May 11, 1965 F. SCHULZ 3,182,916

ATOMIZING NOZZLE

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FIG.1

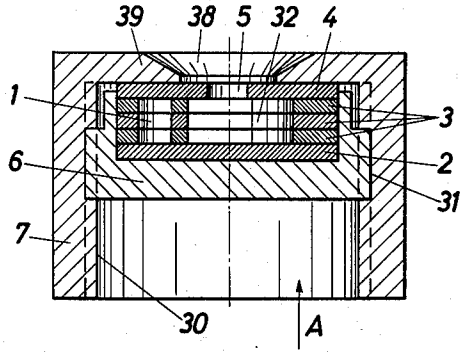


FIG.2

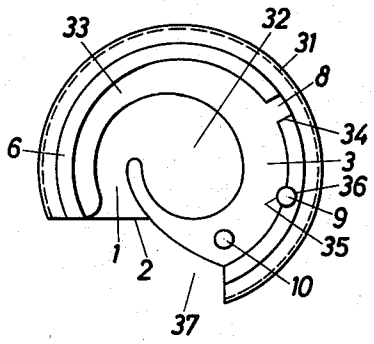


FIG.3

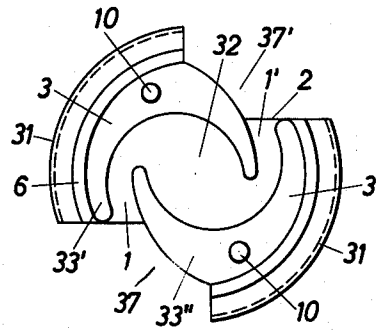


FIG.8

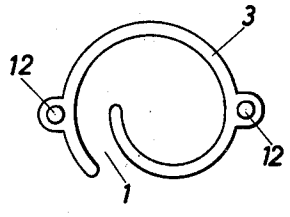


FIG.4

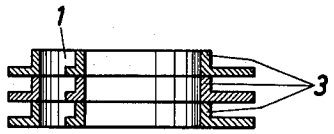


FIG.5

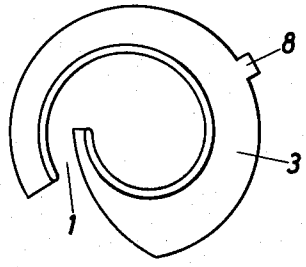


FIG.6

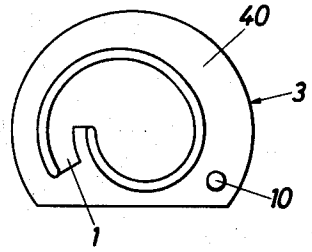
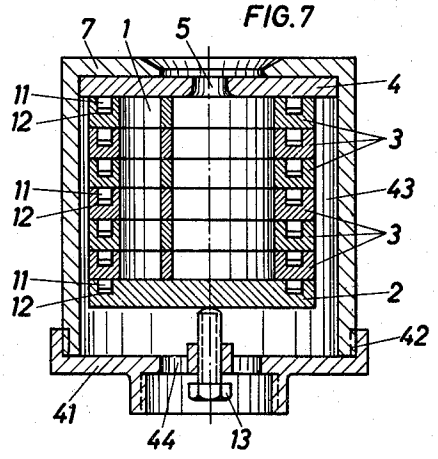


