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[54] **INSTALLATION FOR DETONATION WORKING OF MATERIALS**

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[51] **Int. Cl.** **B05b 1/24,** B05b 17/00

[58] **Field of Search** 239/79, 80, 81, 85

[56] **References Cited**

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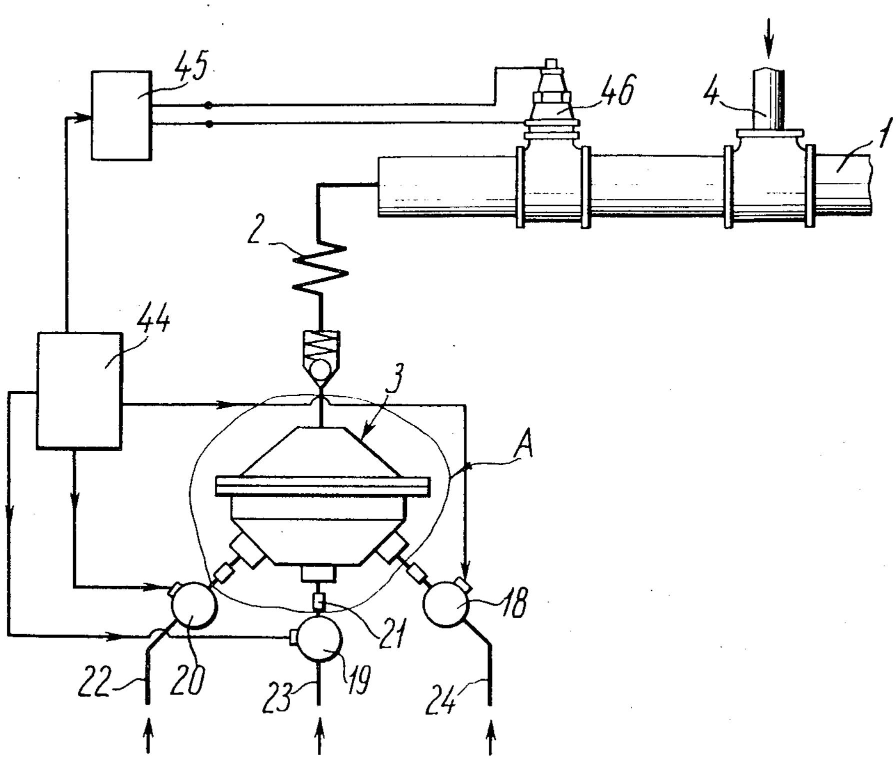
[57] **ABSTRACT**

An installation for detonation working of materials comprising a working chamber communicating with a metering device supplying the material to be treated and with a mixing chamber which prepares the explosive mixture.

The mixing chamber is provided with a lateral partition in which nozzles are installed which improve mixing of the explosive mixture components.

