June 13, 1961 H. COANDA 2,988,139

SPRAYING DEVICE

Filed April 30, 1957 2 Sheets-Sheet 1

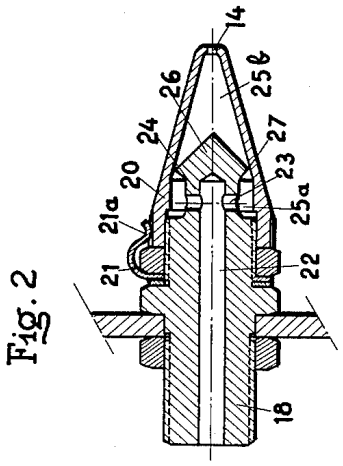

Fig. 2

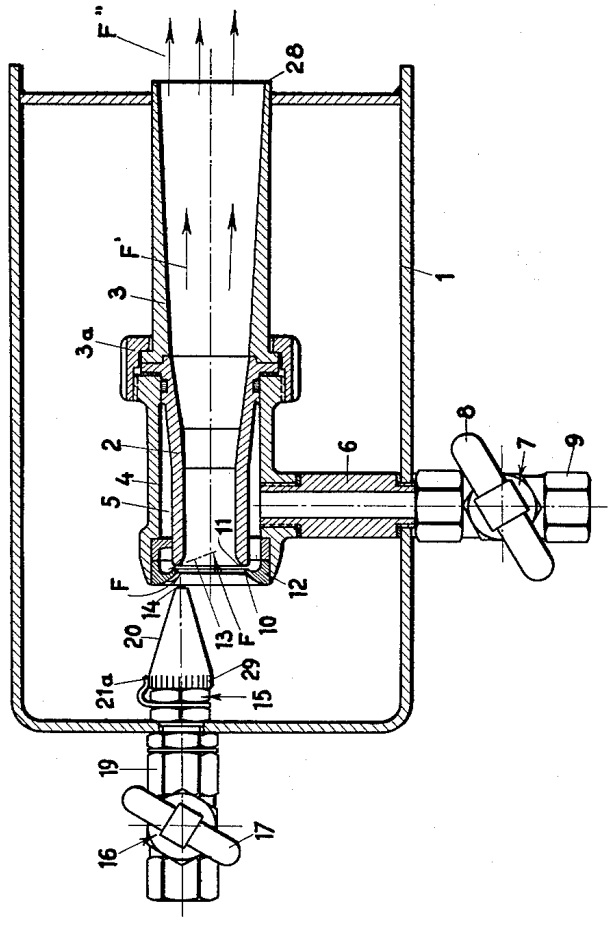

Fig. 1

June 13, 1961 H. COANDA 2,988,139

SPRAYING DEVICE

Filed April 30, 1957 2 Sheets-Sheet 2

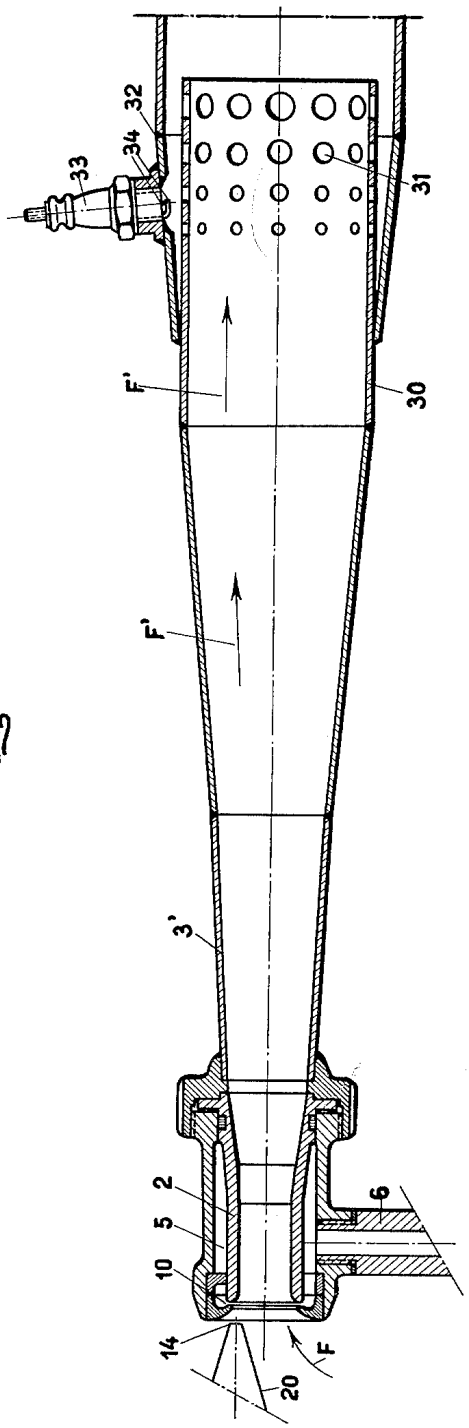

Fig. 3

United States Patent Office 2,988,139 Patented June 13, 1961

2,988,139

SPRAYING DEVICE

Henri Coanda, Paris, France, assignor to Sebac Nouvelle S.A., Lausanne, Switzerland, a corporation of Switzerland

Filed Apr. 30, 1957, Ser. No. 656,025
Claims priority, application France Nov. 14, 1956
3 Claims. (Cl. 158—28)

The present invention relates to an improved spraying device having many useful purposes; in particular, it enables the dust content of the atmosphere to be reduced, eliminates smoke and other particles in suspension, climatises air or produces a fine spray of a liquid fuel in a combustion supporting gas, etc.

In the U.S. Patent No. 2,720, 425 issued October 11, 1955, to Henri Coanda, there has been described a powdering and spraying device which enables a powder or an atomised liquid to be distributed by means of compressed air, through the use of a set of convergent-divergent nozzles of the Venturi type, each comprising an annular slot arranged so as to permit of the application of the physical phenomenon generally known as the "Coanda effect."

The Coanda effect described for example in U.S. Patent No. 2,052,869 issued September 1, 1936, to Henri Coanda, is produced when a mass of an elastic fluid, and in particular a gas, is discharged from a chamber in which it is present under pressure, through a slot. The slot has an extended lip which continually recedes, either in a continuously progressive or stepped manner, from the direction of emergence of the gas from the slot; due to the Coanda effect, the outlet gas creates a pressure drop and draws-in a supplementary mass of ambient fluid which is therefore set into motion.

