# CHARACTERISTICS OF COMPLEX INTEGRATIVE TECHNOLOGY FOR A PIPELINE HYDRODYNAMIC INFRASTRUCTURE PREPARATION AS A PART OF INNOVATIVE MONITORING SYSTEM FOR PIPELINES AND EQUIVALENT COMMUNICATIONS.

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For the qualitative monitoring of the liquids flow parameters, solutions and liquid hydrocarbons in various types of pipelines, it is necessary to solve the basic problem of preparing a pipeline or a system of pipelines for such monitoring.

What is the problem?

According to classical science known that in a fluid flow that moves in any pipe under pressure with  a certain linear speed, the level of turbulence differs in different points of the flow cross section. So the level of turbulence in the center of the flow is minimal and the flow in the section center can be called - laminar.

At the same time, in the peripheral annular zone of the flow contact with the inner pipe wall, due to a certain level of hydraulic resistance to the flow  movement, the level of its turbulence reaches a maximum. This fact takes place in case of different fluid viscosity and in case of different surface treatment purity of the pipe inner wall.

If the fluid consumption in the flow can vary periodically from minimum to maximum or from minimum pressure in the flow to maximum, fluctuations and pulsations can occur in the flow, therefore it will largely distort the measured parameters.

This problem is especially aggravated if the monitoring is carried out with aerial photography or from an unmanned aerial vehicle.

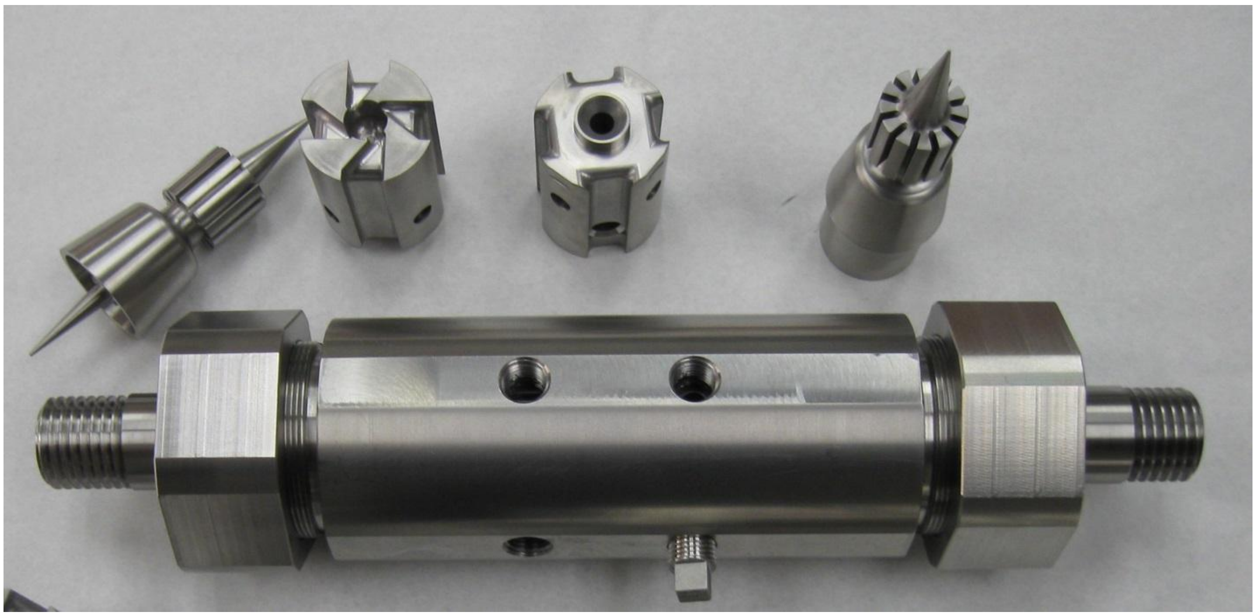

**Figure 1. Device for linear three-dimensional homogenization of fluid flows in pipelines, including homogenization according to the level of turbulence in the center and periphery of the cross section of the pipeline; Productivity of the device - 1000 liters per hour**

In view of the fact that device is the object of a number of inventions, it is necessary to focus on its structural elements features.

Clarification of the created terminology.

In the formula of these inventions synthesized terms are used, such as the double Bernoulli effect, and it is indicated that the Joule-Thomson effect occurs after this effect.