4 Claims, 3 Drawing Figures



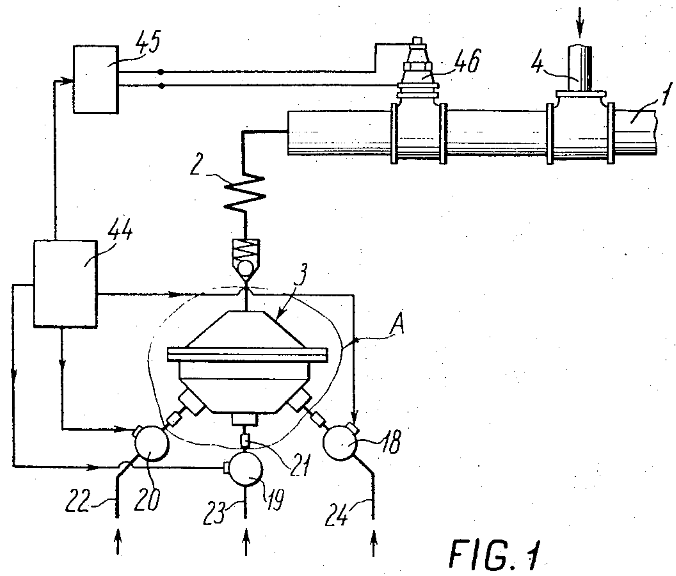

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FIG. 1

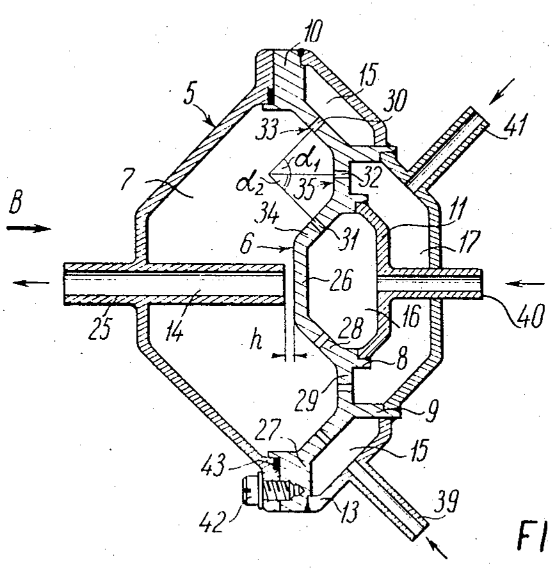
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FIG. 2

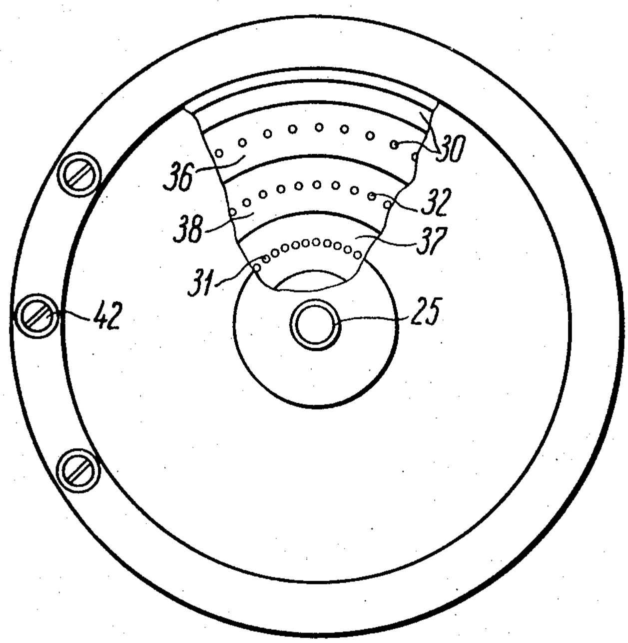

FIG. 3

INSTALLATION FOR DETONATION WORKING OF MATERIALS

The present invention relates to devices which utilize the effect of detonation in real gases for working of materials according to which, if an elongated tube closed at one end is filled with an explosive mixture capable of exothermic reaction and said mixture is ignited at the closed end of the tube by means of, say, an electric spark, the flame front will propagate at an ever-increasing speed until a detonation wave appears at a certain distance from the point of ignition.

Such a wave has constant high pressure and temperature and propagates with a constant and maximum possible speed for the given explosive and given conditions, said speed reaching approximately 2–4 km/s.

This effect has been used widely for stamping large articles, descaling metals after heat treatment, for spheroidizing particles of friable powders of various materials both high- and low-melting as well as in installations for detonation working of materials.

The present invention can be used most successfully for the application of inorganic coatings such as carbides of tungsten, titanium, boron, molybdenum, zirconium, tantalum and various oxides of these metals and alloys applied to metallic and non-metallic materials.

Known in the art are devices utilizing the effect of detonation in real gases for the application of high-melting, corrosionproof and heat-resistant coatings to the metallic and non-metallic materials (see, for example, U.S. Pat. No. 2714563).

These devices comprise a working chamber for treating the material, made in the form of a cylindrical calibrated tube closed at one end and having a certain length and diameter sufficient for the initiation of a detonation wave, a device for delivering the powder to be sprayed (metering device) and a mixing chamber where the components of the explosive mixture are mixed together.

The mixing chamber has valves for the delivery of the components of the combustible mixture, i.e., of a fuel gas and oxidizer and another valve for the admission of a scavenging gas. All these valves are linked kinematically with the camshaft of the electric control drive.