In the case of a convergent-divergent discharge nozzle of the Venturi type provided in its convergent portion with an annular slot supplied with air under pressure, and the slot has an extended lip which continually recedes in a continuously progressive or stepped manner, from the direction of emergence of said compressed air from said slot (in a radial plane), as described and shown in the above-mentioned U.S. Patent No. 2,720,425 referred to above, the Coanda effect ensures the setting in motion of the fluid which is located on the upstream side of the convergent portion of the discharge nozzle. This supplementary fluid carries with it in Patent 2,720, 425 the fluid to be sprayed or the powder which is to be projected.

In the forms of embodiment described and shown in the Patent 2,720,425, two convergent-divergent annular discharge nozzles are arranged in series, each comprising in its convergent portion an annular slot, the first nozzle in the direction of flow of the fluids draws in the liquid or the powder to be distributed, made into a state of fine division by mechanical means, and its divergent portion is adapted to discharge into the convergent portion of the second discharge nozzle, from the divergent portion of which is discharged the jet of powder or liquid to be distributed.

The present invention relates to a spraying device of the same type than that which formed the object of Patent 2,720,425, but in the device according to the present invention, a single convergent-divergent discharge nozzle is provided, having an annular slot for the application of the Coanda effect, and formed in the convergent portion of this nozzle. The liquid to be sprayed is brought in through an injector or jet-nozzle in the immediate vicinity of the said slot, thereby ensuring by the application of the Coanda effect the setting in motion and carrying away of a supplementary quantity of ambient air and finely-divided liquid. An extremely intimate mixture of air and very finely-divided liquid is thus discharged through the divergent portion of the discharge-nozzle.