**Figure 2. The scale factor of device for linear three-dimensional fluid flows homogenization in pipelines, capacity is 1000 liters per hour, if size is minimal and moving parts are completely absent.**

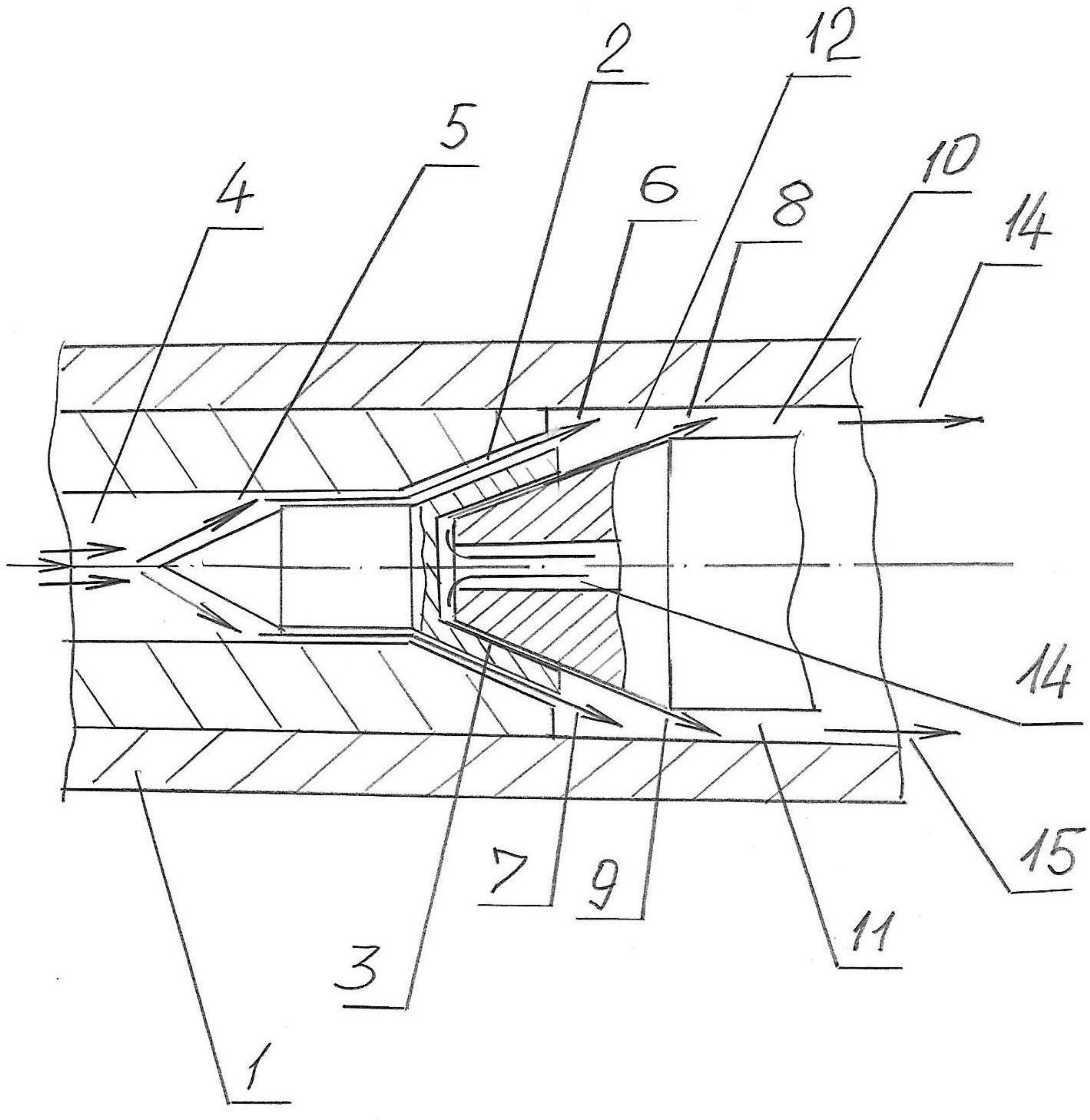


**Figure 3. Diagram of a hydrodynamic or aerodynamic interface in the device for linear three-dimensional homogenization of fluid flows in pipelines**

Double effect of Bernoulli, is defined as follows: device has a combination of two coaxial liquid flows or liquid and gas;

How does this happen:

In case 1, all working channels are on the same axis;

In this case, the conical channel 2 covers the conical channel 3;

The distance between the conical forming surfaces of channel 2 is 100 microns, and the distance between the forming surfaces of channel 3 is 25 microns.

The liquid enters the conical channel 2 through the opening 4, after which the reflector 5 is transformed into an annular flow from where it enters the channel 2 where it accelerates to high linear velocities and forms the Bernoulli effect at the circular output 6 and 7, accompanied by short-term local rarefaction;

The second fluid injection (for the two-fluid operation option) is performed from the second side and the direction of fluid movement is opposite to the first flow.

Input 14 leads the liquid to a turn, after the liquid enters channel 3, in which, due to the small size of the channel (25 microns in total), the linear velocity is bigger at least 4 times than the linear velocity in channel 2.

In view of this, at the outputs 8 and 9 from channel 3, the Bernoulli effect is also formed, accompanied by local rarefaction.

