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APPARATUS FOR PRODUCING POWDERS BY ATOMIZATION OF LIQUID CARRIERS

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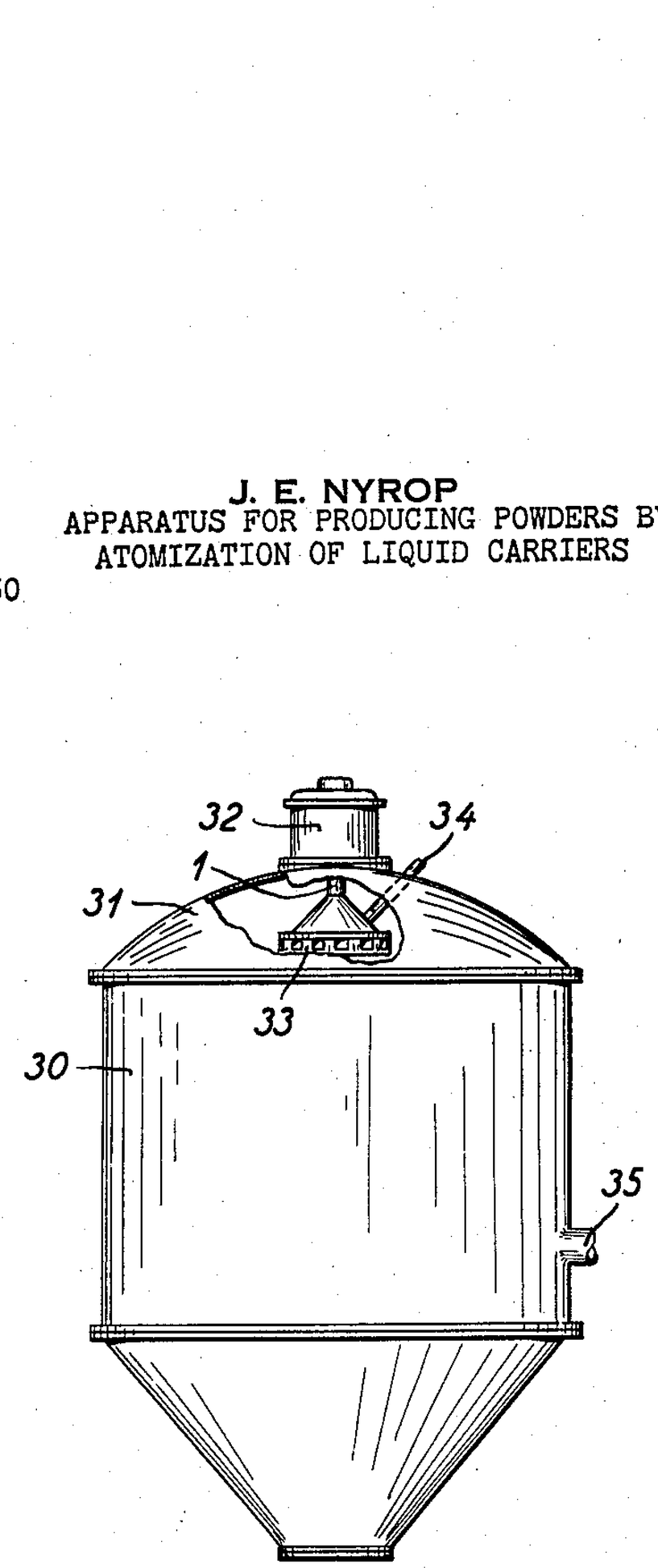