FIG.7



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ATOMIZING NOZZLE

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FIG. 9

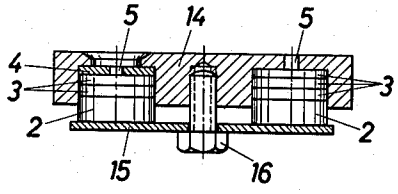


FIG. 10

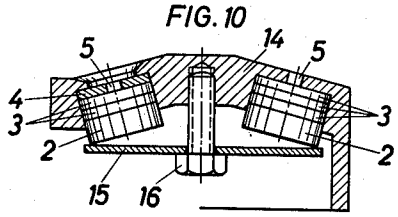


FIG. 11

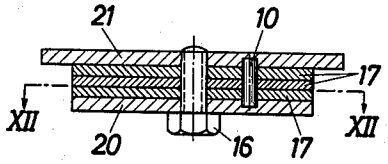


FIG. 12

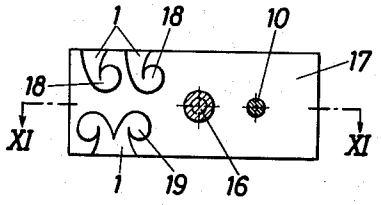


FIG. 13

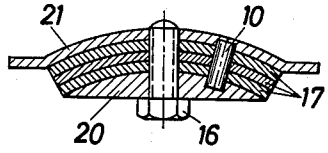


FIG. 14

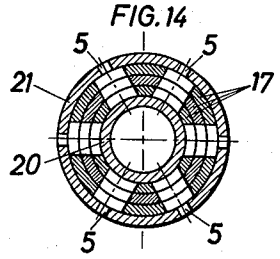


FIG. 15

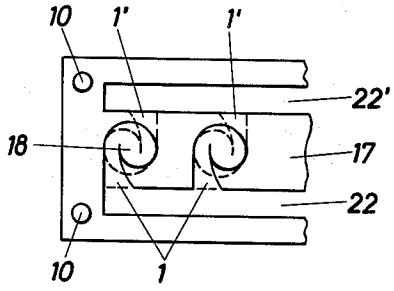


FIG. 16

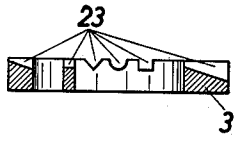


FIG. 17

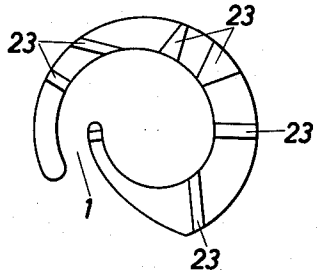


FIG. 18

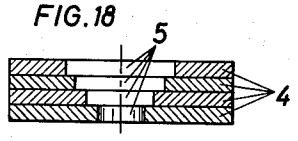


FIG. 19

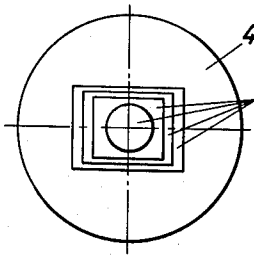
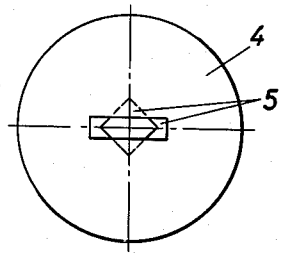


