is operated by turbine action by means of the liquid flung off from the inner wheel, it is also possible to construct the atomizer so that the outer wheel is also motor-driven. This is diagrammatically indicated in Fig. 4, wherein the inner wheel is designated by **21** and the outer wheel by **22**.

The inner wheel **21** is secured to the end of a hollow shaft **23**, and the outer wheel to the end of a shaft **24** between a bushing **25** which is secured with a pin **26** and a nut **27** with a jam nut **28**. The shaft **24** is positioned concentrically inside the hollow shaft **22**. The two shafts **22** and **23** are mounted in bearings of any suitable type not shown on the drawing and are interconnected through a gear G, which is only diagrammatically indicated and are driven through the latter by means of a motor M also only shown diagrammatically.

By means of the gear G the two wheels **21** and **22** will be operated with suitable mutual rotational velocities. The two wheels **20** and **21** may either rotate in the same or in the opposite direction, and the inner wheel may either be operated at a greater or a smaller velocity than that of the outer one. It is noted that the same rotational velocity, but opposite direction of revolution may also be regarded as the mutually different rotational velocities, the essential feature being that a relative movement takes place between the two wheels and further that the velocities are so adjusted that particles flung off from the inner wheel cannot pass the channels of the outer wheel without impelling the inner walls.

A particularly efficient and simply constructed embodiment with three vane wheels is shown in Figure 5.

This embodiment comprises, as is the case in Fig. 4, two vane wheels **31** and **32** which are operated by the motor M, but here no gear for providing the different rates of rotation is used since the vane wheel **32** is secured to the hub **34** of the vane wheel **31** by bolts **33**. As in the embodiments shown in Figs. 2 and 3 a freely running vane wheel **35** is mounted on the hub by means of ball bearings **36**.

Between the vanes **37** and **38** of the wheels **31** and **35** respectively there is maintained a narrow annular space **37** and between the wheels **35** and **32** a narrow annular space **38** is maintained.

Despite the essential simplicity of construction consisting in the two wheels **31** and **32** being secured to each other and rotating with the same rotational velocity, the new result is obtained and the wheel **35** runs in the same manner as in Figs. 2 and 3 at a lower rotational velocity than the wheel **31**, and hence the wheel **32** runs at a higher rotational velocity than the wheel **35**, so that the two wheels adjacent the annular space **38**, viz. the wheels **32** and **35** have a mutual movement as is the case with the two wheels adjacent the space **37**, i. e. the wheels **31** and **35**.

It will be seen that the principle used in Fig. 5 may also be used in case the atomizer is constructed with more than three vane wheels, namely so that all the wheels having odd numbers—counted from the shaft—are firmly secured to the shaft, whereas the intermediate wheels with even numbers are freely rotatable in relation to the former wheels, all the wheels with odd numbers thus having the same rotational velocities, viz. corresponding to the ratio between the outer diameters of the wheels in question.

The atomizer according to the invention is not limited to use for atomizing viscous liquids or conglomerates of solids, but may also be used for atomizing more easily flowing liquids as e. g. aqueous solutions. This may be of particular importance in the production of coarser particles where it is desired to obtain a slow flinging out, and in order to use an atomization chamber of a comparatively small diameter. In this case the outer wheel should rotate more slowly than the inner one or it may be moved in the opposite direction to the inner wheel.

It is thought that the invention and its advantages will be understood from the foregoing description and it is apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing its material advantages, the forms hereinbefore described and illustrated in the drawings being merely preferred embodiments thereof.

What is claimed is:

1. An atomizer comprising a shaft, means for rapidly rotating said shaft, a first vane wheel mounted on said shaft, said first vane wheel having an annular part coaxially surrounding said shaft, the internal surface of said part defining together with said shaft and annular space coaxially surrounding said shaft, said annular part having ducts therein extending from said annular space to the external circumference of said annular part, partitions between each of said ducts separating said ducts from each other, said partitions constituting the vanes of said first vane wheel, a second vane wheel mounted on said shaft having an annular part coaxially surrounding said first vane wheel, said annular part of said second vane wheel having ducts therein distributed about the axis of said part and extending from the internal circumference of said part to the external circumference of said part, partitions separating said ducts from each other and constituting the vanes of said second vane wheel, the inner edges of the vanes of the second wheel and the outer edges of the vanes of the first wheel being spaced from each other by a narrow space, one of said vane wheels being secured on said shaft for rotation therewith and the other being journalled on said shaft.

2. An atomizer as claimed in claim 1, wherein said second vane wheel is journalled on said shaft and is freely rotatable in relation to said first vane wheel.

3. An atomizer as claimed in claim 1, and a gearing device coupling the two vane wheels to each other.

4. An atomizer comprising a motor-operated shaft, a plurality of vane wheels, each wheel having an annular vane part, said vane parts having ducts therein extending from the internal circumference of said annular vane parts to the external circumference thereof, partitions separating said ducts from each other, said partitions constituting vanes in the wheel, said annular vane parts of said wheels surrounding one another concentrically and being disposed at the same level as seen at right angles to the shaft, the ends of the vanes on adjacent wheels being spaced from each other a narrow annular space between adjacent vane parts, the vane wheel with a vane part at one side of each of said spaces being secured to said shaft, the vane wheel with a vane part at the other side of the same space being rotatably mounted on said shaft.

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