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(54) **DETONATION GUN FOR PROJECTION WITH HIGH FREQUENCY SHOOTING AND HIGH PRODUCTIVITY**

DETONATIONSPISTOLE MIT HOHER FREQUENZ UND HOHER EFFIZIENZ

PISTOLET DE PROJECTION PAR DETONATION A HAUTE FREQUENCE DE TIR ET A PRODUCTIVITE ELEVÉE

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Description

OBJECT OF THE INVENTION

[0001] This invention refers to a spray gun, of the type used in the industrial thermal spray area for obtaining coatings, especially in detonation spray technologies.

[0002] The object of the invention is to achieve a new detonation gun with greater productivity than existing ones, maintaining stable and continued optimum spray conditions in each firing cycle. In relation to previous detonation devices, this gun allows the firing frequency to be increased, together with the amount of powder and feeder gases and in consequence, the amount of coating powder deposited per unit of time, maintaining optimum levels of quality that are characteristic of coating produced by detonation technologies.

[0003] For this purpose, a new gas feeding system is proposed, in a new explosion chamber, that permits the gun's operating frequency to be increased, making it possible to maintain the optimized characteristics of each explosion stable and constant, even at high frequencies and a new system for feeding products in the barrel that allows the distributed injection of products to any point within the barrel achieving an increase of the amount of powder injected into the barrel and reducing the limitations associated with obstruction of feeder ducts, together with great operating versatility by being able to select the injection point.

[0004] The barrel feeding system, in addition to the coating powder, it is also useful to introduce other products that can condition the thermal spray process, in this way permitting great flexibility when modifying the operating parameters, by being able to modify the characteristics of the generated explosions and to improve and optimize the coatings obtained in this way.

[0005] It is also an object of the invention to achieve better performance from the gun, based on thermally isolating the gases produced in the explosive process with respect to the cooled barrel wall, in order to obtain better use of the energy that is carried by these gases, with the resulting increase in the gun's performance and its efficiency.

BACKGROUND TO THE INVENTION

[0006] Current detonation spray technologies are mainly used for the application of coatings to parts that are subject to severe conditions of wear, heat or corrosion, and which are fundamentally based on the use of the thermal and kinetic energy produced by the explosion of a gaseous mixture to deposit a coating material powder on these parts.

[0007] The coating materials that are usually employed in detonation spray processes include metallic powder, metal-ceramics and ceramics etc, and are applied to improve the resistance to wear, erosion, corrosion and as thermal insulators or as electrical insulators

or conductors, among other applications as given in the literature.

[0008] Detonation spray is performed with spray guns that basically consist of a tubular explosion chamber with one end closed and the other open, to which a barrel, also tubular, is connected. The explosive gases are injected inside the explosion chamber and ignition of the gas mixture is produced by means of a spark plug, which provokes an explosion and in consequence, a shock or pressure wave that reaches supersonic speeds during its propagation inside the barrel until it leaves the open end. Such a detonation spray is known from US-A-3004822.

[0009] The coating material powders are usually injected inside the barrel in contact with the explosive mixture so that they are dragged along by the propagating shock wave and by the set of gaseous products from the explosion, which are expelled at the end of the barrel, and deposited on a substrate or part that has been placed in front of the barrel. This impact of the coating powders on the substrate produces a high density coating with elevated levels of internal cohesion and adherence to the substrate. This process is repeated in a cyclic manner until the part is suitably coated.

[0010] In traditional detonation spray equipment, the gases used in the generation of the explosive process are mixed in a separate chamber prior to the explosion chamber, which is then fed by a homogeneous mixture of gases in each explosive cycle. Traditionally, this pre-mixing chamber is isolated from the explosion chamber during the explosive phase for safety reasons, through the use of valves in one or more gas lines, with and without the introduction of an inert gas between two consecutive explosions

[0011] In other, more advanced types of detonation equipment, presented by the applicant in PCT US96/20160, this isolation between the pre-mix and explosion chambers is achieved by using dynamic valves, which means they do not have any moving parts, which overcomes the inherent disadvantages of the previously-mentioned mechanical systems. However, these devices continue to employ a pre-mixing chamber in order to homogenize the gas composition that feeds the explosion chamber.

[0012] Recently, the same applicant developed a type of detonation spray equipment, described in PCT ES97/000223, with a gas injection system that does not employ mechanical valves or systems to shut off the gas supply, and, in addition, allows the gases feeding to be fed directly and separately to the explosion chamber through a series of independent passageways, where each passageway is made up of an expansion chamber and a large number of distributor ducts with reduced cross section and/or long length. This results in a system without any moving mechanical parts and/or pre-mixing chamber. In this device, the expansion chamber for each passageway is in direct communication with the corresponding supply line, while the distributor ducts are

suitably arranged so that multiple gas injection points open out on the internal surface of the explosion chamber, producing a continuous and separate feeding at multiple points, which guarantees that the combustible mixture is produced directly and in a homogeneous manner, throughout the entire explosion chamber prior to each ignition and with sufficient flow to fill the chamber in each detonation cycle.

[0013] In turn, in the application PCT ES98/00015, also of the same applicant, a powder injection system is described for a detonation spray gun consisting of a dosing chamber directly fed by a conventional type continuous powder feeder that communicates with the barrel by means of a direct duct. In this way, the pressure generated by the explosion and which advances along the barrel, passes through the communication duct and undergoes a brusque expansion on reaching the dosing chamber, which interrupts the powder feeding from the continuous feeder and produces complete fluidization of the powder in the dosing chamber. The fluidized powder is carried by the suction towards the barrel, where the pressure wave generated in a new explosive cycle drags it out and deposits it on the surface to be coated.

[0014] The detonation guns of the described type produce coatings of excellent quality, but they have a limitation in so far as the amount of powder that can be deposited per unit of time. This is due to the fact that, for a detonation gun of a determined size, the optimum amount of powder that can be processed during each explosion is limited by the existence of a maximum volume of optimized gaseous mixture that may be processed in each explosion and capable of generating proper characteristics of the actual explosive process itself. An increase in the gaseous volumes involved in each explosion on this maximum volume of optimized mixture is not directly translated into an improvement of the explosive process of each cycle, so that an increase in the amount of powder deposited per unit of time should not be obtained so much because of an increase in the powder processed in each explosion, but as a consequence of the increasing in the firing frequency, guaranteeing optimum explosive characteristics of each cycle in all cases.

[0015] On the other hand, the repetition of the explosive cycle at high frequencies and generating explosions with characteristics equivalent to those obtained at lower frequencies also requires higher gas flows in order to guarantee constant gas volumes involved in each explosion. The application of these increments in the gas flows and in the firing frequencies in the previously described equipment produces an increase in the gun's power rating and an increase in the gas supply pressure with an acceleration in the injection and gas mixture processes inside the explosion chamber which causes great difficulty in the maintenance of the actual cyclic detonation process itself, leading to continuous combustion processes and making the spray process impossible with that equipment. In particular, an in-

crease in the gun's power rating and consequently in the gas injection system temperature makes more difficult the cooling of the gases produced in an explosive cycle and which, returning through the injection system ducts allows the cyclic interruption of the supply of oxidizer and fuel to the chamber.

[0016] In the equipment described in PCT ES97/00223, the gases, on their return to the explosion chamber, act as an insulating barrier between the gases produced in the prior explosive cycle and the new gas mixture formed in the explosion chamber, preventing self-ignition. However, the operation of this mechanism at high frequencies is made difficult by an increase in the temperature of the explosion chamber, a reduction in the volume of the return gases that acts as an insulating barrier and their rapid return to the explosion chamber, as a result of the greater pressure in the feed lines. In the previously described detonation devices, this leads to the self-ignition of the combustible mixture and the formation of a continuous combustion process.