The rotating camshaft opens the valves in a definite sequence, admitting the components of the combustible mixture into the mixing chamber. The combustible mixture prepared in this chamber enters the working chamber simultaneously with the spraying powder. After a certain portion of the mixture has been admitted the valves close and the mixing chamber is filled with the scavenging gas (nitrogen) after which the combustible mixture is ignited. The detonation of the mixture creates high pressure and temperature in the working chamber, accompanied by violent liberation of gaseous products. The products of explosion, strongly compressed at the moment of detonation, serve as physical agents whose conversion causes an instantaneous transition of the potential energy of the explosive mixture into the kinetic energy of the moving gases. This energy is transmitted to the particles of the spraying powder suspended in the flow of gases; as a result, these particles are heated, accelerated and, flying out of the working chamber tube, form a coating on the surface of a part.

Practical employment of such installations has shown that the composition of the explosive mixture throughout the tube of the working chamber is not constant.

It is a general opinion that the explosive mixture in such installations contains 49.5 percent of oxygen; however, experiments have proved that the oxygen content along the tube varies from 42 to 56 percent.

It is commonly known that the velocity of the detonation wave depends on the percentage of fuel and oxidizer in the mixture. Prevalence of one of the components exerts a corresponding influence both on the velocity of the detonation wave and on the spraying powder, thereby influencing the quality of the produced coatings.

There have been attempts to change the time of opening and closing of the fuel and oxidizer valves in order to ensure a constant stoichiometric composition of the combustible mixture; however, owing to different viscosities of the mixture components these attempts have mostly been a failure.

Apart from changing the valve opening and closing time some designers used separators or chambers filled with steel balls.

However, in the course of operation it has become evident that the use of steel balls in these installations fails to ensure a sufficiently uniform percentage of the mixture components along the tube, increases the hydraulic losses of the flow and thus influences the dimensions of the installation because the considerations of safety demand that the fuel (in this case acetylene) should not be supplied at pressures exceeding 1.5 kgf/cm^2.

Another common disadvantage of all the known installations lies in that they have practially no provision for adjusting the ignition moment and the volume of the fuel, oxider and neutral gas portions owing to a rigid linkage between the camshaft and the valve discs. Changing the ignition moment and the size of the mixture portion calls for replacing the camshaft and the profile of its cams.

Still another disadvantage of such installations lies in insufficient reliability due to a large number of mechanical elements.

Besides, the inertness oh the drive and a large number of intermediate friction pairs affect adversely the accuracy and quality of the coatings.

An object of the present invention resides in providing an installation for detonation working of materials with such a mixing chamber which would ensure preparation of a homogeneous mixture from the components of fuel, oxider and neutral gas and the possibility of controlling both the volume of the component portions and that of the already prepared mixture entering the working chamber.

Another object of the invention is to provide a possibility for a quick change of the programs for the application of coatings of various materials under various conditions of application, and a maximum versatility of the installation and simplicity of its readjustment to different working conditions for the use of various materials.

These and other objects are achieved by providing an installation for detonation working of materials comprising a working chamber communicating with a metering device supplying it with the treated material and with a mixing chamber wherein the explosive mixture is prepared.

According to the invention, the mixing chamber has a lateral partition dividing it into a discharge space connected with the sources of explosive mixture components and a space for mixing these components, said space being located at the outlet hole of the mixing chamber and communicating with the discharge space through nozzles installed in the lateral portion.

Such a solution promotes mixing of different components while the use of nozzles widens the possibility of selecting the explosive components, including liquid ones.

It is practicable that the nozzles should be arranged in concentric rows coaxially with the outlet hole of the mixing chamber and that the discharge space should be provided with concentric partitions between these rows of nozzles, said partitions dividing said space into closed circular spaces, each connected with the source of one of the explosive mixture components.

This provides for the control of both the individual percentage of each explosive component and the volume of the portion entering the working chamber.

The installation can utilize spray nozzles whose axes in each row are set at the same angle to the axis of the outlet hole of the mixing chamber, said angle ensuring the intersection of the jets of all the explosive mixture components.

As a result of such an arrangement it has become possible, without resorting to any other additional means, to produce a homogeneous mixture which, eventually, is a vital factor influencing the initiation, formation and propagation of a stationary detonation wave and, as a consequence, ensuring a high-quality and homogeneous coating.