Since channels 2 and 3 are coaxial and distance between them is at least 2 millimeters, in coaxial high-speed fluid flows output zone from channels 2 and 3 occur two also coaxially oriented in three-dimensional space rings 10 and 11 in which operate two independent local zones with the Bernoulli effect, and the independence of the effects in these zones has a very short cycle time, after which they are mixed (scale factor within 0.1 second)

The end result of this process makes it possible to homogenize the level of turbulence in the center and on the periphery of the flow cross section.

In addition, at the exit to the section of the annular channel 12, the channel volume increases sharply, it creates conditions for the occurrence of a cooling effect in accordance with the Joule-Thompson effect; This is particularly effective and clearly fixed when gaseous agent is used as a second material.

Gas is significantly cooled when expanding, which is very important in fuel lines - it was recorded in all tests.

After many test cycles  additional effects, that occur in the described process, can be formulated as follows:

- when passing through the device there is no pressure drop

- formation process of cavitation breaks occurs at the time of flow separation from the channel end, which helps to form an encapsulated mixture structure when mixed

- linear flow movement after the described process is stable and smooths the peaks of flow fluctuations

- spray dispersion (in case the components of the fuel were mixed) increases with decreasing injection pressure.

In addition to originality and newness, as it turned out, there is expectation of the new thermodynamic cycle implementation.

Moreover proposed new technology used to homogenize the level of turbulence allows the Humphrey cycle to be implemented in the conditions of the latest internal combustion engines, gas turbines and modern diesel engines that have high-pressure pumps as part of the fuel system.

In such design the implementation of the four processes Humphrey cycle can be carried out in stages, - part before the high pressure pump and part after the high pressure pump, including injection into the combustion chambers or cylinders.

Before the high-pressure pump, the Humphrey cycle is implemented as a micro process, and while it is in the high-pressure pump and before the injection in form of series of pulses, is implemented as a nano process.

The principle of device operation for dynamic instant mixing, simultaneous three-dimensional homogenization and controlled homogeneous activation and forced transformation of liquid fuel into a compressible fuel composite provides precompressed air to the stream of incompressible fuel liquid;

Compressed air is introduced into multichannel integrative input, in which all radial flows converge are in the center, where resistance to movement increases sharply, which causes stagnation and a local increase of temperature in compressed air flows;

Since compressed air is introduced into at least 4 streams and is extracted through only one stream, gradually the amount of air in this zone increases sharply, the pressure also increases and the temperature rises;

The end result of the first process, the static pressure increases, the density of the compressed gas in this point increases and its temperature increases;

All this in conjunction contribute to the formation of cavitation discontinuities in the liquid fuel flow and homogeneous saturation of coaxial liquid fuel flows with micro bubbles of compressed air.

In the proposed technology an additional amount of heat is added to the base volume of heat, which under normal conditions is not added.

Moreover, for the implementation in modern conditions of the processes inherent in the Humphrey cycle, it is not necessary to associate this additional heat with the air supply to the process.

For example, all the processes inherent to and that forming the Humphrey cycle can be implemented using mixtures of diesel fuel with methanol or pure methanol as fuel.

In the new technology, due to the three-dimensional encapsulation, methanol additionally gives off the total heat from methanol evaporation to the overall heat balance of the process (three times more than, for example, gasoline)

When the same mixture is fed to a high-pressure pump, temperature of the mixture compressed to 2000 bar increases significantly and at this temperature the fuel mixture is injected into the combustion chamber.

At the same time, all the main features of the second process are preserved, which means that the specific volume (or density) remains constant throughout the process of additional heat supply.

The new technology allows the third process to be carried out in several ways.

Each option each fully complies with the requirements and conditions of the processes, but time and method of air introducing  differ.

The first option involves the mixing of compressed air with liquid fuel, passing simultaneously with the three-dimensional encapsulation.

In this case, the capsule has the form of at least a two-tier structure in which the core is air microbubble air and the shell is a liquid fuel.

The second option involves the formation, for example, a mixture of liquid fuel and methanol, encapsulation with the formation of three-dimensional capsules in which the core is micro drops of methanol, and the shell is liquid fuel.

After the high-pressure pump, the pressure of the mixture rises to 2000 bar and the size of the capsules is minimized to a nano scale.

When injected, the fuel mixture is combined with compressed air and reaction occurs - take heat and energy to evaporate the nuclei of the capsules, as a result lowering of mixture.

In this state the mixture enters into a combustion reaction under optimal local conditions and homogeneous linear and three-dimensional parameters of the capsules.

The third option is similar to the second and involves the use of water and liquid fuel emulsion.

In the proposed technology, due to the fact that the duration of the combustion cycle due to the encapsulated structure of the fuel mixture is significantly shorter, the process of heat and energy extraction is also reduced.

This process of energy transfer occurs even before the moment when air begins to be forced out of the combustion chamber.