[0017] In currently existing detonation guns as described in this section, there is an additional limitation that derives from the types of powder feeders used since they cannot guarantee the correct fluidity of the powder at high supply speeds. In this sense, it can be seen that current designs are subject to major problems of obstruction and wall deposits on the feeding ducts above a certain amount of injected powder, and this makes continuous and stable operation very difficult. This is mainly due to the geometric aspects of the powder injection devices and/or thermal aspects in relation to the explosive process. In the injection device described in PCT ES98/00015 from the same applicant, the powder is introduced into the barrel through a single orifice, then carried along by the hot gases generated in the explosive cycle. Any increases in the amount of powder, gases and in the operation frequency in order to increase the productivity of the spray process, will soon come up against a limit in the feeding devices, such as that previously stated, since as a consequence of the accumulation of material in a localized area and in the increase of temperature of the gases that interact with the powder in the injector, obstruction and deposit problems as stated before are produced.

[0018] On the other hand, there are spray technologies, known as HVOF, that do not produce cyclic explosions, but a continuous combustion that it used in the formation of a supersonic flow of hot gases that are actually employed in the thermal spray process, requiring, in this case, very high gas flow rates for maintaining this required supersonic flow rate for obtaining coatings with a good technical quality.

[0019] Due to the continuous nature of the HVOF processes, the more advanced designs of HVOF guns have a powder processing capacity per unit of time that exceeds that achieved with traditional detonation spray systems, although they still have similar problems in the injection of powder, obstruction and deposits inside the

spray nozzles.

[0020] However, the lower thermodynamic efficiency of the continuous combustion processes against the explosive processes (pulsed or cyclic combustion) leads to the fact that the amounts of gases and power required to deposit the same amount of powder is greater in the HVOF systems, which results in lower performance in resource use and in the introduction of additional operational problems as a consequence of the high working powers employed in the HVOF systems with high processing capability.

[0021] It would be therefore, desirable to have a spray gun that employs a pulsed explosive process, with high thermodynamic efficiency in the use of gases and precursor materials, allowing a significant increase in the amount of powder processed per unit of time, and maintaining the typical characteristics of the coating produced by the detonation technologies.

DESCRIPTION OF THE INVENTION

[0022] The detonation spray gun of the invention, allows the working at higher frequencies than those employed in currently existing devices with a large volume of powder feeding, achieving greater deposit rates, even when compared with those obtained with current HVOF continuous combustion equipment, but maintaining the higher thermodynamic efficiency of the explosive processes in the use of the gases and precursors, resulting in greater productivity.

[0023] The current detonation spray system is based on the generation of explosive gaseous mixtures of different compositions in different zones of the chamber zone, which is due to a specific design of the gas injectors and the explosion chamber, employing dynamic valves and direct, separate injection for fuel and oxidizer, without pre-mixing of both prior to the explosion chamber itself.

[0024] First, in order to enable the gun to operate at high frequencies with high gas volumes per explosion, it has been planned for the gas feeding to the explosion chamber to be produced via several points, spatially distributed throughout the explosion chamber, so that gaseous mixtures are generated with locally varying compositions in the various zones inside this chamber, allowing higher energy explosions to be generated at higher frequencies and maintaining stable cyclic operation.

[0025] Inside the explosion chamber, just before the orifices employed for oxidizer feeding, there is a protuberance or internal perimeter rib that determines a narrowing of the internal diameter of the explosion chamber, defining an annular volume which is fed exclusively with fuel through multiple distributors arranged in the rearmost zone of the explosion chamber. This constrained volume favors thermal interchange of the gases produced in the explosion with the cooled chamber wall and also allows an increase in the gas volume that acts

as an insulating barrier between the gases involved in two consecutive explosive cycles, and in this way simplifies the maintenance of the pulsed process under the circumstance imposed by the high gas flow rates and high frequency that are the object of this patent.

[0026] In accordance with this operating scheme, after each ignition of the spark plug, the propagation of a shock and temperature wave generated by the explosive process, returns to the said constrained annular volume producing the combustion and decomposition of the fuel present in this volume, together with an over-pressure that produces an interruption of the fuel feeding supply and even the penetration of the products of combustion via the distribution ducts. The high gas flow rates required in order to work at high frequencies cause this latter factor to be reduced so that new fuel is able to rapidly penetrate the explosion chamber via the distribution ducts, however, this effect is compensated by the presence of this constrained annular volume in the explosion chamber, the content of which in combustion products generates a sufficient amount of gas to act as an insulating barrier between the hot gases originated in the previous explosion and the new gases supplied to the explosion chamber.

[0027] The feeding of oxidizer begins in the zones closed to the ignition point (spark plug) to generate a local mixture poor in oxygen, with an injection in this zone of a maximum of 25% of the total volume supplied in each cycle, together with the local injection of the totality of fuel supplied to the explosion chamber.

[0028] The rest of the oxidizer is introduced into the explosion chamber in more advanced positions, closer to the tubular barrel, so that the combustion front that is produced at each spark plug ignition meets up with mixtures that are richer in oxidizer as it progresses along the explosion chamber, increasing its speed and energy, producing very energetic explosions that are suitable for the production of high quality coatings.

[0029] In this way, it is possible to produce, within the same chamber volume, and for the same explosive cycle, zones of greater and lesser energy. In particular, the new design of explosion chamber and the gas injection system favors the supply of energy to the zone closer to the oxidizer injection, and at the same time reduces the energy of the explosion in the rearmost zone of the explosion chamber, thus increasing the efficiency of the injection system in cooling the gases that accompany the retreating pressure wave and favoring the continuity of the cyclic detonation process at higher frequencies than with the previous devices.

[0030] According to a preferable construction, the oxidizer injector is concentrically and internally arranged in the explosion chamber, and has a prolongation at one end that extends practically to the gun's barrel, this prolongation incorporating a series of orifices obliquely arranged with respect to the gun's barrel, for the injection of oxidizer in this advanced location in the explosion chamber.

[0031] A second characteristic of the gun object of this invention, refers to the incorporation of a system for feeding products at any point of the barrel, a system that when it is used for the injection of coating powder permits an increasing of the amount of powder feed to the gun per unit of time, and therefore the amount of powder deposited on the substrate per unit of time, increasing also the gun's productivity.

[0032] For this reason, the barrel comprises an annular chamber at an intermediate point of the barrel, assisted by one or more material feeding inlets, so that the product introduced through them reaches the inside of the barrel with an annular distribution achieving a good mixture with the gases that are present in the barrel and avoiding the formation of high concentrations of material in specific zones, just as occurs with traditional injectors consisting of radial orifices.

[0033] The employment of this type of feeding ducts for the injection of the coating powder permits good distribution of the powder because, instead of entering the barrel through a single point, it does so through the annular chamber and consequently in a more homogeneously distributed manner, reducing the volumetric density of powder injected per unit of area, reducing the problems of blockages, but, in addition, allowing a larger amount of powder to be introduced into the gun.

[0034] In accordance with another characteristic of the invention, it has been planned for the mentioned annular chamber to take the form of a flange that divides the chamber in two segments, to allow the flange to be dismantled for injection duct maintenance and the front part of the barrel corresponding to the exit mouth in order to replace it with one having different characteristics, so that the same gun may have several configurations, including various lengths that allows coatings with different materials that require greater or less thermal and/or kinetic energy and hence a longer or shorter barrel.

[0035] In a similar fashion, it is also possible to connect segments of barrel having different diameters according to the type of coating powder used or the special characteristics of the current process or application.

[0036] It has also been planned for the flange that incorporates the annular injector to be coupled to the gun by means of a device that allows the separation between the flange and the barrel to be varied to established and entrance of external air between the two parts, and even to make one part independent from the other, so that on certain occasions the performance and results of the gun can be improved.

[0037] In accordance with another of the invention's characteristics, it has also been planned that the flange comprises a second annular chamber, with its corresponding inlets for feeding material and which opens to the inside of the barrel and chamber to allow the injection of a product of the same or different characteristics of the one introduced via the main chamber. Specifically, it is possible to introduce powders of different types or to distribute the powder feeding along the length of the

barrel, which will permit to obtain a greater versatility in the composition of the coatings obtained.