FIG. 20



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ATOMIZING NOZZLE

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FIG. 21

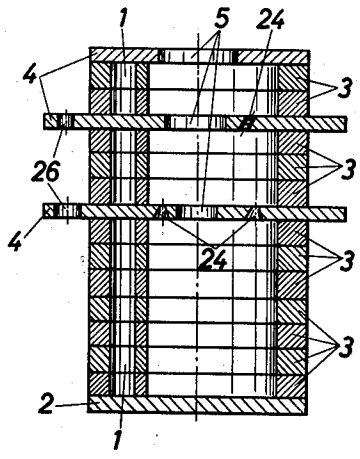


FIG. 22

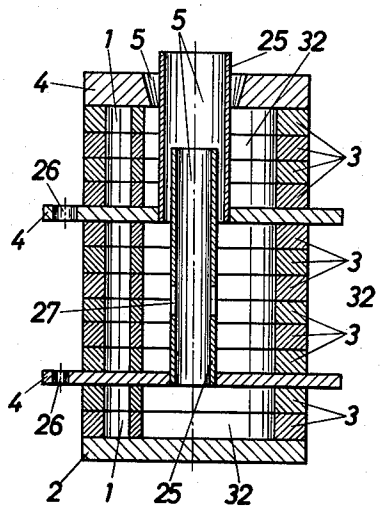


FIG. 23

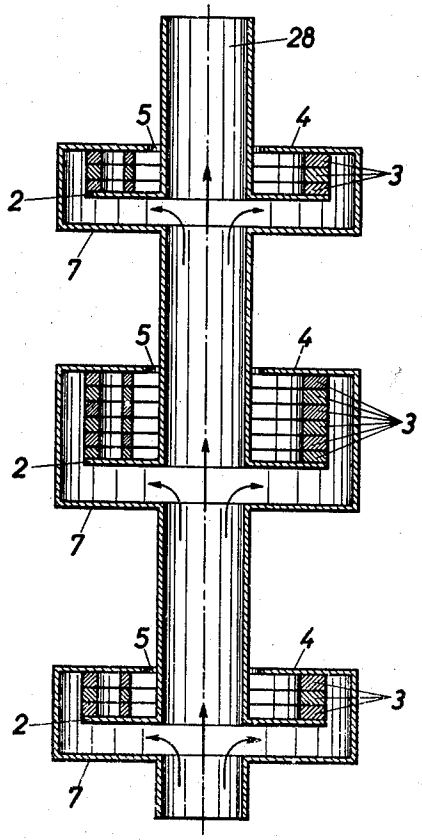
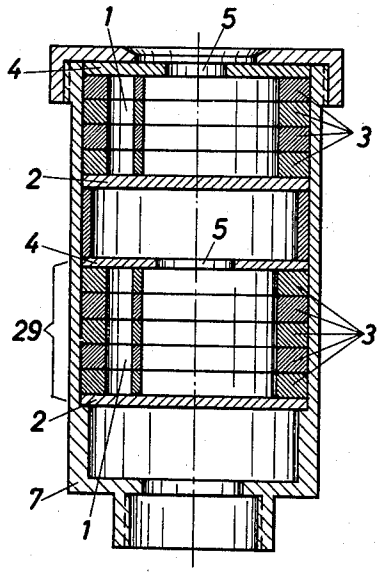