This contributes to the fact that the temperature of the exhaust gases at the initial stage of their displacement from the combustion chamber is significantly lower than in the usual process and when the exhaust gases enter the atmosphere, the heat exchange process is very intense.

One of the main reasons for this phenomenon is the clear structure of the materials in the combustion chamber, where the encapsulated portion of the injected fuel mixes extremely quickly with air. Moreover, the extremely uniform evaporation process of the capsule cores contributes to a more rapid and also homogeneous removal of heat from the entire volume of injected fuel.

Constant pressure heat dissipation. At this stage, heat is removed from the working fluid, while the fluid has constant pressure. In an open engine cycle, this process is usually the expulsion of gas from the engine, where it quickly equalizes to ambient pressure and slowly loses heat to the atmosphere, which is considered as infinitely large reservoir for storing heat at constant pressure and temperature.

Consider the same process when used fuel is a natural gas or a mixture of combustible gases, and in some cases, bio-gases.

Gaseous fuel composite properties in the composition of 100% of the natural gas flow rate and 40% of the optimal air flow rate (stoichiometric air ratio 1: 9.7):

Density - 1.29 kg / m3

Flow pressure - 1.51 bar

The number of vortex spirals per 200 millimeters of flow - 60

The step between the turns of the spiral - 3.3 millimeters.

The linear velocity of the composite flow to ignition - 29.296 m/s.

The linear velocity of the composite is 5 times higher than that of  natural gas stream.

The combustion cycle time is 4 times less than that of natural gas

The number of pulses in a  full combustion cycle - 3637

The geometric shape of the flame - spherical

The torch flame is stable, the emission spectrum is homogeneous.

Type of combustion - volumetric.

Enters the primary phase of combustion during ignition (flash) - 40% of the volume of the composite.

Composite natural gas residence time in the flame zone - 5 times longer than that of natural gas.

The nominal pressure of natural gas in the composite stream is equal to the pressure in the composite stream and is greater than the pressure in the natural gas stream under normal conditions - at least 10 times.

Composite temperature before ignition is lower than the temperature of natural gas under normal conditions by at least 25%.

All this indicates that the gaseous fuel composite during combustion corresponds to the Humphrey cycle and has a wide combustion spectrum, with a high density and constant volume of the flame.

Under equal combustion conditions the oxygen concentration in the exhaust gases of the gaseous fuel composite is 11.4% lower.

The increased pressure of natural gas in the composite stream, the reduced oxygen concentration in the exhaust gases, the volume of the spherical fragment of the flame torch during combustion of the fuel gaseous composite in relation to the total volume of the flame during combustion of natural gas at 95.184% show that homogeneous combustion temperature in the spherical fragment of the flame torch (corresponding to the Humphrey cycle) is higher than the average temperature in an ordinary (corresponding to the Brayton cycle) flame torch by at least 15 - 17%.

The increase in the specific power of the internal combustion engine in relation to the amount of spent fuel, when using fuel fog - a fuel composite obtained by dynamically mixing hydrocarbon liquid fuel with a compressed gaseous oxidizer.

In the event that gasoline is used as fuel for an internal combustion engine:

A homogeneous mixture of gasoline with compressed air, in which compressed air (pressure at least 5 atmospheres), in the form of bubbles with a diameter of not more than 50 microns, is evenly distributed in the volume of gasoline, so that, thanks to surface tension forces, gasoline forms a shell around the air bubbles.

The volume of compressed air in the mixture is more than 200 times the volume of gasoline and its amount is sufficient for optimal combustion.

The mixture has compressibility properties.

When injected into the engine cylinder, the proportions and ratios in the volume of the mixture do not change, due to the fact that the diameter of the bubbles with shells does not exceed 20 -40 microns, due to the minimum size and compressibility, the mixture does not change its properties and geometric proportions during injection;

After injection into the cylinder, the pressure at which at the moment of injection is almost equal to atmospheric, adiabatic expansion of air occurs inside the bubbles, proportional to the difference in pressure inside the bubbles and in the cylinder

The expanding air breaks shells on the bubbles into small fragments of no more than 3-5 microns in size and evenly envelops these fragments, while maintaining volumetric proportions between gasoline and air, sufficient for optimal combustion.

The whole process of converting a mixture - a fuel composite into fuel fog, in which particles of gasoline with sizes of 3-5 microns are uniformly mixed with an air volume sufficient for optimal combustion, takes no more than 0.001 seconds.

Thus, ignition can be carried out immediately after completion of the injection and due to the fact that time for mixing gasoline with air is not required, injection and subsequent ignition of fuel fog are carried out at a time when the motion conversion system in the engine is not in one of the dead points at which at least 60% of engine power is lost.

In a conservative assessment, the use of fuel fog with the properties described above can reduce power losses by 45-50%, and accordingly increase the specific power received per 1 gallon of gasoline.