[0038] It is also possible to use the mentioned annular feeding system for the injection of active gases, in such a way that it would be possible to locally modify the nature of the mixture conditioning the explosive process, so, for example, these active gases may modify the energetic characteristics of the actual spraying process itself, modifying the temperatures and speeds applied to the sprayed particles or they can also provide a thermochemical environment that conditions the reactive interaction between these gases and the particles to be deposited, or even produce the synthesis of the materials deposited during the spray process.

[0039] Of course, the described annular injector may be single, double or multiple, comprising one or several product feeding inlets and one or more injectors of this type can be distributed along the barrel.

[0040] Therefore, by means of the proposed feeding system, it is possible to voluntarily modify the gun's working conditions, since it is possible to inject all types of products that may modify, both the spray process conditions and the coating composition, and this injection may be made at any point of the barrel and so, as already mentioned, the dimensions of the barrel may be rapidly and simply changed, achieving an enormous flexibility in the gun's operation and consequently in its capability of processing a wide range of material.

[0041] It is also possible to use the described annular injector for the introduction of an inert gas to reduce the transfer of heat between the gases produced in the explosion and the cooled wall of the barrel, thus making use of these gases to best advantage.

[0042] In accordance with this structure, the gases produced in the explosion progress along the central zone of the barrel in its output sector, while the gases injected by means of the cited annular chamber flow in contact with the barrel wall, forming a kind of moving cylindrical film that reduces the heat losses of the gases produced in the explosion through contact with the cooled tube that forms the barrel and which determines greater performance from the gun.

[0043] In addition, the film of surrounding gases form at the mouth of the barrel what could be called a virtual barrel, that axially lengthens the size of the actual barrel itself, reducing and delaying the mixture of the explosive process products with the gases in the environment, which leads to the fact that with a shorter, lighter barrel, the powder particles are better melted and this produces a coating with better properties.

[0044] When using easily oxidized powders, it is possible to carry out the injection with an inert gas, so that the powder is protected from the environmental air by being surrounded by this gas and consequently, the quality of the produced layer or coating is improved.

DESCRIPTION OF THE DRAWINGS

[0045] To complete the description that is being made and for further understanding of the invention's characteristics, in accordance with a preferable practical example of the same, a set of drawings is provided as an integral part of the said description, where the following has been represented with an illustrative and non-limiting character:

Figure 1. Shows an schematic representation in section of the gun which is the object of this invention and which also shows a transverse section of one of the annular material injectors that is incorporated into the barrel.

Figure 2. Shows a section of the invention's detonation gun's explosion chamber, indicating the new gas injection system for generating mixtures of different composition in various zones of the chamber.

Figure 3. Shows a partial view of a material injector incorporated into the barrel corresponding to a variation where the annular injector also incorporates an auxiliary product entrance. In addition, it shows a variation of the flange that incorporates the said injector to permit the connection of two-barrel segments with different diameters.

Figure 4. Shows a variation of the view given in Figure 3 where the material exits present a multiplicity of orifices that open out to the inside of the barrel.

Figure 5. Shows a representation of the flange that houses the annular injector comprising separator means that allow the distance between the flange and a segment of the barrel to be varied, this providing an adjustable separation between the two parts for the entrance of outside air.

Figure 6. Shows a variation of the annular injector with a diametrical reduction-expansion. It also shows a variation of this injector with longitudinal grooves.

Figure 7. Shows a variation of the annular injector where the outlet in communication with the barrel is fitted with a multiplicity of radial orifices and an axial feeder ring.

BEST MODE FOR CARRYING OUT THE INVENTION

[0046] In view of these drawings, one can see how the gun object of the invention comprises an explosion chamber (1) and a barrel (2) of suitable length, open at one end (3) and closed at the other, and which is made up of one or more segments (2), (2'), joined by flanges (7), (7') that can incorporate entrances for products.

[0047] The explosion chamber (1) comprises the fuel injector (5), the oxidizer injector (4) and the spark plug (6) for the ignition of the fuel-oxidizer mixture obtained in the explosion chamber. In addition, it incorporates the connectors that correspond to a gun cooling circuit (not represented), for example, using water.

[0048] As can be seen from Figure 2, the explosion chamber (1) comprises in the rearmost zone, just before the orifices (17) used for oxidizer feed, a protuberance or internal perimeter rib (14) that determines a narrowing that defines an annular volume (11) into which the fuel is introduced exclusively and which is fed via the orifices (16) located in a bushing that is concentric to the explosion chamber, or in the actual walls (5) and which open into this chamber at the most rearwards position (11) prior to the rib (14).

[0049] One of the main characteristics of the gun of the invention refers to the fact that it incorporates an oxidizer feeder (4) (for example, oxygen) arranged concentrically and internally to the explosion chamber (1), with a prolongation at one end that extends practically to the zone that communicates with the gun's barrel (13) incorporating a multiplicity of orifices (17), (18) for feeding the oxidizer, for example, oxygen, which allows the feeding of this oxidizer to various locations distributed throughout the explosion chamber.

[0050] Specifically, a first series of oxidizer (for example, oxygen) feeding orifices (17) has been provided in a first location close to the ignition zone (12), where the prolongation (15) of the feeder (4) incorporates other oxidizer feeding ducts (18) along its length that are employed to progressively enrich the mixture during its advance towards the chamber zone that communicates with the barrel (13).

[0051] Another important characteristic of the invention refers to the fact that the gun's barrel (2) incorporates one or more expansion and distribution annular chambers (9) with their corresponding products feeding inlets (8), chambers (9) that open to the inside of barrel (2) via annular outlets (10) directed towards the barrel's exit.

[0052] The annular chambers (9) are established within the flanges (7), independently of the barrel (2) and can be fixed to it by any method, so that these flanges (7), together with the barrel's segment or segments (2), (2'), can be substituted or replaced, having several barrels for a single gun, including various lengths or diameters, which, in addition, permits greater ease during maintenance operations of the injection ducts, which allows the operational features of a single gun to be substantially modified, using the most suitable configuration for each case. Figure 1 and 6 represent a barrel with a terminal segment (2') of the same diameter as the first section (2), whereas figure 3 to 5 show a barrel where the terminal segment (2') has a greater diameter than the first section (2).

[0053] In accordance with another characteristic of the invention, just as can be seen in Figure 5, the flange

(7) can incorporate a separator device (19) that permits the separation between the flange (7) and the initial sector (2) of the barrel to be modified, so that an adjustable separation may be established between them to allow the entry of outside air.

[0054] The feeding duct (8) may be employed for the injection of coating powder, thus achieving a good distribution of the same and minimizing the volumetric density of the powder introduced per unit of area, since instead of entering the barrel at a single point, it does so via chambers (9) and annular outlets (10) and consequently in a more homogeneous and distributed form.

[0055] The annular feeding duct can also be used for the injection of active, reactive or neutral substances, such as, for example, fuel, oxygen air or nitrogen etc, in this way modifying the conditions of the actual thermal spray process itself and making it possible to modify the parameters based on the injection of various products at different points inside the barrel.

[0056] As from this basic structure and in accordance with Figures 3 and 4, it is possible to incorporate, in the same flange (7), in addition to the already mentioned annular chamber (9), a second annular chamber (20), with its corresponding inlet (21) and outlet (22) ducts, designed to make up an auxiliary products injector, which may be the same or different to those injected via the main feeding chamber (9) and therefore, for example, it would be possible to inject different powders in order to form coatings with two or more different materials.

[0057] In addition, and as can be perfectly seen in the cited Figures 3 and 4, the diameter of the barrel segment (2') is greater than that of the first segment (2), and more specifically, the second segment (2') diameter coincides with the external or maximum diameter of the annular outlet (10') of the chamber exit, also annular (9), at the same time being larger than the internal diameter of the first segment (2) of the said barrel, with which, as already said and in accordance with the invention's object, the injection of a gas via the entrance (8), emerges from the annular outlet (10) forming a kind of film, which is also annular and established between the actual barrel wall itself (2') and the hot gases produced in the explosion, making contact between them and the cooled barrel difficult and consequently allowing a reduction in the energy losses.

