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Singh

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[54] **ATOMIZING APPARATUS FOR FINELY DISTRIBUTING A LIQUID IN AN AIR STREAM**

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[21] Appl. No.: **509,492**

Related U.S. Application Data

[63] Continuation of Ser. No. 352,542, April 19, 1973, abandoned.

[52] **U.S. Cl.** **239/400;** 239/404; 239/406; 239/430

[51] **Int. Cl.**[2] **B05B 7/00**

[58] **Field of Search** ..... 239/400, 403–406, 239/424.5, 425, 429, 430, 431, 433, 434, 434.5; 60/39.74 R

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Attorney, Agent, or Firm—Eric Y. Munson

[57] **ABSTRACT**

An apparatus is disclosed for efficiently atomizing and finely distributing a liquid in an air stream, for extracting maximum benefit from the liquid for the intended use, which may be for combustion as in jets and combustion chambers for gas turbines, or for moisturizing equipment, or for use in the chemical industry, for example, where the liquid will be suitable for the purpose intended, as for extraction of heat energy, or for mixing purposes, or the like.

7 Claims, 3 Drawing Figures

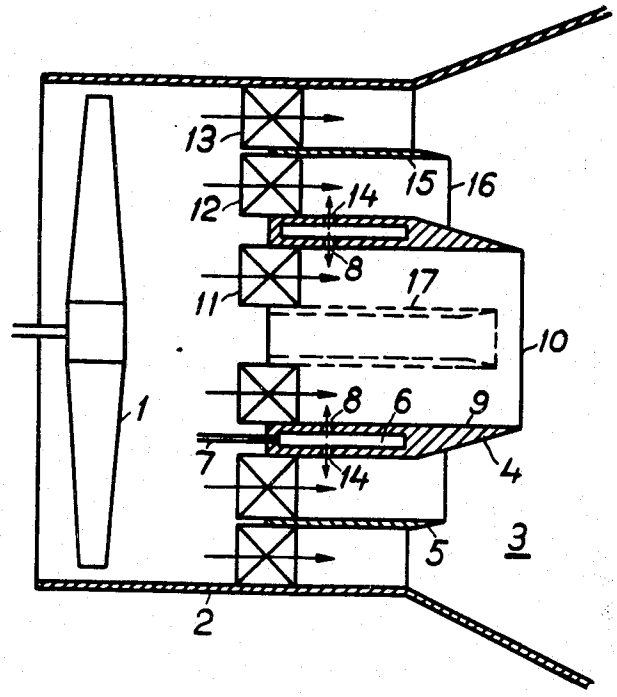
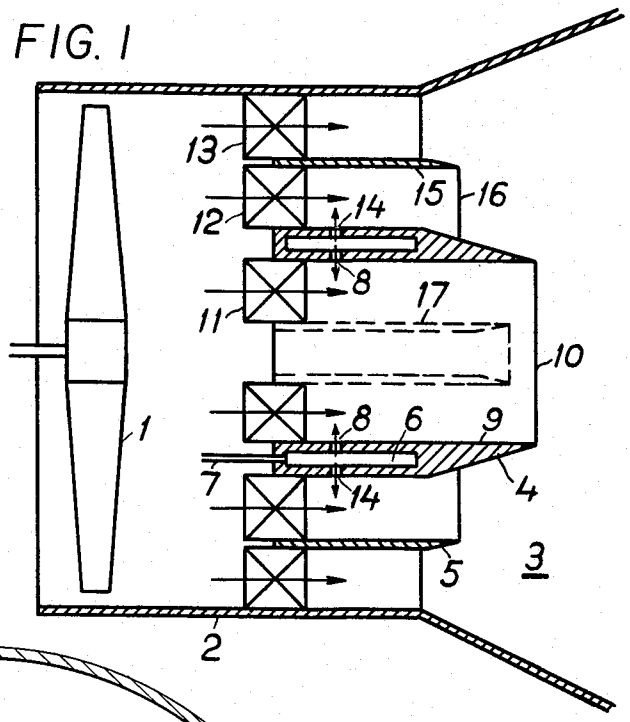