The lateral partition can be made in the form of a disc provided in the middle with a projection in the shape of a truncated cone directed towards the outlet hole of the mixing chamber while on the periphery said disc has an inverted truncated cone whose walls are provided with calibrated through holes used in the capacity of spray nozzles.

Now the invention will be described in detail by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a schematic general view of the installation for detonation spraying of coatings;

FIG. 2 is fragment A in FIG. 1, longitudinal section;

FIG. 3 is a view along arrow B in FIG. 2.

The installation is designed for detonation spraying of protective coatings.

The installation according to the invention comprises a working chamber 1 (FIG.1) in the form of an elongated calibrated cylindrical tube closed at one end, and having a certain length and diameter which are sufficient for the initiation and propagation of a detonation wave in said tube. The chamber 1 is communicated with a mixing chamber 3 through a coil 2 with a non-return valve. A metering device 4 installed on the working chamber 1 supplies accurately metered portions of the powdered coating.

The mixing chamber 3 has an airtight body 5 (FIG.2) with a lateral partition 6 inside, said partition dividing the mixing chamber 3 into a mixing space 7 and a discharge space which, in its turn, is divided by three concentric partitions 8, 9 and 10 and circular covers 11, 12 and 13 of the body 5, which are coaxial with the axis of the outlet hole 14 of the mixing chamber 1, into three circular discharge spaces 15, 16 and 17.

Each of these spaces 15, 16 and 17 is communicated by respective electromagnetic valves 18, 19 and 20 (FIG.1), a filter 21 and a respective pipe 22, 23 and 24 with the source (not shown) of one of the components of the explosive mixture.

The mixing space 7 of the chamber 3 communicates with the inlet of the working chamber 1 through an outlet opening 14 in the pipe connection 25 of the body 5, the inner end of said pipe connection being set at a distance "h" from the front face of the partition 6, said distance ensuring a maximum rate of flow through the outlet hole 14 of the mixing chamber 3.

The lateral partition 6 is made in the form of a disc whose central part has a projection 26 in the form of a truncated cone directed towards the outlet hole 14 of the chamber 3 while on the periphery it has an inverted truncated cone whose walls 27, 28 and 29 have calibrated through holes used as spray nozzles 30, 31 and 32 whose outlet orifices 33, 34 and 35 are directed towards the mixing space 7.

The nozzles 30, 31 and 32 are arranged in concentric rows 36, 37 and 38 (FIG.3) coaxially with the outlet hole of the mixing chamber 3, each row 36, 37 and 38 of the nozzles being supplied from the respective circular spaces 15, 16 and 17 which are in communication through pipe connections 39, 40 and 41 with the source of the respective mixture component.

In the given installation the discharge space 15 communicates with the source of oxidizer (oxygen), the discharge space 16 is supplied with fuel (acetylene) and the discharge space 17, with neutral gas (nitrogen).

The axes of the nozzles 30, 31 and 32 of each concentric row 36, 37 and 38 are directed at the same angle α_1, α_2 and α_3 respectively, which ensures intersection of the jets of all the explosive mixture components (in this case $\alpha_3 = 0$).

The body 5 of the chamber 3 is removable to ensure free access to the nozzles for inspection and is held by screws 42 to the partition 6. The tightness of the joint is ensured by a sealing ring 43 located in a circular groove.

In addition to the above-mentioned operating elements the installation comprises an electronic control unit 44 (FIG.1) a H.T. pulse generator 45 and a spark plug 46 for igniting the emplosive mixture.

Operation of the installation for detonation spraying of protective coatings on metals and non-metallic materials consists in the following:

In accordance with the control cyclogram the unit 44 sends strictly coded pulses (their direction is shown by arrows in FIG.1) to the electromagnetic control valves 18, 19 and 20.

The control unit 44 also sends a signal to the H.T. pulse generator 45 which sends a pulse to the spark plug 46 for igniting the explosive mixture in the working chamber 1.

The operational cycle of the detonation installation consists in the following.

Initially, the electromagnetic valves 18, 19 and 20 (for oxidizer, fuel and neutral gas) are opened; the neutral gas valve 20 may be either "Open" or "Closed" depending on the required percentage of the explosive mixture components.