Fig.1

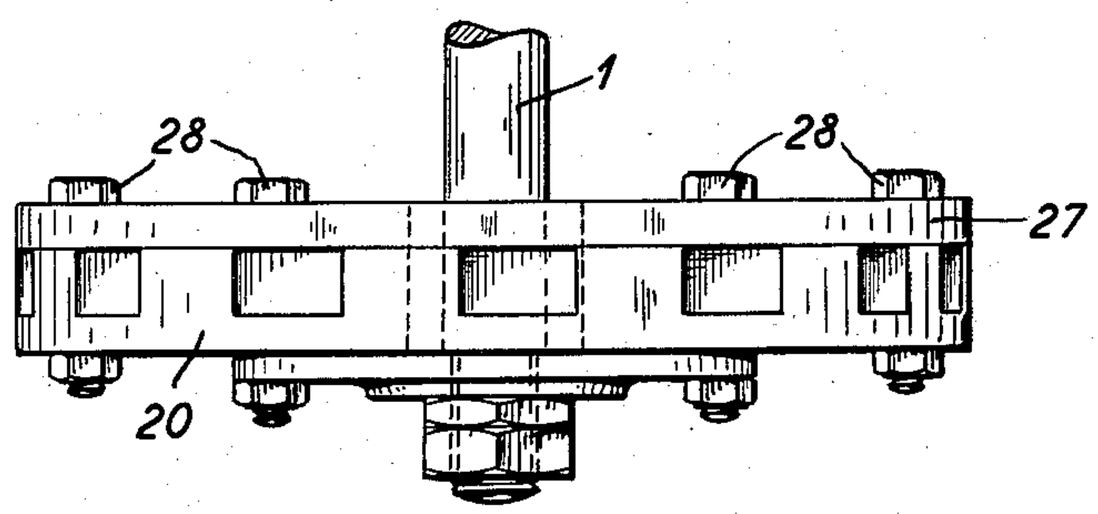

Fig.3

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Fig. 2.