[0058] In Figure 1, the flange (7) allows the connection of the two segments of the barrel (2, 2') of the same diameter, where it is also possible to make this connection with the layout shown in Figure 6, where two sectors (2, 2') of the barrel with the same diameter are connected by means of a progressive reduction of diameter in the terminal zone of the first section (2) of the barrel, and of a posterior progressive expansion in correspondence with the output outlet (10) of the annular chamber (9).

[0059] As can be seen in Figure 4, one of the barrel access outlets (22') can be made, instead of being a continuous annular slot, through a series of orifices, ar-

ranged approximately in a ring. Also shown in Figures 1 and 6 is the presence of longitudinal slots (23) in the outlets (10) with the function of increasing the amount of powder that may be processed by the said components. These configurations may be used at any of the outlets of any of the material injectors incorporated into the gun.

[0060] In Figure 7, the outlet (10), in addition to presenting an annular axial communication with the barrel, includes a multiplicity of orifices (24) along its length, which open radially on the inside of the barrel and allow the product feeding to be performed in a more distributed manner. This configuration may be used at any of the outlets of any of the material injectors incorporated into the gun.

[0061] The outlets (10) that communicate the annular chambers (9) with the inside of the barrel (2) are configured as ducts formed by the internal wall of the barrel and by an axial rib (25) in the flange (7), which, on the one hand, permits the correct distribution of the material inside the barrel and, on the other, regulates the interaction between the gases produced by the explosions and the materials supplied in the annular chambers (9). The outlets may be configured as annular ducts that are variable in longitude and section in combination, or not, with radial ducts of the type represented by the orifices (24) and the slots (23). Ultimately, the geometry of the outlet (10) is determined by the characteristics of the product injected into the barrel and by the properties of the coating to be achieved. For example, if the material fed into the barrel is a gas and it is to be used to insulate the gases produced in the explosion from the cooled walls of the barrel, then the most suitable outlet would have a configuration similar to that numbered (10) in Figure 6. On the other hand, for feeding a material in the form of powder, an outlet configuration such as that represented in Figure 7 is more appropriate.

Claims

1. High frequency pulse rate and high productivity detonation spray gun of the type that incorporates an explosion chamber (1) and a barrel (2), to which fuel and oxidizer are directly and separately supplied which, with the collaboration of an ignition system (6), generates gases produced in an explosion process for carrying a coating material, fed into the barrel (2) and which is then sprayed towards the piece to be coated, **characterized by** comprising

a) means for feeding the fuel and oxidizer to produce explosive mixtures of different compositions in different zones of the explosive chamber, so as to generate, within the same chamber volume (1) and for the same explosive cycle, zones with greater or lesser energy and **[deletion(s)]**

- b) means for the distributed feeding of products into the barrel to obtain high feeding volumes and suitable mixtures of the gases present in the barrel, where the position of these means, along the length of the barrel (2), may be selected and modified by the user, for the injection of products to any point in the barrel and thus providing great operational versatility.
2. High frequency pulse rate and high productivity detonation spray gun, as in claim 1, **characterized in that** the means for feeding the oxidizer (4) present multiple injection points (17, 18), that are spatially distributed along the length of the explosion chamber (1), while the means for feeding the fuel (5) present multiple injection points (16), all of which are located in the rearmost zone (11) of the explosion chamber (1), all this is intended to generate a mixture that is rich in fuel in the zones close to the ignition zone (12), but progressively increasing the percentage of oxidizer in zones (13) close to the connection with the barrel (2).
 3. High frequency pulse rate and high productivity detonation spray gun as in previous claims, **characterized in that** the explosive mixture generated in the ignition zone (12) is the result of the local injection in this zone (12) of a maximum of 25% of the oxidizer and 100% of the fuel supplied to the explosion chamber in each cycle.
 4. High frequency pulse rate and high productivity detonation spray gun as in previous claims, **characterized in that** the explosion chamber (1) incorporates, between the first oxidizer feeding orifices (17) and the fuel feeding orifices (16) an internal protuberance or perimetral rib (14) that determines a narrowing of the explosion chamber (1) forming a constrained volume (11) which is exclusively fed with fuel via the injector (5) orifices (16).
 5. High frequency pulse rate and high productivity detonation spray gun as in previous claims, **characterized in that** the means for feeding the oxidizer comprise an axial injector (4), arranged concentrically and internally to the explosion chamber (1), with a series of radial orifices (17) placed outside the volume (11) and immediately after the perimetral rib (14), and where the axial injector includes at one end a prolongation (15) extending practically to the beginning of the barrel (2), also with radial orifices (18), these orifices being arranged along the length of the explosion chamber (1).
 6. High frequency pulse rate and high productivity detonation spray gun as in previous claims, **characterized in that** the radial orifices (17) and (18) for the oxidizer feeder are arranged obliquely with respect to the barrel (2) axis.
 7. High frequency pulse rate and high productivity detonation spray gun as in previous claims, **characterized in that** the means for the distributed feeding of products into the barrel (2) consist of one or more annular chambers (9) established in any position of the barrel, and assisted by one or more product feeder inlets (8), where the annular chamber or chambers (9) have outlets (10) or exit ducts, through which the products gain access to the barrel (2) in a distributed manner, so that when these means of feeding are used for the injection of coating powder, they enable the amount of powder fed into the barrel to be increased and reduce possible obstructions of the injection duct, whereas if they are used for the injection of active products in the combustion, it is possible to locally modify the nature of the mixture and/or condition the spray process at will.
 8. High frequency pulse rate and high productivity detonation spray gun as in claims 1 and 7, **characterized in that** the outlets (10) are configured as annular ducts with variable length, section and orientation.
 9. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7 and 8, **characterized in that** the annular chamber or chambers (9) are established in one or more moveable flanges (7) mounted in any position on the barrel, where the said flange or flanges (7) define physically independent segments of the barrel, both for facilitating access to the injectors during gun maintenance and to enable a single gun to have various interchangeable segments in order to determine various functional characteristics for the gun.
 10. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7, 8 and 9, **characterized in that** the outlets (10) are configured as ducts defined between the internal wall of the barrel (2) and an axial rib (25) of the flange (7).
 11. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7, 8, 9 and 10, **characterized in that** the outlets (10) of the annular chamber (9) comprise longitudinal grooves (23) in order to increase the amount of material injected, particularly in the case of coating powder.
 12. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7, 8, 9, 10 and 11, **characterized in that** the outlets (10) of the annular chamber (9) comprise, in addition to an axial annular communication with the barrel, a multiplicity of orifices (24) that open radially to the barrel, in which

case the annular chambers are especially appropriate for the injection of coating powder, achieving large productivity of the gun and reducing obstructions in the injection duct.

13. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7, 8, 9, 10, 11 and 12, **characterized in that** the annular chambers (9) open out into the interior of the barrel (2) via annular ducts (10) and/or via a circumferential alignment of orifices (22').
14. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7, 8, 9, 10, 11, 12 and 13, **characterized in that** the axial rib (25) presents an enlarged length that is superposed on the interior of the barrel (2), in such a way that when the injector is used for the introduction of an inert gas, the explosion gases progress along the central zone of the barrel (2), while the inert gas flows in contact with the barrel wall, forming a kind type of moveable, cylindrical film that reduces the heat losses through the barrel (2) walls and defines at the exit of the same a protective film, which reduces and delays the mixture of the products from the explosive process with the gases of the environment.
15. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7, 8, 9, 10, 11, 12, 13 and 14, **characterized in that** the cited flanges (7) comprise a second annular chamber (20), placed before the annular chamber (9), and provided with its own inlets ducts (21) and which open out on the interior of the barrel (2), immediately in front of the outlet (10) of the annular chamber (9), and being designed to provide a second feeding point for the supply of product to the gun's barrel, a product with the same or different characteristics as that introduced via the first entrance.
16. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7, 8, 9, 10, 11, 12, 13, 14 and 15, **characterized in that** the flanges (7) incorporate a separator device (19) for modifying the separation between each flange (7) and the barrel segment to which it is joined so as to establish an adjustable separation between the two, which allows the entrance of outside air.
17. High frequency pulse rate and high productivity detonation spray gun as in claims 1, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16, **characterized in that** the flange (7) presents a first converging section, followed by a diverging section in correspondence with the exit outlet (10) allowing two barrel sections (2) (2') to be connected.