FIG. 24



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ATOMIZING NOZZLE

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FIG. 25

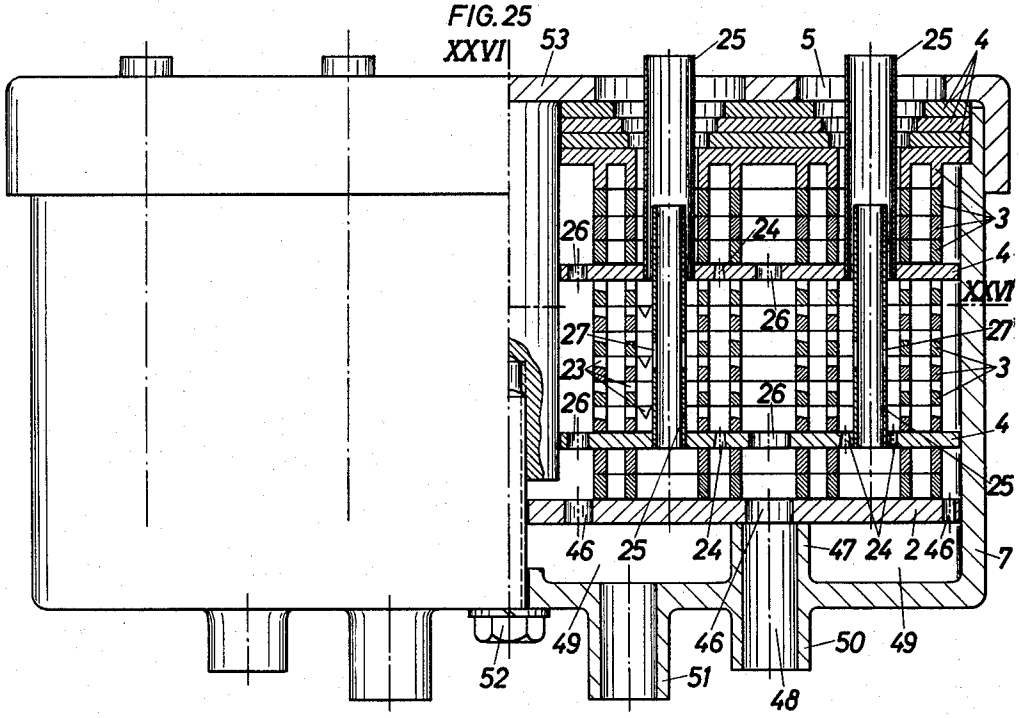
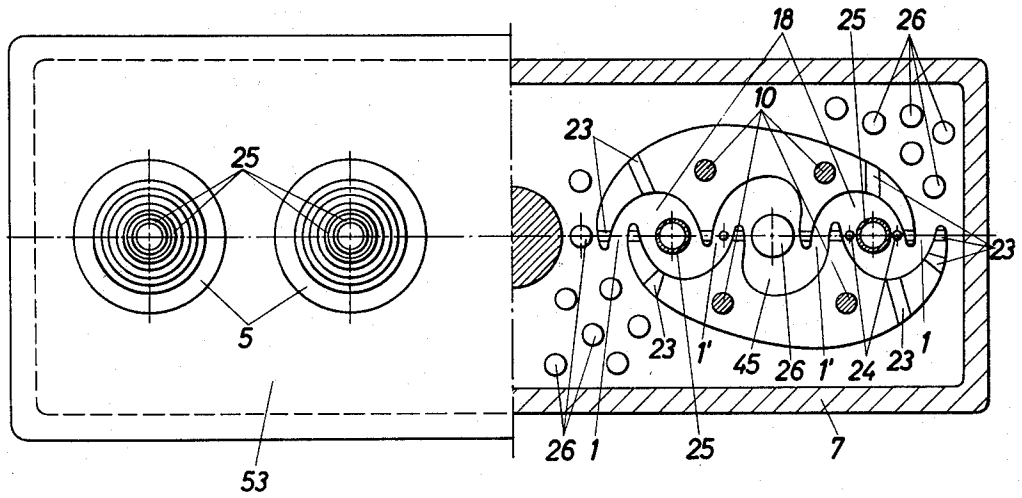


FIG. 26



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United States Patent Office 3,182,916 Patented May 11, 1965

3,182,916

ATOMIZING NOZZLE

Ferdinand Schulz, 5 Arsenal, Vienna, Austria

Filed June 27, 1963, Ser. No. 291,039
Claims priority, application Austria, June 29, 1962, A 5,213
9 Claims. (Cl. 239—468)

This invention relates to an atomizing nozzle having a swirl generator which has one or more inlets and is used, for instance, in fountains.

It is an essential feature of the invention to provide means which result in short friction paths and a small axial movement of the liquid in order to enable the utilization of a maximum portion of the energy supplied to the liquid for the atomization thereof so that a very fine atomization is achieved.

An important feature serving to fulfill this requirement resides in the provision of perfect conditions for the inflow of the liquid to the nozzle and of a high accuracy of the confining walls of the nozzle and of the position of the outlet opening relative to the nozzle chamber.

The manufacture of such "ideal" nozzles, however, is very difficult, particularly regarding the inside confining surface which is intended to produce a spray which is as nearly centrally symmetrical as possible when one or more inlets are provided. An important difficulty in this connection resides in the machining of the materials from which the nozzles are made.

It is an object of the invention to teach how an "ideal" nozzle for any forms of sprays and atomizing effects, as are desired, for instance, with fountains and liquid atomizers, can be made economically and to highest precision from any desired materials.

For this purpose, it is a feature of the invention that the swirl generator comprises a plurality of superimposed plates having the internal contour of the nozzle, and means for locating the plates relative to each other and the plates are clamped together to form a stack, which is supported at both ends by supporting members, and openings being provided for the flow of the liquid to be atomized to the swirl generator and for the outflow of the liquid to be atomized from the swirl generator.