By adding different portions of neutral gas to the explosive mixture through the valve 20 it is possible to regulate within wide limits the temperature, pressure and velocity of the detonation wave and thus to select quickly the required operating conditions of the installation for the different materials of the coating.

Besides, on operator's decision it is possible to supply oxidizer into the discharge spaces **15, 16** simultaneously with the supply of fuel into the space **17** or vice versa depending on the viscosity of the supplied components, thereby ensuring homogeneity of the explosive mixture.

The last-mentioned factor becomes particularly important if one of the explosive components is liquid.

In this case the neutral gas is supplied from a separate electromagnetic valve (not shown in the drawing). In such a case all the valves are controlled from one and the same control unit **44.**

On opening the electromagnetic valves **18, 19** the oxidizer and fuel flow through pipe connections **39, 40** into the discharge spaces **15, 16,** the nominal bore and length of these pipe connections **39** and **40** between the valves **18, 19** and discharge spaces **15, 16** being selected so as to ensure an identical resistance to the flow. This is highly important for preparing a homogeneous explosive mixture and, eventually, produces homogeneous coatings with regard to their composition.

Flowing through the nozzles **30** and **31** the components of the explosive mixture enter the mixing space **7** where they are mixed and form a homogeneous explosive mixture which fills the working chamber **1,** passing through the outlet hole **14** of the pipe connection **25** of the body **5** of the mixing chamber **3,** then through the non-return valve **3** and coil **2.**

The quantity of the sprayed powder is controlled by the metering device **4.**

As the working chamber **1** is filled with the explosive mixture, the control unit sends a signal for opening the neutral gas valve and another signal to the H.T. pulse generator **45** which, in turn, sends a pulse to the spark plug **46** for igniting the explosive mixture.

After the neutral gas has forced the remaining explosive mixture from the mixing space **7** of the chamber **3,** the mixture is ignited with a certain delay and, on completion of the process, the working chamber **1** is scavenged with a neutral gas and the working cycle is repeated over again.

The installation according to the invention produces a truly homogeneous explosive mixture and delivers it into the working chamber.

The stability of the composition and the homogeneity of the produced explosive mixture have improved materially the initiation, formation and propagation of a stationary detonation wave which, in turn, has improved the quality of the applied coatings.

Another advantage of the present invention lies in that such operations as changing the programs of the coating application, increasing or decreasing the portion of one of the explosive mixture components supplied into the mixing chamber, increasing or decreasing the time of scavenging, changing the beginning and end of the spraying cycle and the time of ignition delay, accelerating or slowing down the rate of explosions, etc. are performed at a distance, directly from the operator's control desk.

An extremely high versatility of installation and ease of its handling while switching over to different coating materials does not call for a high skill of the servicing personnel.

Taking into account the above advantages it can be concluded that the industrial employment of such installations will save funds in the production of costly equipment used in aircraft rocket and space engineering, in general mechanical engineering, etc.

What is claimed is:

1. An installation for detonation working of materials comprising: a working chamber in the form of a cylindrical tube closed at one end; a metering device communicating with said working chamber and supplying it with the treated material; a mixing chamber communicating with said working chamber and supplying it with explosive mixture; a lateral partition installed in said mixing chamber and dividing it into a discharge space communicating with the source of the explosive mixture components and a space for mixing these components, located at the outlet hole of the mixing chamber; nozzles installed in said partition and communicating said discharge space with said mixing space.

2. An installation according to claim **1** wherein the nozzles are arranged uniformly in concentric rows coaxially with the outlet hole of the mixing chamber while its discharge space between these rows of nozzles has concentric partitions dividing said space into closed circular spaces connected, each, with the source of one of the explosive mixture components.

3. An installation according to claim **2** comprising spray nozzles whose axes in each row are directed at the same angle to the axis of the mixing chamber outlet hole, said angle ensuring intersection of the jets of all the mixture components.

4. An installation according to claim **3** wherein the lateral partition is made in the form of a disc whose central part has a projection in the form of a truncated cone directed towards the outlet hole of the mixing chamber while on the periphery it has an inverted truncated cone whose walls have calibrated holes used as spray nozzles.

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