Patentansprüche

1. Detonationssprühpistole mit einer Hochfrequenzpulsrates und einer hohen Produktivität, wobei die Pistole von der Art ist, die eine Explosionskammer (1) und eine Trommel (2) umfaßt, in die ein Brennstoff und ein Oxidationsmittel direkt und getrennt geleitet werden, die in Zusammenarbeit mit einem Zündsystem Gase erzeugt, die in einem Explosionsprozess erzeugt werden, um ein Beschichtungsmaterial zu transportieren, das in die Trommel (2) zugeführt und dann in Richtung des Stückes gesprüht wird, das beschichtet werden soll, **dadurch gekennzeichnet, daß** sie umfaßt:
 - a) Mittel zum Zuführen des Brennstoffes und des Oxidationsmittels, um explosive Mischungen verschiedener Zusammensetzungen in verschiedenen Bereichen der Explosionskammer zu erzeugen, um in demselben Kammer-volumen (1) und für denselben Explosionszyklus Bereiche mit größerer oder geringerer Energie zu erzeugen, und
 - b) Mittel zum verteilten Zuführen von Produkten in die Trommel, um hohe Zufuhrvolumina und geeignete Mischungen der Gase, die in der Trommel vorliegen, zu erreichen, wobei die Lage dieser Mittel entlang der Länge der Trommel (2) durch den Bediener gewählt und geändert werden kann, für das Einspritzen der Produkte zu jedem Punkt in der Trommel, um auf diese Weise eine hohe Vielseitigkeit im Betrieb zu ermöglichen.
2. Detonationssprühpistole mit einer Hochfrequenzpulsrates und einer hohen Produktivität nach Anspruch 1, **dadurch gekennzeichnet, daß** die Mittel zum Zuführen des Oxidationsmittels (4) mehrere Einspritzpunkte (17, 18) umfassen, die räumlich entlang der Länge der Explosionskammer (1) verteilt angeordnet sind, während die Mittel zum Zuführen des Brennstoffes (5) mehrere Einspritzpunkte (16) umfassen, die alle in dem hintersten Bereich (11) der Explosionskammer (1) angeordnet sind, wobei all dies dazu dient, eine Mischung zu erzeugen, die reich an Brennstoff in den Bereichen ist, die nahe dem Zündbereich (12) liegen, jedoch fortschreitend den Prozentsatz an Oxidationsmittel in den Bereichen (13) erhöht, die nahe an der Verbindung zu der Trommel (2) sind.
3. Detonationssprühpistole mit einer Hochfrequenzpulsrates und einer hohen Produktivität nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die explosive Mischung, die in dem Zündbereich (12) erzeugt wird, das Ergebnis des örtlichen Einspritzens in diesen Bereich (12) von

maximal 25 % des Oxidationsmittels und 100 % des Brennstoffes, die der Explosionskammer in jedem Zyklus zugeführt werden, ist.

4. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die Explosionskammer (1) zwischen den ersten Oxidationsmittelzuführöffnungen (17) und den Brennstoffzuführöffnungen (16) einen inneren Vorsprung oder eine Umfangsrippe (14) umfaßt, die eine Verengung der Explosionskammer (1) festlegt, wodurch ein beschränktes Volumen (11) gebildet ist, dem ausschließlich Brennstoff über die Öffnungen (16) einer Injektoreinheit (5) zugeführt wird. 5
5. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die Mittel zum Zuführen des Oxidationsmittels eine axiale Injektoreinheit (4) umfassen, die konzentrisch zu und in der Explosionskammer (1) angeordnet ist, wobei eine Reihe von radialen Öffnungen (17) außerhalb des Volumens (11) und unmittelbar nach der Umfangsrippe (14) angeordnet sind, und wobei die axiale Injektoreinheit an einem Ende eine Verlängerung (15) aufweist, die sich praktisch bis an den Anfang der Trommel (2) erstreckt, ebenso mit radialen Öffnungen (18), wobei diese Öffnungen entlang der Länge der Explosionskammer (1) angeordnet sind. 10 15 20 25 30
6. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die radialen Öffnungen (17) und (18) für die Oxidationsmittelzuführung bezogen auf die Achse der Trommel (2) schräg angeordnet sind. 35 40
7. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die Mittel zum verteilten Zuführen von Produkten in die Trommel (2) aus einer oder mehreren ringförmigen Kammer(n) (9) bestehen, die an irgendeiner Stelle der Trommel gebildet ist (sind), und von einer oder mehreren Produktzuführöffnung(en) (8) unterstützt wird (werden), wobei die ringförmige(n) Kammer(n) (9) Auslässe (10) oder Austrittsleitungen aufweist (aufweisen), durch die die Produkte in einer verteilten Weise Zugang zu der Trommel (2) erhalten, so daß, wenn diese Mittel zum Zuführen für das Injizieren eines Beschichtungspulvers verwendet werden, sie ein Erhöhen der Pulvermenge, die der Trommel zugeführt wird, ermöglichen und mögliche Hindernisse der Einspritzleitung verringern, und wobei, wenn sie zum 45 50 55

Injizieren von aktiven Produkten in die Verbrennung verwendet werden, es möglich ist, die Art der Mischung und / oder den Zustand des Sprühprozesses örtlich nach Belieben zu ändern.

8. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach Anspruch 1 und 7, **dadurch gekennzeichnet, daß** die Auslässe (10) als ringförmige Leitungen mit variabler Länge, variablem Querschnitt und variabler Ausrichtung ausgebildet sind.
9. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach Anspruch 1, 7 und 8, **dadurch gekennzeichnet, daß** die ringförmige(n) Kammer(n) (9) in einem oder mehreren bewegbaren Flansch(en) (7) gebildet ist (sind), die in irgendeiner Position auf der Trommel angeordnet sind, wobei der (die) Flansch(e) (7) physikalisch unabhängige Abschnitte der Trommel bildet (bilden), um sowohl einen Zugang zu den Injektoreinheiten während einer Wartung der Pistole zu ermöglichen wie auch verschiedene austauschbare Abschnitte für eine einzelne Pistole bereitzustellen, um verschiedenen funktionelle Merkmale für die Pistole festzulegen.
10. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach den Ansprüchen 1, 7, 8 und 9, **dadurch gekennzeichnet, daß** die Auslässe (10) als Rohre gebildet sind, die zwischen der inneren Wand der Trommel (2) und einer axialen Rippe (25) des Flansches (7) gebildet sind.
11. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach den Ansprüchen 1, 7, 8, 9 und 10, **dadurch gekennzeichnet, daß** die Auslässe (10) der ringförmigen Kammer (9) Längsrillen (23) umfassen, um die Menge des eingespritzten Materials zu erhöhen, insbesondere im Fall von Beschichtungspulver.
12. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach den Ansprüchen 1, 7, 8, 9, 10 und 11, **dadurch gekennzeichnet, daß** die Auslässe (10) der ringförmigen Kammer (9) zusätzlich zu einer axialen ringförmigen Verbindung mit der Trommel eine Vielzahl von Öffnungen (24) umfassen, die sich radial in die Trommel öffnen, wobei in diesem Fall die ringförmigen Kammern besonders für das Injizieren des Beschichtungspulvers geeignet sind, wodurch eine hohe Produktivität der Pistole erreicht wird und Hindernisse in der Einspritzleitung verringert werden.
13. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach den

Ansprüchen 1, 7, 8, 9, 10, 11 und 12, **dadurch gekennzeichnet, daß** die ringförmigen Kammern (9) in das Innere der Trommel (2) über ringförmige Leitungen (10) und/oder über Öffnungen (22'), die entlang eines Umfangs ausgerichtet sind, münden.

14. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach den Ansprüchen 1, 7, 8, 9, 10, 11, 12 und 13, **dadurch gekennzeichnet, daß** die axiale Rippe (25) eine vergrößerte Länge aufweist, die mit dem Inneren der Trommel (2) derart überlagert ist, daß, wenn die Injektoreinheit zum Einbringen eines inerten Gases verwendet wird, die Explosionsgase entlang des mittleren Bereiches der Trommel (2) voranschreiten, während das inerte Gas in Kontakt mit der Trommelwand strömt, wodurch eine Art bewegbarer zylindrischer Film gebildet ist, der die Wärmeverluste durch die Wände der Trommel (2) verringert und an deren Austritt einen Schutzfilm bildet, der die Mischung der Produkte des Explosionsprozesses mit den Gasen der Umgebung verringert und verzögert.

15. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach den Ansprüchen 1, 7, 8, 9, 10, 11, 12, 13 und 14, **dadurch gekennzeichnet, daß** die angeführten Flansche (7) eine zweite ringförmige Kammer (20) umfassen, die vor der ringförmigen Kammer (9) angeordnet ist und mit ihren eigenen Einlassleitungen (21) versehen ist, die unmittelbar vor dem Auslass (10) der ringförmigen Kammer (9) in das Innere der Trommel (2) münden und ausgelegt sind, einen zweiten Zuführungspunkt für die Zuführung eines Produktes in die Trommel der Pistole zu bilden, wobei das Produkt dieselben oder andere Merkmale aufweisen kann wie das, das über den ersten Zugang zugeführt wird.

16. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach den Ansprüchen 1, 7, 8, 9, 10, 11, 12, 13, 14 und 15, **dadurch gekennzeichnet, daß** die Flansche (7) eine Abstandseinrichtung (19) umfassen, um den Abstand zwischen jedem Flansch (7) und dem Trommelabschnitt, mit dem er verbunden ist, zu ändern, um einen einstellbaren Abstand zwischen den beiden zu bilden, der den Zugang von Außenluft ermöglicht.

17. Detonationssprühpistole mit einer Hochfrequenzpulsrate und einer hohen Produktivität nach den Ansprüchen 1, 7, 8, 9, 10, 11, 12, 13, 14, 15 und 16, **dadurch gekennzeichnet, daß** der Flansch (7) einen ersten konvergierenden Abschnitt aufweist, dem ein divergierender Abschnitt in Entsprechung mit der Auslassöffnung (10) folgt, wodurch es mög-

lich ist, zwei Trommelabschnitte (2) (2') zu verbinden.

5 Revendications

1. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée du type qui incorpore une chambre d'explosion (1) et un fût (2), auquel le combustible et l'oxydant sont amenés directement et séparément qui, avec la collaboration d'un système d'allumage (6), produit des gaz produits lors d'un processus d'explosion pour porter un matériau de revêtement, amené dans le fût (2) et qui est ensuite pulvérisé vers la pièce à revêtir, **caractérisé en ce qu'il** comprend

a) un moyen pour amener le combustible et l'oxydant pour produire des mélanges explosifs de différentes compositions dans différentes zones de la chambre d'explosion de manière à produire, dans le même volume de chambre (1) et pour le même cycle d'explosion, des zones d'énergie plus grandes ou plus petites et

b) des moyens pour l'amenée distribuée de produits dans le fût afin d'obtenir des volumes d'amenée élevés et des mélanges appropriés des gaz présents dans le fût, où la position de ces moyens, sur la longueur du fût (2), peut être sélectionnée et modifiée par l'utilisateur, pour l'injection des produits à n'importe quel point dans le fût et en réalisant ainsi une grande souplesse d'utilisation fonctionnelle.

2. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon la revendication 1, **caractérisé en ce que** les moyens pour amener l'oxydant (4) présentent de multiples points d'injection (17, 18) qui sont distribués spatialement sur la longueur de la chambre d'explosion (1), tandis que les moyens pour l'amenée du combustible

(5) présentent de multiples points d'injection (16) dont tous se situent dans la zone la plus arrière (11) de la chambre d'explosion (1), tout cela est destiné à produire un mélange qui est riche en combustible dans les zones proches de la zone d'allumage (12) mais en augmentant progressivement le pourcentage de l'oxydant dans des zones (13) proches de la connexion avec le fût (2).

3. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications précédentes, **caractérisé en ce que** le mélange explosif produit dans la zone d'allumage (12) est le résultat de l'injection locale

dans cette zone (12) d'un maximum de 25% d'oxydant et de 100% de combustible fourni à la chambre d'explosion dans chaque cycle.

4. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications précédentes, **caractérisé en ce que** la chambre d'explosion (1) incorpore, entre les premiers orifices d'amenée d'oxydant (17) et les orifices d'amenée de combustible (16) une protubérance interne ou une nervure périmétrale (14) qui détermine un rétrécissement de la chambre d'explosion (1) formant un volume restreint (11) qui est exclusivement alimenté en combustible par les orifices (16) de l'injecteur (5). 5
5. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications précédentes, **caractérisé en ce que** les moyens pour l'amenée de l'oxydant comprennent un injecteur axial (4), agencé concentriquement et à l'intérieur de la chambre d'explosion (1), avec une série d'orifices radiaux (17) placés à l'extérieur du volume (11) et directement après la nervure périmétrale (14), et où l'injecteur axial comprend à une extrémité un prolongement (15) s'étendant pratiquement jusqu'au début du fût (2), également avec des orifices radiaux (18), ces orifices étant agencés sur la longueur de la chambre d'explosion (1). 10 15 20 25 30
6. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications précédentes, **caractérisé en ce que** les orifices radiaux (17) et (18) pour l'amenée de l'oxydant sont agencés en biais par rapport à l'axe du fût (2). 35
7. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications précédentes, **caractérisé en ce que** les moyens pour l'amenée distribuée de produits dans le fût (2) sont constitués d'une ou de plusieurs chambres annulaires (9) établies à n'importe quelle position du fût et assistées par une ou plusieurs entrées d'amenée de produit (8), où la ou les chambres annulaires (9) ont des sorties (10) ou des conduits de sortie à travers lesquelles le produit accède au fût (2) d'une manière distribuée de sorte que lorsque ces moyens d'amenée sont utilisés pour l'injection de la poudre de revêtement, elles permettent que la quantité de poudre amenée dans le fût soit augmentée et réduisent des obstructions possibles du conduit d'injection, alors que lorsqu'ils sont utilisés pour l'injection de produits actifs dans la combustion, il est possible de modifier localement la nature du mélange et/ou la condition du processus de projection selon le besoin. 40 45 50 55
8. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications précédentes, **caractérisé en ce que** les sorties (10) sont configurées comme des conduits annulaires de longueur, section et orientation variables.
9. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7 et 8, **caractérisé en ce que** la ou les chambres annulaires (9) sont établies dans une ou plusieurs brides mobiles (7) installées à n'importe quelle position sur le fût, où la ou les brides précitées (7) définissent des segments physiquement indépendants du fût, à la fois pour faciliter l'accès aux injecteurs pendant l'entretien du pistolet et pour permettre à un pistolet unique d'avoir divers segments interchangeables pour déterminer diverses caractéristiques fonctionnelles du pistolet.
10. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7, 8 et 9, **caractérisé en ce que** les sorties (10) sont configurées comme des conduits définis entre la paroi interne du fût (2) et une nervure axiale (25) de la bride (7).
11. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7, 8, 9 et 10, **caractérisé en ce que** les sorties (10) de la chambre annulaire (9) comprennent des rainures longitudinales (23) pour augmenter la quantité de matériau injectée, particulièrement dans le cas de la poudre de revêtement.
12. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7, 8, 9, 10 et 11, **caractérisé en ce que** les sorties (10) de la chambre annulaire (9) comprennent, en plus d'une communication annulaire axiale avec le fût, une multiplicité d'orifices (24) qui s'ouvrent radialement vers le fût, auquel cas les chambres annulaires sont particulièrement appropriées pour l'injection de la poudre de revêtement, en obtenant une grande productivité du pistolet et en réduisant les obstructions dans le conduit d'injection.
13. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7, 8, 9, 10, 11 et 12, **caractérisé en ce que** les chambres annulaires (9) s'ouvrent vers l'intérieur du fût (2) par des conduits annulaires (10) et/ou par un alignement circonférentiel d'orifices (22').

14. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7, 8, 9, 10, 11, 12 et 13, **caractérisé en ce que** la nervure axiale (25) présente une plus grande longueur qui est superposée à l'intérieur du fût (2) de telle manière que lorsque l'injecteur est utilisé pour l'introduction d'un gaz inerte, les gaz d'explosion progressent le long de la zone centrale du fût (2) tandis que le gaz inerte s'écoule en contact avec la paroi du fût en formant un type de film cylindrique mobile qui réduit les pertes de chaleur à travers les parois du fût (2) et qui définit à la sortie de celui-ci un film de protection qui réduit et retarde le mélange des produits du processus d'explosion avec les gaz de l'environnement.
15. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7, 8, 9, 10, 11, 12, 13 et 14, **caractérisé en ce que** les brides citées (7) comprennent une seconde chambre annulaire (20) placée en amont de la chambre annulaire (9) et présentant ses propres conduits d'entrée (21) et qui s'ouvrent vers l'intérieur du fût (2), directement devant la sortie (10) de la chambre annulaire (9), et conçus pour réaliser un second point d'amenée pour l'amenée du produit au fût du pistolet, un produit avec des caractéristiques identiques ou différentes de celui introduit par la première entrée.
16. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7, 8, 9, 10, 11, 12, 13, 14 et 15, **caractérisé en ce que** les brides (7) comprennent un dispositif de séparation (19) pour modifier la séparation entre chaque bride (7) et le segment de fût auquel il est relié de manière à établir une séparation ajustable entre les deux, qui permet l'entrée de l'air extérieur.
17. Pistolet de projection par détonation à taux d'impulsions haute fréquence et à productivité élevée selon les revendications 1, 7, 8, 9, 10, 11, 12, 13, 14, 15 et 16, **caractérisé en ce que** la bride (7) présente une première section convergente, suivie d'une section divergente en correspondance avec la sortie (10) permettant que les deux sections de fût (2) (2') soient connectées.

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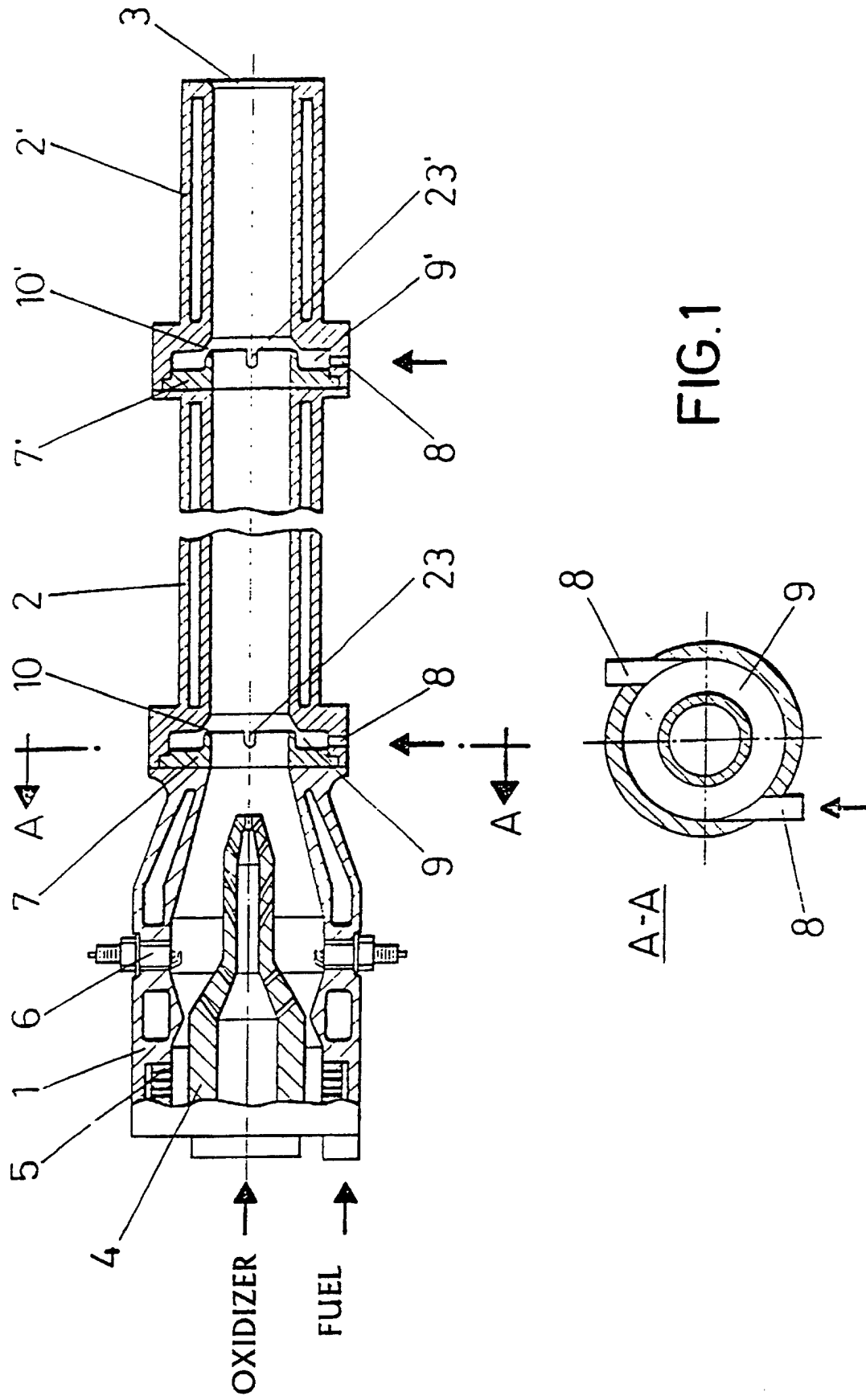
35

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45

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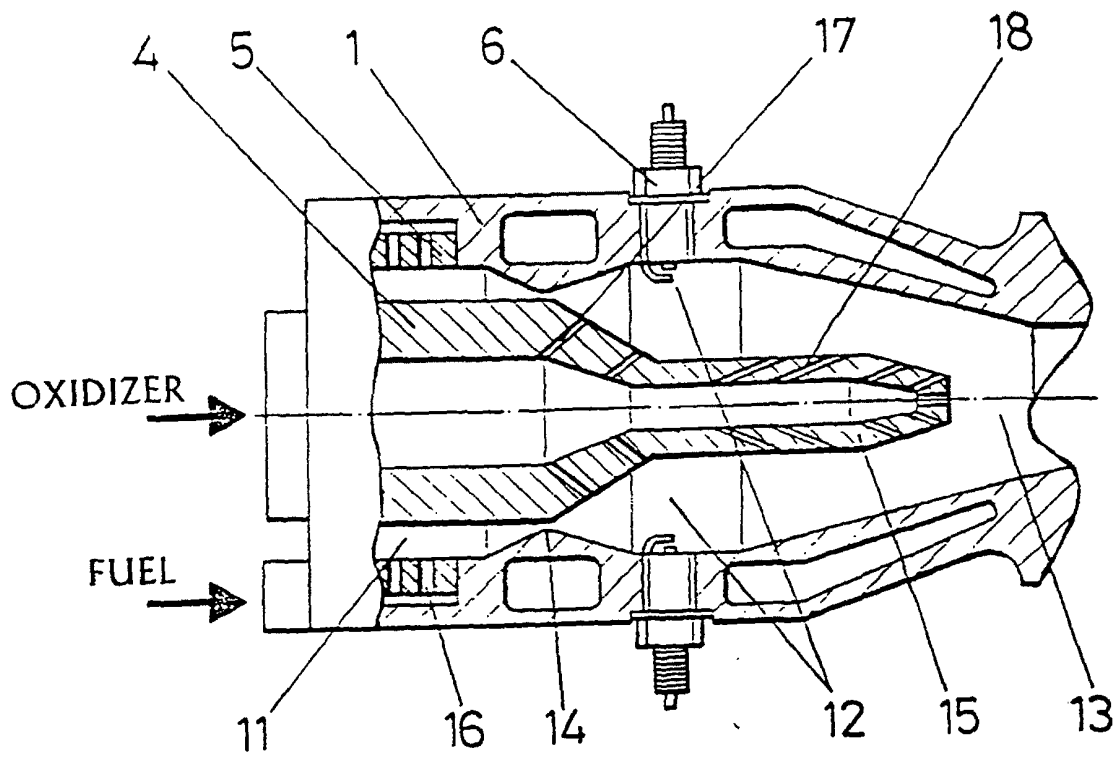