There can be thus sprayed or atomized, for the purpose of removing dust, either pure water or water containing a surface active or wetting liquid (as a quaternary ammonium compound, an aryl alkyl sulfonate, or sulfated alcohol etc.) which facilitates the precipitation of the dust, smoke or other particles in suspension in the air to be purified. There is obtained at the outlet of the divergent, an aerosol or an extremely fine mist containing very fine particles of liquid, which ensure an excellent precipitation of the various kinds of dust and smoke contained in the air. It is thus possible to reduce the content of harmful particles in the atmosphere of mines to an acceptable value.

It is in fact well-known that silicosis is a disease caused among miners by the absorption into the lungs of fine particles of silica caused by the boring of sterile rocks, during the excavation of tunnels through such rocks. These fine particles of silica give rise to lesions in the lungs of the miners and, in spite of the various methods applied to reduce the content of particles of silica in the atmosphere of underground workings, it has still not been possible to overcome this disease, due to the fineness of the silica particles, because all known methods remove only the more coarse particles.

Similar problems of dust removal are encountered in other industries, for example in certain chemical industries and in the cement industry.

The present invention provides a radical solution to the problem of dust removal in underground workings, work-shops, mines, etc., by enabling the dust content to be reduced to a very small value by means of the projection of very fine particles of liquid which ensure the precipitation of the dust without giving any trouble to the workmen or miners, the effective protection of whom is ensured against silicosis, and other similar occupational diseases.

It is another object of the present invention to enable the content of smoke to be reduced in work-shops of all kinds by precipitation of the smoke.

Tests carried out with the device according to the invention in the Bruay mine in France have proved that the device enables the content of particles in rock-mining workings to be reduced to a value less than the content of particles at the surface in the neighbouring town of Douai (France).

The device in accordance with the invention comprises essentially a convergent-divergent discharge-nozzle of the Venturi type, a chamber (preferably arranged around the discharge-nozzle) supplied with a gas under pressure such as compressed air, through a piping system. The gas under pressure is discharged from the chamber through an annular slot formed in the convergent portion of the discharge-nozzle, one lip of the mouth of the slot continually recedes (in a radial plane) from the outlet axis of the said slot (in said plane). An injector supplied with liquid to be distributed is located so as to discharge in the immediate vicinity of the said slot. The liquid is drawn-in with a mass of supplementary air in said convergent portion by the air under pressure passing out of the slot, while the mixture of air and very finely-divided particles of liquid in the discharge nozzle is discharged from the extremity of said nozzle.

The spraying device in accordance with the invention may also be applied to other uses. It can be employed to produce air-conditioning.

It is also an object of the invention to provide a spraying device producing an atomisation of a fuel with a view to ensuring an excellent combustion, and in this case an ignition device is provided at the extremity of the divergent portion, consisting, for example of an electric spark

plug of the kind used in internal combustion engines, with a view to ensuring the ignition of the carburetted mixture passing out of this divergent.

Other objects and advantages of the invention will appear to those skilled in the art from the following detailed description.

There will now be described, by way of illustration of the possibilities of the application of the invention, two forms of embodiment given by way of example without implied limitation, and shown in the accompanying diagrammatic drawings, in which:

FIG. 1 shows in elevation, partly in section, a spraying device in accordance with the invention.

FIG. 2 is an enlarged horizontal section of the liquid injector of the device shown in FIG. 1, and

FIG. 3 is a longitudinal section of a burner embodying the invention.

A spraying device for mines in accordance with the invention comprises essentially: an open casing **1** in which is arranged a convergent-divergent discharge-nozzle **2** extended by a divergent portion **3**. Around the discharge-nozzle **2**, a casing **4** is fixed by a nut **3***a* so as to surround the discharge-nozzle **2** by an annular chamber **5**, which is supplied with compressed air through a piping system **6** (screwed into the casing **4**) on which is screwed a coupling **7** terminated by a valve **8**, the coupling **7** receiving the compressed air from a supply tube (not shown) which is screwed into the internally threaded end **9**.

The chamber **5** discharges into the interior of the discharge nozzle **2** through an annular slot **10** formed between the upstream extremity **11** of the discharge-nozzle **2** and a member **12** which forms the front portion of the convergent-divergent unit **12**, **2**, **3** and being arranged in the front portion of the casing **4**, said member **12** being screwed inside the front portion of casing **4**. By construction, the extremity **11** is such that it forms an extended lip of the slot **10** which continually recedes from the outlet direction **13** (in broken lines) of the slot **10**, in the plane of FIG. 1.