FIG. 1



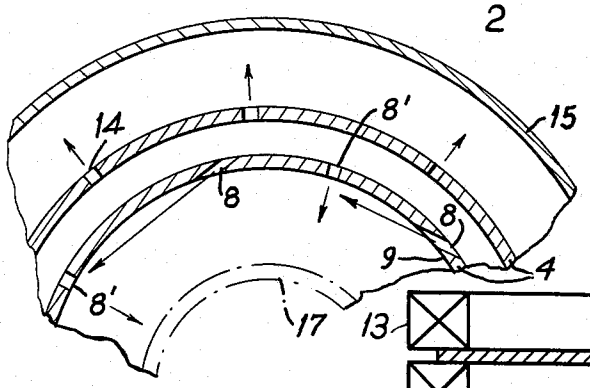


FIG. 3

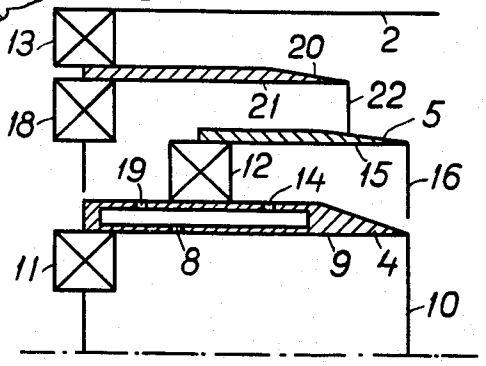


FIG. 2

ATOMIZING APPARATUS FOR FINELY DISTRIBUTING A LIQUID IN AN AIR STREAM

This is a continuation of application Ser. No. 352,542, filed Apr. 19, 1973, now abandoned.

BACKGROUND OF THE INVENTION

This invention is directed to an atomizing structure, which serves to provide a fine distribution of liquid for introduction into an air stream driven past the apparatus; which structure functions to provide a high degree of atomization of the liquid and consequent optimum mixing with the air stream. The apparatus embodies a primary or basic hollow cylinder with a hollow wall chamber for receiving a liquid, that passes through perforations in the inner wall of the chamber into thin layers onto the surface of the cylinder. The perforations are disposed in a direction as near as possible to the tangential to the inner surface of the cylinder, in order to embody sharp edges, that will tend to reduce the thickness of the liquid layer at those edges and will stimulate the formation of small droplets for maximum efficiency in mixing the liquid and air stream.

OBJECTS OF THE INVENTION

The primary object of this invention is to provide a fluid distributor, for use in and with a moving air stream, that will provide a highly effective and efficient atomization of the fluid for optimum and highly efficient mixing of the fluid in a finely divided state in the air stream.

Another object of the invention is to provide a fluid distributor that may be easily enlarged in sectional area dimensions to take care of treating air streams of increased dimensions.

Another object of the invention is to provide a liquid atomizing distributor, that is simple in construction and economical to manufacture.

A further object is to provide such a structure for atomizing and distributing a fluid into an air stream, that is highly efficient in establishing a good mixing action between the fluid and the air stream.

Another object of the invention is to provide a simple liquid distributor of simple construction, free of moving parts, and serving to achieve maximum atomization of liquid into an air stream, by creating a high degree of turbulence in the air stream, in such manner as to establish a high degree of wiping action of the air stream on the surfaces of the distributor by such turbulence, during the passage of the air stream past and through the liquid distributor.

SUMMARY OF THE INVENTION

This invention relates to an atomizing system for finely distributing a liquid in an air stream.

There are many applications where it is desired to atomize a combustible liquid in an air stream for optimum combustion and extraction of energy for many utilitarian purposes. Such a system is used, for example, in jets and combustion chambers for gas turbines, and in oil-fired boilers, and can also be used in drying equipment, or moisturizing equipment in the chemical industry, for example. In accordance with this invention, apparatus of the type disclosed herein is suitable to permit large quantities of air to be extracted to take up correspondingly large quantities of finely distributed atomized liquid.

In conventional apparatus for this atomizing purpose, generally one or more nozzles have been used to project a conical or annular jet of liquid out into the air stream. Atomization of the liquid is achieved by expressing liquid out through fine apertures or gaps in the nozzle, and the quantity of liquid that can be thus ejected from a nozzle is extremely limited. If larger quantities are required, the number of nozzles may be increased, but that is in itself a complication just as the individual nozzles are rather complicated.