Several illustrative embodiments of the atomizing nozzle according to the invention and the parts thereof are shown on the drawing. FIG. 1 is a sectional view showing an atomizing nozzle according to the invention. FIG. 2 is a top plan view showing a swirl generator having one inlet. FIG. 3 is another top plan view showing a swirl generator having two inlets. FIGS. 4 to 6 show swirl generators having an angle-shaped cross-section in sectional and top plan views. FIGS. 7 and 8 show another nozzle according to the invention assembled from individual plates, FIG. 7 being a sectional view showing the nozzle assembly and FIG. 8 a top view showing the swirl generator. FIGS. 9 to 14 show multiple nozzles, FIG. 9 illustrating a plane socket or nozzle plate, FIG. 10 showing inclined nozzles, FIG. 11 being a sectional view taken on line XI—XI of FIG. 12 and FIG. 12 a sectional view taken on line XII—XII of FIG. 11 showing a plane plate pack, FIG. 13 showing a plate pack forming a hollow body and FIG. 14 showing an annular plate pack. FIG. 15 shows a nozzle for two fluids. FIGS. 16 and 17, respectively, are a sectional view and a top plan view showing a swirl plate formed with grooves. FIGS. 18 to 20 show nozzle plate packs also in sectional and top plan views. FIGS. 21 and 22 are sectional views showing swirl chambers divided by nozzle plates, FIG. 21 showing nozzle plates without outlet extensions and FIG. 22 showing nozzle plates with such extensions. FIG. 23 is a sectional view showing a multiple nozzle having a central supply pipe. FIG. 24 is a sectional view showing an atomizing nozzle with a dirt separator. FIG. 25 is an axial longitudinal sectional view showing another embodiment of a multiple nozzle and FIG. 26 is a top plan view partly in a section taken on line XXVI—XXVI of FIG. 25.

The nozzle shown in FIG. 1 has a pot-shaped housing 7 having internal screw threads 30, which are in threaded engagement with the external screw threads 31 of a pot-shaped socket 6. For this purpose, a recess or slot, not shown, is provided on the outside of the bottom of the socket 6 and serves for receiving a wrench or handle, which serves for screwing the socket 6. The socket 6 has inserted in it a bottom plate 2, to which three plates 3 of the form shown in FIG. 2 or 3 are applied, which are covered by a nozzle plate 4 formed with an outlet opening 5. The plates 3 may be provided in any suitable number and are held together with the bottom plate 2 and the nozzle plate 4 to form a pack in the socket 6. Together with the bottom plate 2 and the nozzle plate 4, the plates 3 define the nozzle chamber 32, in which the fluid is atomized. The plates may have one inlet 1, as is shown in FIG. 2, or two inlets 1, 1', as is apparent from FIG. 3. For this purpose, the design shown in FIG. 2 is provided with a substantially spirally extending swirling sector 33 whereas the embodiment shown in FIG. 3 has two sectors 33', 33'' extending one into the other.

The plates or chamber elements 3 are relatively centered. For this purpose, they may be provided with a nose 8, which engages a corresponding longitudinal groove 34 in the socket 6. In addition to or instead of these noses 8, keys 9 may be provided, which are inserted into a groove defined by registering groove portions 35, 36 of the plates 3 and the socket 6. Another illustrated modification comprises pins 10, which extend through the plate pack inclusive of the bottom and nozzle plates and enter into the bottom of the socket 6. If the outlet opening 5 is concentric and circular, it need not be held against rotation relative to the nozzle chamber 32. The same applies to the bottom 2.

The fluid to be atomized flows into the housing 7 in the direction of the arrow A and through an opening 37 in the bottom of the socket 6 and of the bottom plate 2 and through the openings 37 and 37' in the design shown in FIG. 3 enters the chamber 32. The atomized fluid escapes through the outlet opening 5 and the adjoining opening 38 in the cover 39 of the housing 7.