In the immediate vicinity of the slot **10** is arranged the end orifice **14** of an injector **15** which receives liquid to be sprayed from a conduit system (not shown) through the intermediary of a coupling **16** provided with a valve **17**.

The injector **15**, which is shown to a larger scale and in a longitudinal section in FIG. 2, comprises a threaded tube **18** on which is screwed, on the one hand, the threaded end **19** of the coupling (see FIG. 1), and, on the other hand, a conical hood **20** in which is formed the end orifice **14**. A clip **21** is provided to retain the hood **20** in its correct position, as explained below.

The bore **22** of the tube **18** communicates by means of holes **23** formed in the reduced end portion **24** of this tube, with a chamber **25***a* which is provided between the hood **20** and the tube **18**. The end of the tube **18** has, in longitudinal section, the shape of an arrow-head **26** so as to form a peripheral narrowed portion or slot at **27** between the chamber **25***a* and a chamber **25***b*. The thickness of the peripheral narrowed portion can be varied by screwing-in or out the hood **20**.

The operation of the device shown in FIGS. 1 and 2 is as follows:

By opening the valves **8** and **17**, the chamber **5** is supplied with compressed air and liquid is supplied to the bore **22**. The compressed air is discharged from the chamber **5** through the slot **10** and creates a pressure drop or reduced pressure in the vicinity of the slot, due to the above-mentioned Coanda effect, which results in a suction of fluid in the vicinity of the slot. There is produced in consequence a movement of air inside the casing **1** in the direction of the arrows F and of liquid through the hole **14**.

The liquid entering through the bore **22** passes through the holes **23** and is discharged through the adjustable slot **27** into the chamber **25***b* from which it passes out at **14**. The particles of liquid passing out through the hole **14** are carried away with the air arriving in the direction of the arrows F into the interior of the discharge nozzle **2** and of the extension **3**. There is thus produced a fine atomization of liquid in the air (arrow F'). Finally, an extremely fine mist and/or an aerosol is discharged in the direction of the arrows F'' at the extremity **28** of the extension **3** which passes into the free air.

The means of regulation are as follows: action on the valve **8** to regulate the rate of flow of compressed air; controlling the relative position of the members **12** and **2** by screwing or unscrewing the member **12** in the casing **4** thereby varying the width of the slot **10**; regulation by the valve **17** to regulate the admission of liquid; action on the hood **20** to vary the slot **27**, the extremity **21***a* of the clip **21** passing into one of the reference marks formed on the periphery of the hood **20**.

The burner shown in FIG. 3 comprises an atomisation or spraying portion identical with that shown in FIGS. 1 and 2, and the same reference numbers have been applied in FIG. 3 to the corresponding elements shown in FIGS. 1 and 2.

In FIG. 3, only the end of the hood of the injector can be seen, the injector is identical with that shown in FIG. 2. The convergent-divergent discharge-nozzle **2** is extended by a divergent portion **3'** which is longer than the portion **3** of FIG. 1, and is extended in its turn by a substantially cylindrical portion **30**, in which there has been formed a series of orifices **31** which preferably have increasing diameters in the direction of flow of the fluids according to arrows F'. The portion **30** is surrounded by a casing **32** provided with at least one spark plug **33** of the type used in internal combustion engines, and producing between its electrodes **34** at the level of the holes **31**, a spark which ignites the carburetted mixture F' which passes through the holes **31**.

The adjustment of the burner is effected by means of the regulating elements described above in connection with the spraying device of FIGS. 1 and 2; regulation of the admission of air by the valve which controls this flow in the conduit **6**; adjustment of the width of the slot **10** through which the chamber **5** discharges into the convergent of the discharge-nozzle **2**; regulation of the quantity of liquid fuel arriving through the hole **14** by means of the liquid control admission valve and the screwing in or out of the hood **20**.

It will of course be understood to those skilled in the art that various improvements may be made to the forms of construction above described and shown together with modifications or additions, or replacement of certain members by corresponding members, without thereby departing from the scope of the present invention as determined by the appended claims.