In case that diesel is used as fuel for a diesel engine: a homogeneous mixture of diesel fuel with compressed air, in which compressed air (pressure at least 5 atmospheres), in the form of bubbles with a diameter of not more than 50 microns, is evenly distributed in the volume of diesel fuel, so that, due to surface tension forces, and high viscosity, diesel fuel, forms a shell around air bubbles.

The volume of compressed air in the resulting mixture is more than 200 times the volume of diesel fuel and its amount is sufficient for optimal combustion

The mixture has compressibility properties.

The mixture - fuel composite - is fed into a high-pressure pump, from where it is injected in an even more compressed form into the cylinder of a diesel engine.

When a diesel engine is injected into the cylinder, the proportions and ratios in the volume of the mixture do not change, due to the fact that the diameter of the bubbles with shells during formation does not exceed 20 -40 microns, and in a high-pressure pump with strong compression, the size of the bubbles with shells still decreases to 15 - 20 microns;

Due to its minimal size and compressibility, the mixture does not change its properties and geometric proportions during injection;

After injection into the cylinder of a diesel engine, the pressure at which at the time of injection is substantially lower than in the bubbles, adiabatic expansion of air occurs inside the bubbles, proportional to the difference in pressure inside the bubbles and in the cylinder of the diesel engine.

The expanding air breaks the bubbles shells into small fragments less than 2-4 microns in size and evenly envelops these fragments, while maintaining volumetric proportions between diesel fuel and air sufficient for optimal combustion.

The whole process of converting a mixture - a fuel composite into fuel fog, in which particles of diesel fuel with sizes of 2 to 4 microns are uniformly mixed with an air volume sufficient for optimal combustion, takes no more than 0.001 seconds.

Thus, compression in the cylinder and ignition can be carried out immediately upon completion of the injection and due to the fact that time for mixing diesel fuel with air is not required, injection and subsequent compression and ignition of the fuel fog are carried out at a time when the motion conversion system in the diesel engine is not in one of the dead spots in which at least 50% of the diesel engine power is lost.

In a conservative assessment, the use of fuel fog with the properties described above can reduce power losses by 40 - 45%, and accordingly increase the specific power received per 1 gallon of diesel fuel.

If as a fuel for an internal combustion engine, natural gas is used:

Before injection into the engine cylinder, natural gas with compressed air in a device for dynamic vortex mixing, form a vortex tube;

In this vortex tube, the natural gas stream is uniformly mixed with cooled compressed air in a volume ratio of 9.7 to 1, and after mixing, the mixture is a fuel gaseous composite, is completely ready for combustion and does not require additional air.

The mixture, after exiting the hermetically sealed space, retains the state and proportions obtained during its formation in the vortex tube for more than 3 seconds.

As the mixture is completely ready for ignition at the moment of injection, the injection and ignition are performed at the moment when the engine movement conversion mechanism is not in one of the dead points, and thus eliminate or reduce engine power loss to overcome the dead points that are in a conventional engine can reach 60% or more.

This fact allows reducing power losses for overcoming dead points by 45 - 55% and in the same proportion to increase the specific power developed by the engine per 1 cubic foot of natural gas.

**Figure 4. Geometry of the apparatus internal parts for linear three-dimensional homogenization of fluid flows in pipelines.**

It makes sense to dwell on the design and functional features of the device in more detail.