The present invention uses considerably simpler basic components to permit liquid to be mixed into air streams of unlimited magnitude. The basic element according to the invention is a tubular surface, which may be cylindrical or conical, and which is disposed in the path of the air stream, i.e. parallel, coaxial or concentric with such path, so that the air stream flows over and sweeps the surfaces of the basic elements for maximum intermingling activity. The liquid is flowed out onto those surfaces and is even further distributed over those surfaces by the air stream, which is controlled to be turbulent to achieve maximum atomizing and mixing, after which the atomized liquid leaves the surfaces in the direction of the air stream in the form of a finely distributed veil at the edge of the surface, thereafter becoming mixed with the air stream. By arranging several such surfaces concentrically or coaxially with each other and the air stream, it is in principle possible to operate with air streams of any size, and, by varying the spacing between these surfaces, the desired concentration of liquid in the air stream can be obtained with maximum efficiency of the atomization.

The basic element is constructed as a hollow double-walled cylindrical, or conical, tubular ring, which serves as distributor of the liquid. A chamber is formed between the walls of that distributor, and is connected to the liquid supply, suitably via a pressure pump. Holes drilled through the inner wall of the ring, preferably almost tangential to the inner surface of the distributor, serve as passages through which liquid is laid out as a film on the inner surface.

By surrounding the first ring with an extra ring, the fine holes on the outside of the first ring direct a spray onto the second ring so an extra distribution surface is obtained for the liquid and, as will be seen in the following, it is possible to continue in this way, thus increasing the system to an arbitrary cross section, according to the dimension of the air stream desired.

The atomizer apparatus according to the invention is described in the following specification, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an atomizing distributor according to the invention; and

FIG. 2 shows how such a structure can be extended.

FIG. 3 is a fragmentary section of the distributor shown in FIG. 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 1 shows an atomizing apparatus according to the invention, for use in, for example, an oil burner for a gas turbine, or for a steam boiler. The air stream is produced by a compressor or fan 1 in the casing 2, and the air stream then continues through the atomizing device or distributor 3. The distributor consists here of a

basic cylindrical element **4**, and an extra cylinder ring **5** surrounding the inner cylindrical ring **4**.

The basic cylindrical element **4** consists of a ring which may be cylindrical, as shown, or it may converge forwardly to be conical. It is placed with its axis parallel to the air stream. The ring **4** is hollow and has an internal chamber **6** to which liquid is supplied through at least one tube **7**, for distribution into the air stream. The chamber walls are provided with drilled holes **8**, through which the liquid is sprayed out. These drilled holes are preferably directed obliquely, with respect to the radii of the ring. The obliquely drilled holes are disposed to be substantially tangential to the inner surface **9** of the ring. It is thus ensured that the liquid is distributed immediately over the inner surface **9** instead of streaming out solely freely into the centre of the ring, with the risk of larger drops being carried out into the air stream. It is intended, that the liquid shall be distributed in a fine thin layer over the surface **9** and glide down this surface in the direction of the air stream until it leaves the sharp edge **10** of the ring in a fine veil in the direction of the air stream. The sharp edges of the oblique holes **8** aid in thinning and breaking the thin layer of liquid.

The air stream is also controlled by guide vanes **11**, **12** and **13** which may be randomly disposed but for simplicity are disposed in concentric layers, so that suitable and controlled turbulence and eddy-formation is achieved in the air stream, to increase droplet formation and break-up by relative scrubbing action and movement against the wetted surfaces and hole edges. For the same purpose the ring **4** is bevelled at the outlet edge **10**, this being substantially knife-sharp. The inner and outer air streams from the guide vanes **11** and **12** are thus well mixed with each other and the liquid leaves the sharp edge **10** in the form of a uniform veil which is easily dispersed and distributed completely homogenously in the air stream.

Holes **14**, drilled through the outer chamber wall on the outside of the ring **4** guide liquid in spray against the inside surface **15** of the extra ring **5**. This ring **5** is also bevelled towards its front sharp edge **16**, thus ensuring satisfactory and uniform dispersal of the liquid veil from that edge also of ring **15**.