All parts may be made from materials of any desired kind commercially available in plate form, such as sheet metal elements or plastic plates, preferably by stamping. The plates defining the nozzle chamber, inclusive of the bottom and nozzle plates, may be made from materials of particularly high grade. The socket and the housing may be made from lower-grade material.

Components which are subjected to wear by the abrasive action of the flow can easily be replaced at any time without need for replacing the socket or the housing. The bottom plate 2 and/or the nozzle plate 4 may be integral with the socket 6 or housing 7 respectively. For a control of the flow rate, the bottom may form a piston, which is preferably composed of a plurality of plates and which is slidable in the chamber.

Alternatively, all components may be made by pressing, drawing, casting or the like, as is enabled by the materials being used.

To save weight, the plates provided with one or more inlets 3 may have an angle-shaped cross-section (FIGS. 4 and 5). They may be made with a continuous rim 40 (FIG. 6) to increase the stability of the swirl generator. In this case, the plates 3 or the bottom and nozzle plates may be fixed in their relative position in the manner described hereinbefore. Another modification of the means for fixing the plates 3 in their relative position is shown in

FIGS. 7 and 8, in which each plate 3 has on its underside two diametrically opposed centering extensions 11, which extend each into a corresponding opening 12 formed on the upper side of the underlying plate 3. The centering relative to the nozzle plate 4 and the bottom plate 2 may be effected by analogous means.

In the present case, the plates 3 are held together with the bottom plate 2 and the nozzle plate 4 by a thrust screw 13, which is screwed into the bottom cover cap 41, which has a screw-threaded portion 42 in threaded engagement with the housing 7. A plurality of thrust screws may be provided rather than a single thrust screw. The pack consisting of the plates 3 and the bottom plate 2 is smaller in outside diameter than the inside space of the housing 7 so that the pack is surrounded by a clearance 43, through which the fluid to be atomized, which has entered the housing 7 through the bottom opening 44, can reach the inlets 1.

According to the invention, individual nozzles or swivel chambers may be combined in nozzle heads. For this purpose, the individual nozzles are accommodated in a socket plate 14 of any desired form. The bottoms 2 and with them the nozzles are clamped together by a common pressure plate 15 by means of one or more screws 16 (FIG. 9). Alternatively, each individual nozzle may be held down by a separate thrust screw held in the pressure plate. In all these embodiments, the nozzle openings may be formed in the socket plate itself, as is shown in the right-hand half of FIG. 9.

It is shown in FIG. 10 that the invention enables an inclination of the nozzles relative to the horizontal so that any desired nozzle head shapes and particularly large spray angles can be achieved. In this case, the housing may also constitute a nozzle plate, as is shown in the right-hand half of FIG. 10.

According to the same principles, a plurality of nozzles may be combined in one plate, in strips or the like (FIGS. 11 and 12), and a plurality of chambers may be made at the same time. Individual chambers 18 or double chambers 19 are formed in the plates 17. In the illustrative embodiment shown in FIGS. 11 and 12, the chamber pack is held together by a common bottom plate 20 and a common nozzle plate 21 with the aid of one or more screws 16 and is fixed by a centering pin 10 in its position relative to the bottom and nozzle plates. This entire nozzle pack is accommodated in known manner in a housing and is supported by this housing or a supporting plate, which may be provided, if desired.

The embodiments illustrated in FIGS. 13 and 14 show that the plates 17 may consist of hollow bodies or have an annular or polygonal configuration.

The nozzle design according to the invention may be used to advantage for mixing nozzle arrangements. An example of such an arrangement is shown in FIG. 15. The plates 17 are of rectangular shape. A plurality of openings 18 forming the nozzle chamber are arranged one beside the other and have an inlet 1, which communicates with a common supply duct 22. To enable the mixing and atomizing of two different fluids in the nozzle chamber, the latter must have two inlets, like the embodiment shown in FIG. 3. For this purpose, the plates 17 are stacked so that alternate inlets 1, 1' open in mutually opposite directions. Because the fluid to be atomized flows through the supply ducts 22 at right angles to the plane of the drawing, each plate must have two duct openings 22, 22' so that a continuous supply duct is obtained on both sides of the nozzle chamber regardless of the orientation of the plate 17. The fluids to be mixed, which may consist of liquids and/or gases, are fed through the supply ducts 22 to the mixing nozzle chambers. The desired mixing ratio can be obtained by the provision of different numbers of plates having different orientations.