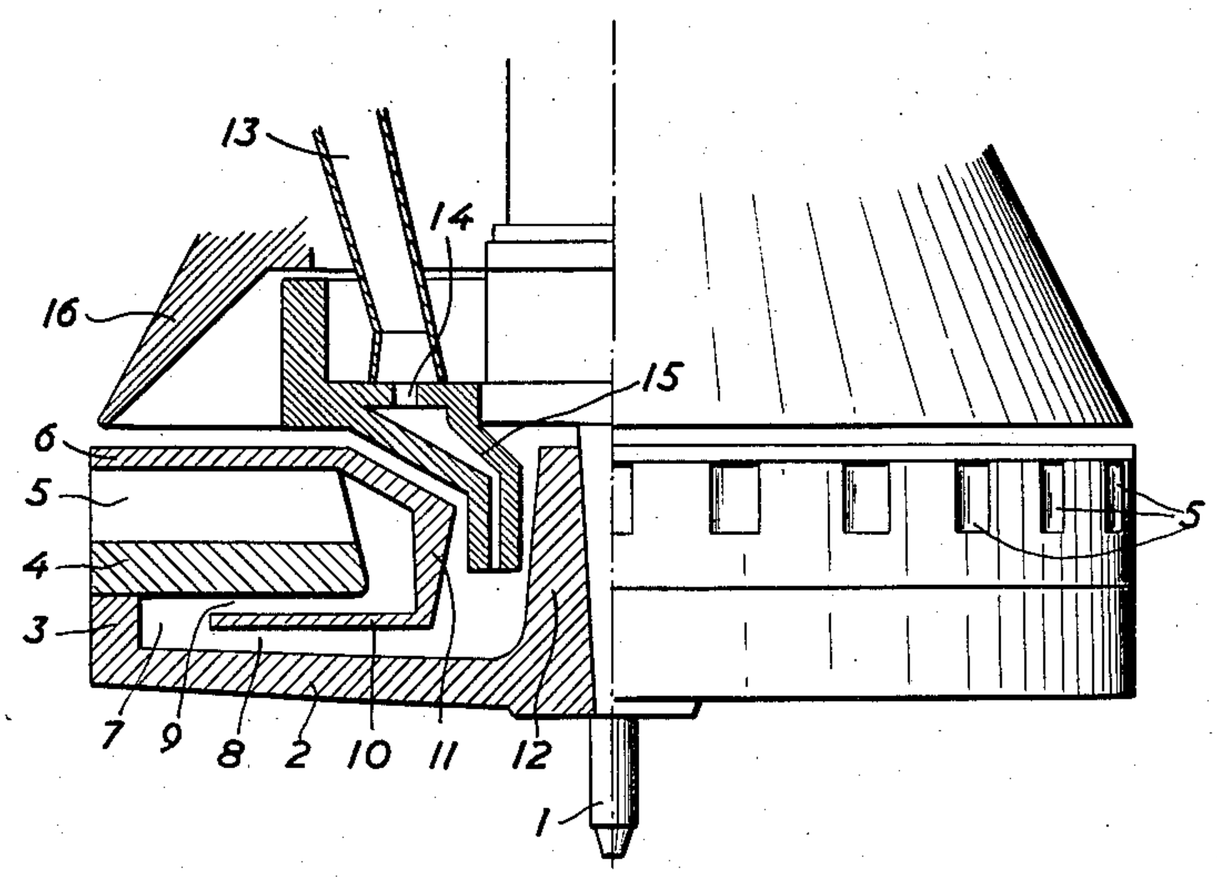
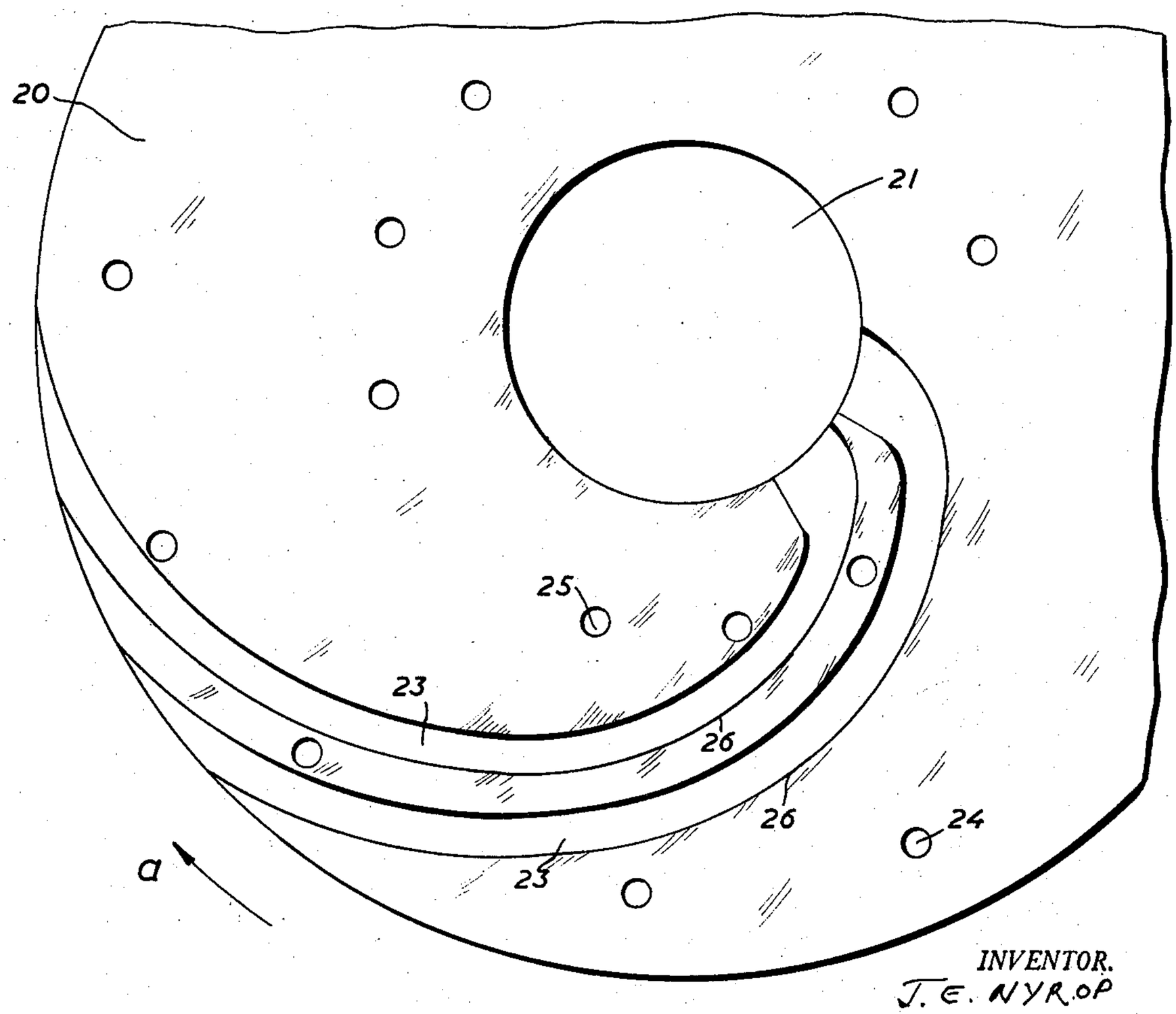