What I claim is:

1. A burner comprising in combination, a venturi nozzle having an inlet end, a convergent portion, a divergent portion downstream of the convergent portion and a discharge end, means defining a chamber provided with a circular slot opening into the convergent portion of said venturi nozzle in the vicinity of the inlet end, means for delivering gas under pressure into said chamber to cause it to flow out of said slot, said slot having in an axial section through said nozzle an extended lip which continually recedes from the direction of emergence of said compressed gas through said circular slot, an atomizer-injector nozzle cooperative with the venturi nozzle spaced axially from the venturi nozzle and disposed eccentric to a longitudinal axis of said venturi nozzle and parallel to said axis for discharging a combustible fluid into the inlet end of said venturi nozzle in the immediate vicinity of the circular slot, said venturi nozzle having a plurality of peripheral axially spaced apertures of different areas forming orifices of different sizes in the vicinity of said discharge end, means providing a chamber around the nozzle orifices forming a burner therewith, and ignition means in said chamber for igniting a combustible fluid

discharged from the atomizer-injector nozzle, and means to supply a combustible liquid under pressure to said atomizer-injector nozzle, whereby said generator is usable as a burner.

2. An aerosol generator comprising in combination, a venturi nozzle having an inlet end, a convergent portion, a divergent portion downstream of the convergent portion and a discharge end, means defining a chamber provided with a circular slot opening into the convergent portion of said venturi nozzle in the vicinity of the inlet end, means for delivering gas under pressure into said chamber to cause it to flow out of said slot, said slot having in an axial section through said nozzle an extended lip which continually recedes from the direction of emergence of said compressed gas through said circular slot, an atomizer-injector nozzle cooperative with the venturi nozzle spaced axially from the venturi nozzle and disposed eccentric to a longitudinal axis of said venturi nozzle and parallel to said axis for discharging a finely divided liquid into the inlet end of said venturi nozzle in the immediate vicnity of the circular slot, said atomizer-injector nozzle comprising a minute discharge orifice positioned to discharge in the immediate vicinity of a limited portion of said slot, and means to supply a liquid under pressure to said atomizer-injector nozzle.

3. An aerosol generator comprising in combination, a venturi nozzle having an inlet end, a convergent portion, a divergent portion downstream of the convergent portion and a discharge end, means defining a chamber provided with a circular slot opening into the convergent portion of said venturi nozzle in the vicinity of the inlet end, means for delivering gas under pressure into said chamber to cause it to flow out of said slot, said slot having in an axial section through said nozzle an extended lip which continually recedes from the direction

of emergence of said compressed gas through said circular slot, an atomizer-injector nozzle cooperative with said venturi nozzle spaced axially from the venturi nozzle and disposed eccentric to a longitudinal axis of said venturi nozzle and parallel to said axis for discharging into the inlet end of said venturi nozzle in the immediate vicinity of the circular slot, said atomizer-injector nozzle being disposed eccentric to a point corresponding to a center for said slot, and means to supply a liquid under pressure to said atomizer-injector nozzle.

References Cited in the file of this patent

UNITED STATES PATENTS

588,227	Kikow	Aug. 17, 1897
1,261,282	Peabody	Apr. 2, 1918
1,481,597	Forster	Jan. 22, 1924
1,770,011	Poston	July 8, 1930
1,774,953	Titmas	Sept. 2, 1930
2,143,259	Clarkson	Jan. 10, 1939
2,185,369	Bowen	Jan. 2, 1940
2,497,939	Garraway	Feb. 21, 1950
2,504,320	Gamble	Apr. 18, 1950
2,595,999	Way et al.	May 6, 1952
2,664,702	Lloyd et al.	Jan. 5, 1954
2,713,510	Coanda	July 19, 1955
2,720,425	Coanda	Oct. 11, 1955
2,745,250	Johnson	May 15, 1956
2,753,925	Campbell	July 10, 1956
2,757,723	Schlitt	Aug. 7, 1956
2,763,321	Schuster	Sept. 18, 1956

FOREIGN PATENTS

508,729	France	Oct. 21, 1920