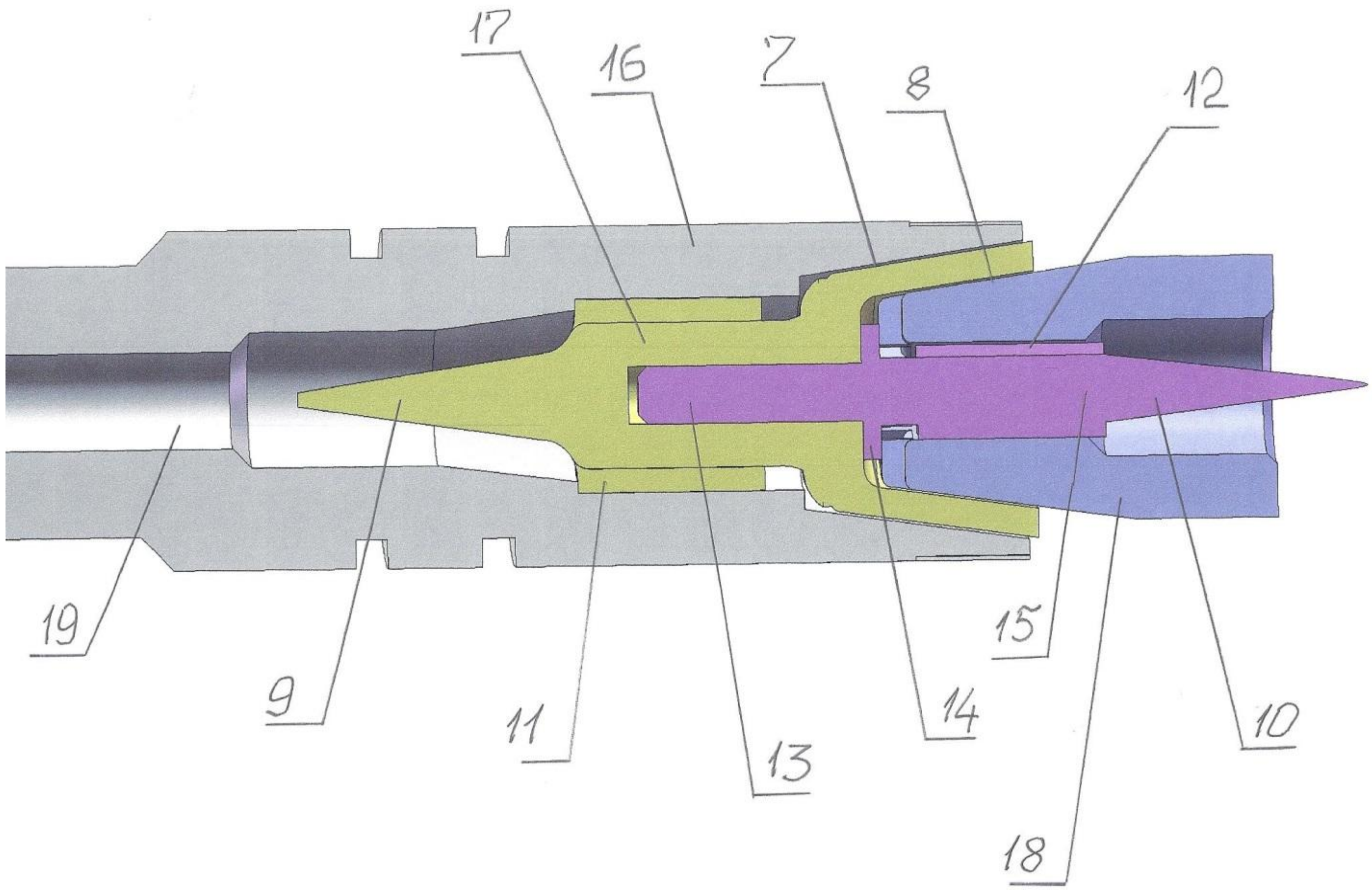


**Diagram 1.**

Diagram 1 shows an axial section of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, compressed gases.

The cross section shows two reflectors constituting the hydrodynamic interface of the device in combination with the hydrodynamic transformation section of the liquid component of the mixture and the aerodynamic (according to the first version) transformation section or the second hydrodynamic transformation of the liquid component of the mixture (according to the second version)

The numbers on the diagram indicate:

7- conical channel with a distance between the conical forming surfaces of 100 microns, which is part of a system that homogenizes the mixture flows components in terms of turbulence, consisting of two coaxial conical ring channels of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

8 - conical channel with a distance between the conical forming surfaces of 25 microns, which is also part of the system homogenizing the flows of the components of the mixture in terms of turbulence, consisting of two coaxial conical ring channels of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

9 - the first conical reflector in the direction of movement mixture components, which is part of the hydrodynamic interface; The specified reflector in the device acts as a transducer of the cylindrical flow of the mixture component into a circular flow with a more uniform turbulent background.

10 - the second conical reflector along the movement of the mixture components, depending on the nature of the mixture componentsbeing part of either the hydrodynamic or aerodynamic interface; The top of the reflector conical surface is directed in the opposite direction from the top of the reflector 9.

11 - a system of linear, mainly capillary channels, uniformly distributing the annular flow of the mixture components over the annular cross section and at the same time increasing the level of turbulence and the linear velocity of the mixture flow

components; The specified system relates to an integrated hydrodynamic interface of a mixing device, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

12 - a system of linear, mainly capillary channels, uniformly distributing the annular flow of the mixture components over the annular cross section and at the same time increasing the level of turbulence and the linear velocity of the mixture flow components; The specified system relates to the second part of the integrated hydrodynamic or aerodynamic interface of a mixing device, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

13 - orienting, centering, fixing and spacing pin of the integral interface of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

14 - orienting, centering, fixing and spacing flange of the integral interface of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases, by which the distance between the conical surfaces of the annular conical channel 8 is changed.