Fig. 4.



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APPARATUS FOR PRODUCING POWDERS BY ATOMIZATION OF LIQUID CARRIERS

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2 Claims. (Cl. 159—4)

The invention relates to a apparatus for producing powders by atomization of liquid carriers.

The main object of the invention is an improved method for obtaining powders of very little air content in a simple and cheap manner.

In many cases it will be desirable to get powders with as little air content as possible. By way of example should be mentioned that in different places certain maximum contents of air are prescribed for packings with dried milk. For the removal of air it is common in such cases to evacuate the packing, which has generally the form of a tin, before the closing of the latter. The free quantity of air present above the powder and between the particles of the powder can in this way be quickly and easily removed, but the air incorporated in the individual particles will diffuse very slowly so that a removal of said air will be an exceedingly lengthy affair. The air thus incorporated in the particles plays a very important part, however, and therefore it is of importance to achieve a simple and quick method for its removal.

Also in many other powders, e. g. easily oxidizable powders, the air content in the individual particles can be regarded as detrimental, and the purpose of the present invention is to indicate a generally applicable solution of said problem. The invention is based on the discovery that an improved practical solution to this problem is obtained by producing the atomized liquid in such a manner that the powder resulting from the drying of the atomized liquid has as little an air content as possible in preference to removing the air content afterwards.

According to the invention powders with little air content are produced by reducing the air content of the liquid by centrifugation before the atomization, and by preventing the absorption of air to the liquid on its way from the place of centrifugation to the place of final atomization.

It proves that by this method a powder can be obtained with a considerably lower air content than was the case by the usual methods for the production of powders, and this result is presumably due to the fact that the liquid particles resulting from the atomization are substantially not inclined to absorb air in the drying chamber so that the air content of the liquid at the moment of atomization are decisive of the air contents of the powder produced.

By the method indicated a further very important advantage is attained, viz. a high specific gravity of the powder so as to make it far less voluminous than powders produced by the methods hitherto used being afterwards freed from part of their air content. This is due to the fact that an evacuation of the powder does not influence the size of the individual powder particles. The reduced voluminousity is of special importance with regard to the freight costs for shipments, especially for long-distance shipments.

In atomization by means of a rotating atomizer, it

is an object of the invention to utilize the centrifugal force derived from the rotation of the atomizer for the removal of the air from the liquid.

The invention also concerns different apparatus for carrying out the method indicated.

A further object of the invention is a device for producing powders with a reduced air content by atomization, said device being provided with means for centrifugation of the liquid before the atomization takes place.

In some embodiments of such device the centrifugation takes place in a centrifuge means inserted in the path of the liquid between the inlet of the device and the atomizer.