An individual nozzle according to the invention having a plurality of inlets (such as shown in FIG. 3) may also be used for mixing a plurality of fluids if the various inlets are fed with the various fluids. As has been mentioned hereinbefore, the supply ducts 37, 37' may be formed in the plates 2 and 3.

In order to enable any desired form or nature of spray to be achieved, it is another feature of the invention to provide the plates 2, 3 and 4 with grooves 23, which may be formed by impressing or casting and which may have any desired direction and any desired cross-section, which may vary along the length of the grooves. These grooves serve for feeding a part of the liquid into the chamber, as is apparent from FIGS. 16 and 17. More particularly, different cross-sectional and longitudinal sectional shapes of the slots 23 are shown in FIG. 16. Different angular positions and top plan outlines of the grooves are shown in FIG. 17. In addition, the bottom plate may be provided with openings of any desired cross-sectional shape and any desired inclination.

The nature of the spray may alternatively be controlled by a nozzle plate 4 consisting of a pack of plates which have registering openings 5 of different shapes. This is illustrated in FIGS. 18 to 20. In the embodiment shown in FIGS. 18 and 19, the first nozzle plate has circular openings and the succeeding nozzle plates have rectangular openings of progressively increasing area. In the embodiment shown in FIG. 20, the last nozzle plate has a slot-shaped opening, which overlaps the underlying opening at two diametrically opposite corners to impart a special shape to the emerging spray.

The mounting of any desired outlet nozzles on the nozzle plate will also result in sprays of different shapes and in different atomizing effects.

Another possibility of controlling the shape of the spray is shown in FIGS. 21 and 22, in which the chamber consisting of identical or differently shaped plates 3 is divided in axial direction by one or more nozzle plates 4, which may have flow passage openings 24 of any desired shape in addition to the nozzle outlet 5. FIG. 21 shows the division of the chamber by simple nozzle plates. FIG. 22 shows the division by nozzle plates having tubular outlet extensions 25, which may be provided with peripheral openings 27 and/or diffusers. The lower outlet extension enters the upper one and for this reason is smaller in diameter than the latter. In this case, the nozzle outlet openings 5 consist only of the outlet openings of the extensions 25 and of the slot formed in the uppermost nozzle plate 4 and exposed around the outlet extension. To enable the feeding of corresponding rates of liquid to the various chambers, the invention teaches to provide throttle openings 26 in the bottom and in the nozzle plates extending as far as to the housing wall.

The feeding to the various nozzle chambers may alternatively be effected in all cases by supply ducts extending through a side wall of the housing 7 surrounding the swirl generator (not shown in FIGS. 21 and 22) and opening into the clearance space 43 (FIG. 7). It is obvious that the inlet openings in the bottom of the housing 7 will be eliminated in this design. Protruding nozzle plates 4 (FIG. 21), which extend as far as to the housing wall, may be made without throttle openings.

In the embodiment shown in FIG. 23, a plurality of nozzles are arranged one behind the other and are connected by a central supply pipe 28 for the fluid to be atomized. This fluid flows in the direction of the arrows shown in the drawing. A spray of the atomized fluid emerges from the annular slot 5 of each nozzle so that multiple sprays are obtained.

In order to prevent a change of the nature of the spray in the course of time as a result of an accumulation of foreign matter in the nozzles, the portion of the nozzle near the supply end may constitute a centrifugal dirt separator 29 so that the period of operation of the nozzles until servicing is required may be prolonged (FIG. 24).