15 -  inverse element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

16 - hydrodynamic section of mixing device, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

17 - direct element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

18 - multifunctional hydrodynamic or aerodynamic section of mixing device, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

19 - input channel of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

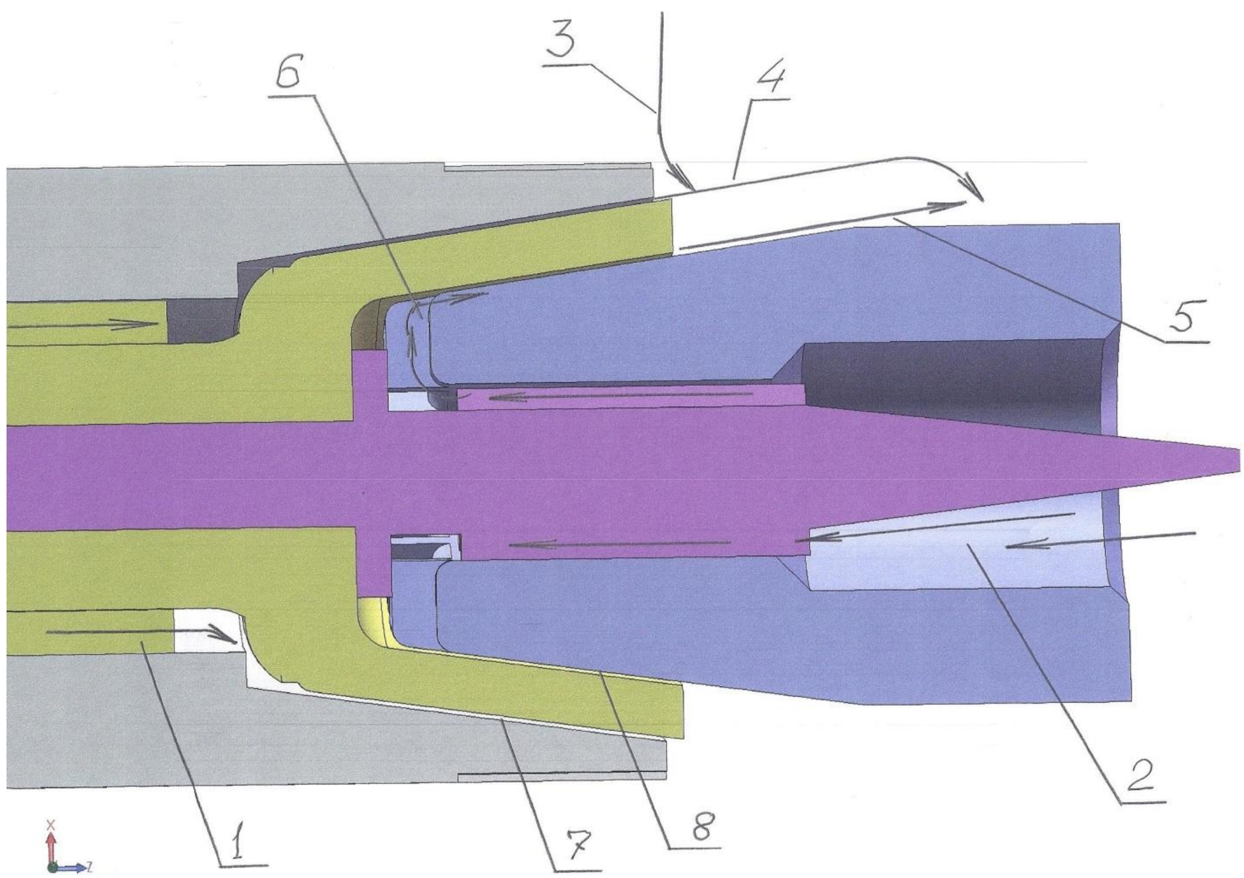


**Diagram 2**

Diagram 2 shows the axial section of the zone of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases, in which the first stage of mixing and homogenizing the mixture occurs according to the level of turbulence.

Mixing and homogenizing the mixture according to the level of turbulence is carried out in the developed hydrodynamic mode, in a high-speed flow of moving components of the mixture, in a constant volume of the annular cavity into which the mixture components are introduced at constant speed and constant pressure in the form of coaxial high-speed ring-shaped flows, the thickness of which is in place input into the specified annular cavity is 100 microns for the external stream and 25 microns for the internal stream.

The numbers in diagram 2 indicate:

1 - flow of the base mixture component (60% of its volume or weight); The flow direction coincides with the direction from the entrance to the mixing device, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases to exit the specified device.

2 - the flow of the base component of the mixture (in case liquid is mixed with liquid) in an amount of 40% of its volume or weight; If liquid and gas are mixed, then this is a gas flow in an amount of 100% of its volume or weight; The flow has a direction of motion directly opposite to the flow of the base component 1.

3 - flow of the second liquid mixture component (for cases of mixing several liquid components.

4 - the trajectory of flow 1 after exiting the conical annular channel 7 and at the place of formation of the conditions for the Bernoulli effect to occur, local ring rarefaction due to the Bernoulli effect, and the formation of cavitation gaps in the stream; The thickness of the stream is 100 microns.