The surface **9** of inner ring **4** is designated as a primary distribution surface, whereas the surface **15** of ring **5** is designated as a secondary distribution surface. An extra secondary distribution surface **17** is indicated in broken lines, as formed by a tube inside the ring **4**, to show how additional distributing surface area may be provided, if desired. In that case, some of the holes **8** could be effectively directed towards the secondary surface **17**, while others are directed tangentially towards the primary surface **9**, as previously noted.

FIG. **2** shows how yet another secondary surface may be arranged. For the sake of simplicity FIG. **2** shows only one half of the atomizing device **3**. Between the outer ring **5** and the casing **2** is an additional ring **20**, the inner surface **21** of which is sprayed with liquid from holes **19** in the ring **4**. In order to make room for the holes **19**, the holes **14**, ring **5** and guide vanes **12** have been displaced to the right. An extra set of guide vanes **18** is shown provided for the ring **20**.

Where desired, instead of the ring **20**, or outside this, a second or additional hollow ring, like the basic inner ring **4**, may be arranged, having its liquid supply and perforated chamber walls as the inner and outer sides. It is possible in this way to continue with primary and secondary distributing surface areas increased indefinitely in principle, thus providing a device with working surface areas as large as the corresponding quantity of air desired.

The quantity of liquid which can be distributed is, for a given liquid having a certain viscosity, substantially determined by the length of the edges **10**, **16** and **22** of the rings **4**, **5** and **20**, respectively, since the thickness of the layer of liquid flowing off with a certain air speed is limited by the requirement of effective atomization. For a given quantity of air, a given quantity of liquid, i.e. concentration of liquid in the air, and a given flow crosssection, the number or rings and their diameter may be provided so that the desired mixing ratio can be achieved with desired atomization.

By providing an expansion chamber immediately beyond the atomizing region, increased homogeneity of the mixture is obtained.

The structure may be modified in dimension and arrangement without departing from the spirit and scope of the invention as defined in the claims, as for example, forming the main cylinder as a conical structure truncated at the front apex end.

What is claimed is:

1. Atomizing apparatus for finely distributing a liquid into an air stream, comprising:

a. at least one primary, cylindrical tubular structure defining an open ended passage and having its inner and outer surfaces exposed to the air stream, said tubular structure having a cylindrical inner surface and an outer surface having an upstream cylindrical part and a downstream conical part forming together with said inner surface a sharp downstream edge, said tubular structure embodying a hollow chamber between said inner and outer surfaces with perforations in the walls of said chamber, said perforations leading to the inner surface of the tubular structure, and serving to conduct liquid from said chamber onto said inner surface, and distributing said liquid onto said inner surface;

b. and means for propelling an air stream through said passage and along said tubular structure, to pick up and entrain minute liquid droplets at the downstream edge of said surface.

2. Atomizing apparatus as claimed in claim **1**, having at least one secondary tubular structure arranged coaxially with said primary tubular structure, said secondary structure also having a sharp downstream edge formed by a cylindrical surface facing said primary tubular structure and a conical surface part facing away from said primary tubular structure, further perforations in the wall of said primary structure arranged for directing jets of liquid onto the said cylindrical surface of the secondary structure.

3. Atomizing apparatus, as in claim **2**, including, further, means for introducing fluid into said hollow chamber to travel through said perforations.

4. Atomizing apparatus, as in claim **3**, in which said fluid introducing means include a pressure pump.

5. Atomizing apparatus, as in claim **3**, including, further,

means for creating turbulence in said air stream to increase the entraining activity of said air stream.

6. Atomizing apparatus, as in claim **5**, in which said turbulence means include guide vanes to modulate the directional flow of portions of said air

stream.

7. Atomizing apparatus, as in claim 3, in which said perforations are inclined to be closely tangential to said inner surface of said tubular structure.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,917,173 Dated November 4, 1975

Inventor(s) Ritindar Singh

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Application Priority Data

April 21, 1972 Sweden.....5252/1972

Signed and Sealed this

first Day of June 1976

[SEAL]

Attest:

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