In the embodiment shown in FIG. 25, a nozzle head of the type shown in FIG. 9 is provided with two swirl

generators. Like the plates **17** shown in FIG. 15, the plates **3** of these swirl generators have a plurality of openings **18**, in the present case two, which are formed with two inlets **1**, **1'** each, the inlets **1** opening outwardly and the inlets **1'** opening into a common supply duct **45**. The swirl generators are based on the same principle as the type shown in FIG. 22 and divided by intervening nozzle plates **4**. In the embodiment shown in FIGS. 18 and 19, the uppermost nozzle plate **4** consists of a plurality of plates. The other nozzle plates have additional openings **24** shown in FIG. 21. Besides, each intervening nozzle plate has an outlet extension **25** at the nozzle outlet opening of each chamber formed by the opening **18**. Just as in the embodiments shown in FIGS. 16 and 17, grooves **23** are formed in the plates **3** of the swirl generator. The bottom plate **2** is formed with openings **46**, which communicate partly with the supply ducts **45** and partly with the space feeding the inlets **1**. To feed in this case each group of inlets **1** and **1'** with another liquid, as has been explained with reference to FIG. 3, partitions are provided, which define chambers **48**, **49**, each of which is connected to a different supply conduit **50** or **51**. The plates **3** are held in their relative position by pins **10**. A screw **52** connects the cover **53** to the housing **7** and clamps the plates **3** together. The atomizing nozzle has the same mode of operation as the illustrative embodiments described hereinbefore.

If it is not necessary to take the nozzle apart, for instance, to facilitate the cleaning, it is within the scope of the invention to connect the plates to each other and, if desired, to the housing by a method known per se, for instance, by soldering, brazing, welding or adhering, to form a pressure-resisting and liquid-tight body.

To facilitate the fixing of a pack of plates which can be separated from each other to the bottom plate **2** or the nozzle plate **4**, the last plate **3** of the pack may be integral with the nozzle plate **4** or the bottom plate **2**.

What is claimed is:

1. A swirl generator for an atomizing nozzle comprising a plurality of thin superimposed plates each having opposite parallel surfaces and an edge formed as a curve to define part of a swirl chamber, the peripheral contours of said plates being congruent, means including supporting end members clamping said plates together with their parallel surfaces touching to form a stack and with said curved edges aligned to form a single swirl chamber, means for preventing relative angular dislocation of the plates in the stack with respect to each other, openings in said supporting end members for the flow of the liquid to be atomized to said swirl chamber and for the outflow of atomized liquid from the swirl chamber, and at least one liquid inlet extending over the full height of said stack and communicating laterally with said swirl chamber formed by the curved edges of said plates.

2. A swirl generator according to claim 1, wherein at least one of said plates at one end of said stack is integrally bonded to the confronting supporting end member.

3. A swirl generator according to claim 1, wherein one of said supporting end members constitutes a nozzle plate formed of a stack of plate-like elements, each of which has an outlet opening, said outlet openings having an increasing area in the direction of flow of the atomized fluid.

4. A swirl generator as set forth in claim 1 in combination with a tubular housing partially closed at one end, said stack of plates and end supporting members being seated against said partially closed end of the housing and said clamping means including at least one thrust screw extending substantially axially through the housing and against the other end of the stack.

5. A swirl generator according to claim 1, further comprising an additional and similar stack of plates to form at least a second swirl chamber axially aligned with the first swirl chamber.

6. A swirl generator as set forth in claim 5, wherein said second swirl chamber is separated from said first swirl chamber by a nozzle plate.

7. A swirl generator as set forth in claim 6, wherein at least one of the nozzle plates disposed between the swirl chambers is provided with a tubular outlet extension.

8. A swirl generator as set forth in claim 7, wherein said tubular outlet extension is formed with peripheral openings leading to one of said swirl chambers.

9. A swirl generator as set forth in claim 1, in combination with at least one other and similar swirl generator, all of said swirl generators being housed in a casing to form a plurality of nozzles combined in a multiple nozzle.

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