FIG. 2

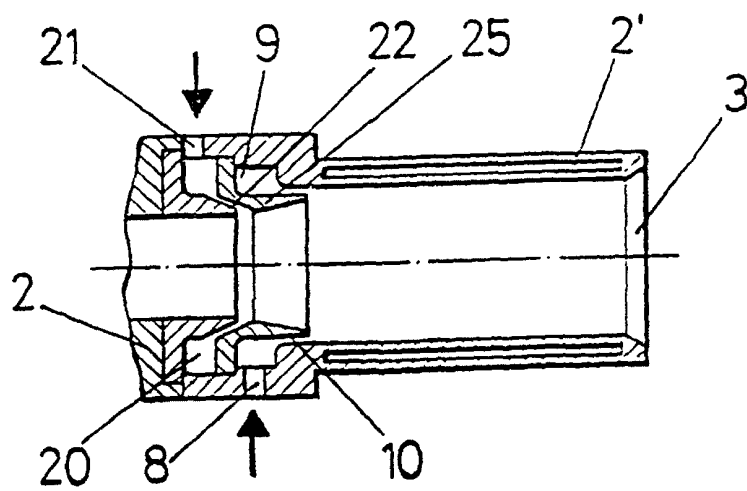


FIG. 3

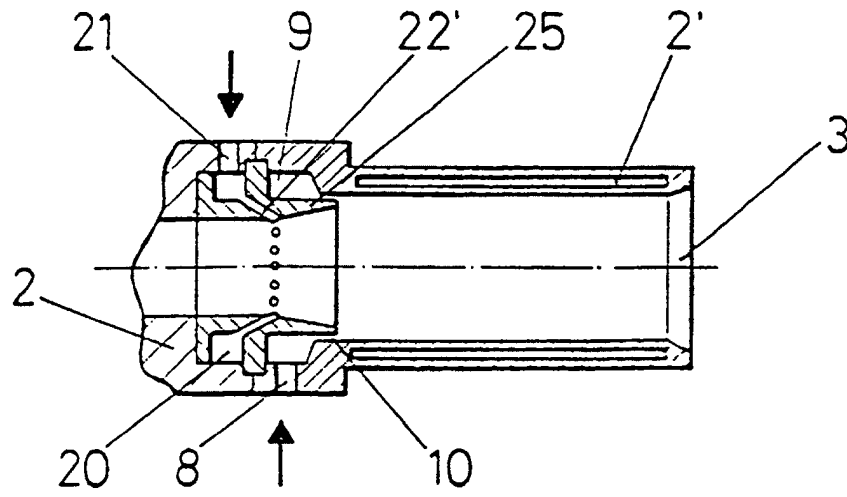


FIG. 4

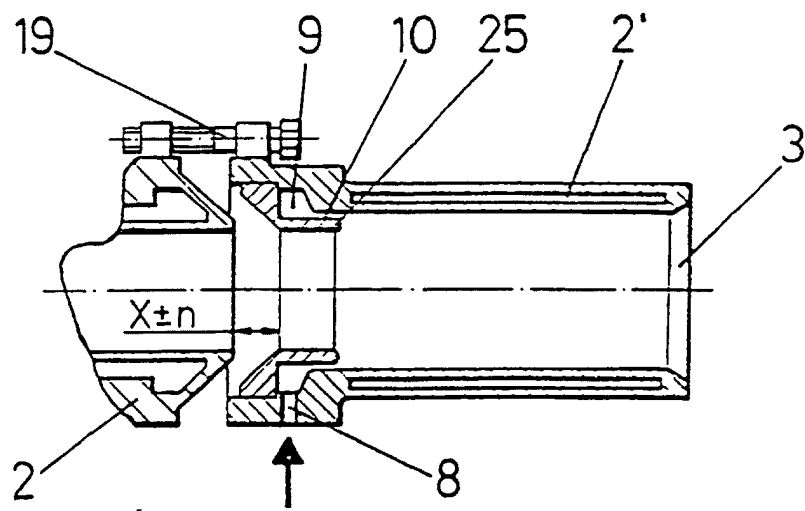


FIG. 5

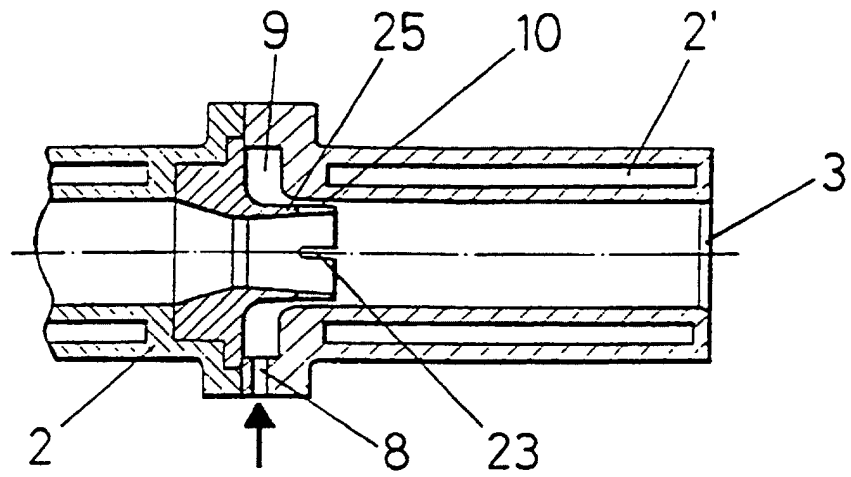


FIG. 6

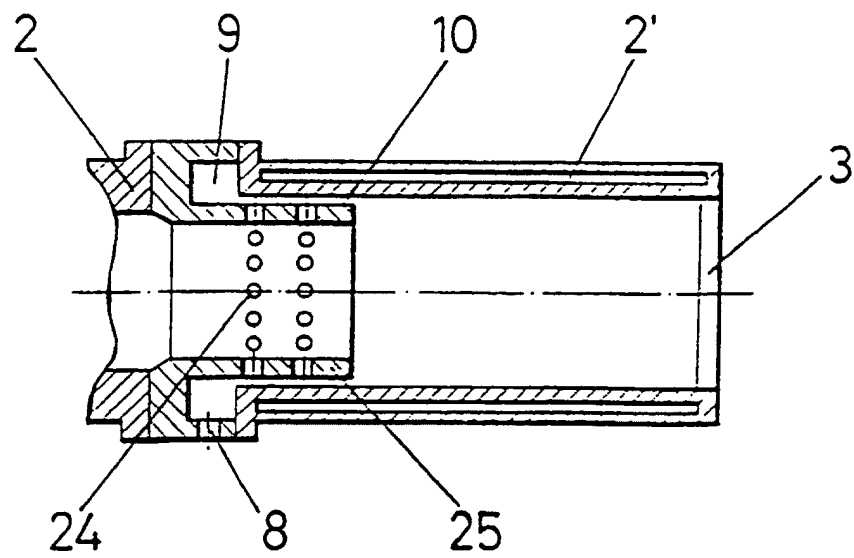


FIG. 7