In other embodiments especially to be realized in connection with devices of the kind having a rotating atomizer with a vane wheel, in which the vanes are constituted by channels in the plate shaped wheel, the channels have a form of curvature by which a centrifugal force is exerted on the liquid on its way through a channel in such a way that a separation of air from the liquid takes place.

Other and further objects and advantages of the invention will appear from the following description referring to the accompanying drawings in which the invention will be illustrated as embodied in some different types of apparatus.

Fig. 1 shows a partly sectional view of an atomization drying device of known type in which a device according to the invention is mounted.

Fig. 2 shows diagrammatically part of a device according to the invention, partly an axial section.

Fig. 3 shows in side elevation part of another embodiment of the device according to the invention, and

Fig. 4 shows a horizontal projection of a detail of the embodiment shown in Fig. 3.

In Fig. 1 **30** represents a drying chamber of a well known kind. On the top part **31** of said chamber **30** a driving means **32**, such as an electro-motor is mounted with its shaft **1** penetrating into the drying chamber **30**. On the shaft **1** is an atomizer **33** mounted inside the chamber **30**. A tubular means **34** serves for supplying liquid to the atomizer **33** and another tubular means **35** serves for supplying a drying medium, such as hot air, into the chamber **30**.

The structure as hitherto described is commonly known and used for the production of dried powders and need no further description and the specific shape of it should mean no limitation of the invention as any arbitrary drying device comprising a drying chamber in which a liquid is to be atomized may be mounted with a device according to the invention.

The device according to the invention is now to be described in further detail by way of example with reference to Figs. 2–4.

In the embodiment diagrammatically shown in Fig. 2 a wheel-shaped plate **2** is mounted on the rotating shaft **1**, said plate **2** being at its circumference provided with an upwardly-directed flange **3**. On this flange a ring-shaped plate **4** is secured which in the case shown is shaped as a vane wheel, being at its upper side provided with recesses **5** which extend from the interior of the vane wheel to its outer circumference and form its vanes. On top of the plate **4** a cover **6** is mounted which closes the recesses **5** upwardly so that they form channels which are open only at the inner and outer circumference of the vane wheel **4**, and the walls, facing the direction of rotation, of the channels form the vanes of the vane wheel. From the parts **2**, **3**, and **4** has thus been formed a ring-shaped, inwardly open space **7** and, as will appear from the figure, said space is divided into two chambers **8** and **9** by means of a ring-

shaped disc **10** which terminates some distance from the flange **3** and at the inner circumference merges into a substantially cylindrical part **11** which extends up into the ring-shaped clearance between the boss **12** of the plate **2** and the plate **4** and is in fixed connection with the cover **6**.

All the parts hitherto mentioned thus rotate with the shaft.

The liquid to be atomized is supplied through one or more pipes **13** leading to one or more apertures **14** and one or more pipes **15** being mounted below said aperture or apertures, resp. and leading down into the clearance between the cylindrical part **11** and the boss **12**.

In the section shown in Fig. 2 only one of the elements **13**, **14**, and **15** resp. is shown, but in case of several such elements it should be understood that they are arranged in the same manner but in different radial sections through the device.

By the action of the centrifugal force the liquid is flung out into the space **7** and gets a mainly vertical surface substantially at the level of the internal circumference of the plate **4**. From there the liquid flows up to the vanes formed by the recesses **5** and is flung out along the surfaces of these vanes due to the action of the centrifugal force and finally the liquid leaves the extreme edges of the vanes in an atomized state.

On account of the accumulation of liquid occurring in the spaces **7**, **8**, and **9** the liquid flows comparatively slowly through these spaces, and due to the centrifugal force the air content in the liquid is influenced by a "buoyancy" directed inwards towards the axis, and this buoyancy will cause a considerable quantity of the air to move inwards towards the axis in the chamber **8** against the direction of the flow of liquid so that the liquid present in the chamber **9** and going outwards to the vanes has considerably less air content than the liquid supplied to the chamber **8**.

Above the cover **6** a stationary screen **16** is mounted for preventing air from being sucked in by the rotation of the vane wheel. The quantity of air released in the chamber **8** can escape through the clearance between the cover **6** and the screen **16**.

By using an atomizer with a vane wheel of the type shown in the figure, but without the air separator **8–11** indicated and under ordinary operation conditions, generally a powder with an air content of about 24 cm.^{3} per 100 g. is obtained. Under the same conditions and with the same vane wheel but by the application of the air separator shown in the figure is obtained a very substantial reduction of the air content, viz. by way of example a reduction of the air content down to 8 cm.^{3} air per 100 g. powder.

Even if in the embodiment shown the vane wheel is in direct connection with the members causing the air separation, this is no condition for carrying out the invention in practice, the essential feature being that the liquid poor in air given off from the chamber **9** is led to an atomizer of some kind or other in such a way that a renewed mixing of the liquid with air is substantially avoided.

Renewed absorption of air by the liquid is substantially avoided. It is not necessary that the liquid be atomized immediately after the air has been separated therefrom, the only essential condition being that renewed absorption be avoided before atomization.

Thus, the centrifuge means shown need not necessarily be directly connected with the atomizer wheel as shown. However, the particular combination shown in the drawings and described herein is more inexpensive to manufacture than separate elements having connecting means therebetween would be.

Figs. 3 and 4 show diagrammatically a centrifugation wheel for another embodiment of the apparatus according to the invention. This wheel comprises a circular disc **20** and a corresponding cover plate **27** connected

to each other by means of bolts and nuts **28** and mounted on the shaft **1** by means of a boss **29** secured to the wheel by the same bolts and nuts **28**. As shown in Fig. 4 the disc **20** is provided with a circular aperture **21**. In this disc channels **23** of substantially uniform breadth have been milled down or produced in some other way, which channels extend from the internal periphery of the disc to its external periphery. **24** and **25** are holes for the bolts **28** for securing the cover plate **27** to the disc **20** and by means of said cover plate the channels **23** get closed in cross section and are in communication with the surroundings only through the inner and outer mouths.

The wheel is intended for rotating in the direction of the arrow as shown, and as appears from the figure the mouths of the channels **23** in the outer periphery of the wheel are displaced in the direction of rotation in relation to the corresponding admission openings in the inner periphery of the wheel. This is due to the fact that the channels extend along curved lines which in the case shown have the form of involutes of a circle, but need not be bound to this form.

When liquid is supplied to the wheel at the inner periphery, the walls **26** of the channels, which walls lie on the side of the channels facing the direction of motion, will act as vanes and make the liquid rotate. The centrifugal force produced thereby will cause the liquid to be forced out through the channels along said walls **26** in the form of a thin film. Due to the curvature of the channels the centrifugal acceleration has a component directed at right angles to the tangent of the channel. According to a known physical law an acceleration field is equivalent to an opposite directed gravity field. Further when air is suspended in liquid and the liquid is subjected to a gravity field a buoyancy will act on the air. Accordingly this buoyancy is of the opposite direction as the centrifugal acceleration and so the air content will travel relative to the liquid in the direction of rotation at right angles to the tangent of the channel in the point in the question which means that the air will travel out from the liquid across the channel. Both liquid and air will generally be forced out through the channels due to the centrifugal force but due to the said component of the same the liquid will substantially travel along one wall in the channel and the air along the other one. At the end of the channel, the centrifugal force will carry the particles of liquid radially outwardly, and the same centrifugal force will prevent the absorption of air by the particles for perhaps a short distance radially outwardly of the periphery of the atomizer wheel. Atomization therefore takes place before the liquid can absorb air.

It should be added that in a known vane wheel of an atomizer having a radial channel, the air content of the liquid passing through the channels is also subjected to a buoyancy. This is, however, directed along the channel i. e. in the direction of movement of the liquid with the result that the relative movement between air and liquid may be regarded as a "phase-shift" since the path of the air particles in a certain portion of the liquid leaving the channel is different from the path of the air particles contained in the same portion of liquid when supplied to the channels, but the quantity of the air content is substantially the same.

The best effect is obtained when the channels are curved in the form of a spiral- or evolute-curve which reckoned from its starting point and outwards lies in increasing distance in the direction of motion of the wheel from the radius through the inner mouth of the channel.

An extremely effective separation is obtained when the angle between the tangent to the channel curve and the radius through the point of tangency for all points of a channel is substantially constant and as large as possible.

It will be understood that the angle cannot become 90° which should theoretically give the best possible utiliza-

tion of the centrifugal force. This would, however, necessitate that each channel should wind as a spiral with an infinite number of terms which cannot be obtained in practice, and at the same time the driving force becomes very small. In practice it is therefore necessary that the angle be a certain amount less than 90°. The closer the angle can approach to 90° the better is the centrifugal force utilized for the air separation and therefore the angle is as close to 90° as permitted by the construction in combination with regard to obtaining the necessary driving force for the liquid.

The wheel shown may in itself serve as an atomizer wheel and can thus directly substitute for the atomizer wheel of a corresponding size in an ordinary rotating atomizer.

The atomization brought about by the wheel may, however, also be regarded as a preliminary stage of the complete atomization so that the liquid flung out from the wheel may through different further spraying members be led to the final atomizer.

It is, however, also possible to use the wheel shown in Figs. 3 and 4 in connection with the apparatus shown in Fig. 1 so that the channels in the vane wheel **5** are shaped like the channels **23** shown in Fig. 4.

The channels need not necessarily be shaped in the manner shown in Fig. 4, since other forms may be used where a component of the centrifugal acceleration is obtained at right angles to the tangent to the channel curve thereby obtain the inventive effect.

It is also pointed out that with a wheel of the type shown in Fig. 2 and with radial channels, under normal operation conditions a powder is obtained with an air content of about 24 cm.^{3} per 100 g., whereas in accordance with the invention, there is obtained a reduction of the air content to about 8 cm.^{3} air per 100 g. powder.

The figures given for the two embodiments of the apparatus are to be understood as illustrative since a still greater reduction of the air content may be obtained in accordance with various obvious modifications of the invention, the reduction being substantially dependent on the design of the channels and the velocity of rotation used.

On the basis of the above detailed explanation of the parts being more essential for the invention it is thought that all details not shown or described or only mentioned in short in the foregoing will be apparent to those skilled in the art.

It should, however, be understood that the above description of a few embodiments shown on the drawing should have no limiting effect on the invention as any possible changes in size, proportions, shape and details may be made and any other possible means than those shown may be used in practising the new method, all within the scope of the appended claims.

I claim:

1. In a device for production of powders by atomization of a liquid, having a drying chamber, a disc-shaped vane wheel suspended in said chamber, a shaft secured to said wheel, means for rotating the shaft, said wheel having a central opening from which the vanes of said wheel extend to the periphery of said wheel, each of said vanes being shaped as a wall and defining a channel of substantially uniform breadth with one of the other vanes, the channels extending from the central opening to the periphery of the wheel, means for supply of liquid to the channels through the central opening in said wheel, said channels being curved from the radial direction in the direction of motion of said wheel as defined by said means for rotating said shaft, the magnitude of the curvature being such that the centrifugal force derived from the rotation of said wheel has a component at right angles to the channel and the angle between the tangent to the curvature of said channels and the radius through the point of tangency being only a little less than 90° for all points of a channel.

2. Centrifugation means for separating air from liquid comprising a disc-shaped wheel having an opening concentrically in the middle of the wheel, means for rotating said wheel, walls in said wheel defining channels extending from said opening to the outer periphery of the wheel, said channels being curved so as to deviate from the radius of said wheel in the direction of rotation of the wheel, the angle between the tangent to the curvature of said channels and the radius through the point of tangency being only a little less than 90° for all points of a channel, and means for supply of liquid to the said channels through said opening in the wheel.

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