5 - the trajectory of flow 2 after a complete turn and change of direction and after exiting the conical annular channel 8 and at the place of conditions formation for the Bernoulli effect to occur, local ring rarefaction due to the Bernoulli effect, and the formation of cavitation gaps in the stream; The thickness of the flow is 25 microns, which provides an increase in the linear velocity of the motion in comparison with the linear velocity of the flow of 1 by approximately 4 times, and all this together allows increasing the level of turbulence in the central zone of the flows and allows homogenizing the mixture flow by the level of turbulence.

6 - a place in which the flow moves in the opposite direction; Due to this, a coaxial system of flows is formed, each of which forms a local Bernoulli effect, but with different depths of rarefaction and with different sizes of cavitation discontinuities; Due to the higher flow velocity in the central zone and within the dimensions, as well as the creation of the most optimal conditions for volume homogenization of the level of turbulence of the mixture flow.

7 - conical channel with heights between conical surfaces of 100 microns, which is part of a system of homogenizing flows of mixture components at the turbulence level, consisting of two coaxial conical ring channels, gases.

8 - conical channel with a distance between the conical forming surfaces of 25 microns, which is also part of a system that homogenizes the flows of the components of the mixture in terms of turbulence, consisting of two coaxial conical ring channels of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

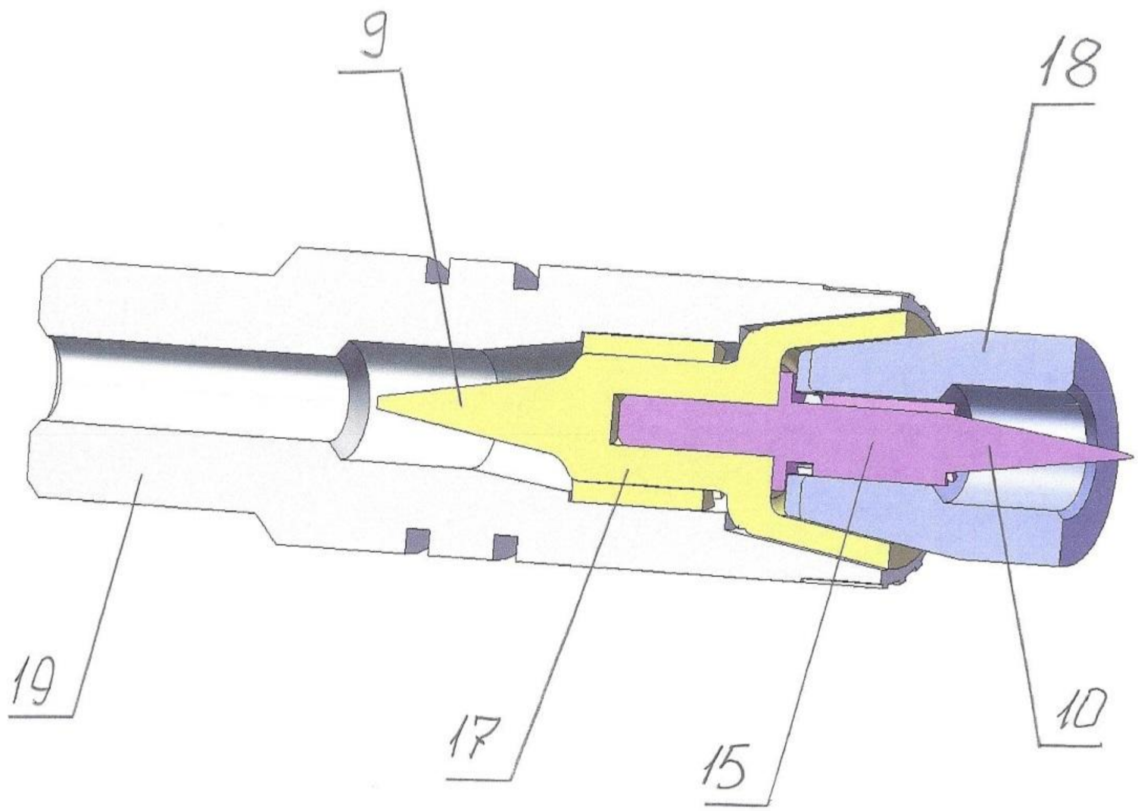


**Diagram 3**

Diagram 3 shows the zone of the integrated interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases

The specified area is shown in axial section.

The numbers in diagram 3 indicate:

9 - the first in the direction of movement of the mixture components conical reflector, which is part of the hydrodynamic interface; The specified reflector in the device acts as a transducer of the cylindrical flow of the mixture component into an annular flow with a more uniform turbulent background

10 - the second conical reflector along the movement of the components of the mixture, depending on the nature of the components of the mixture being part of either the hydrodynamic or aerodynamic interface; The top of the conical surface of the reflector is directed in the opposite direction from the top of the reflector 9

15 - an inverse element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

17 - direct element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

18 - multifunctional hydrodynamic or aerodynamic section of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

19 - input channel of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

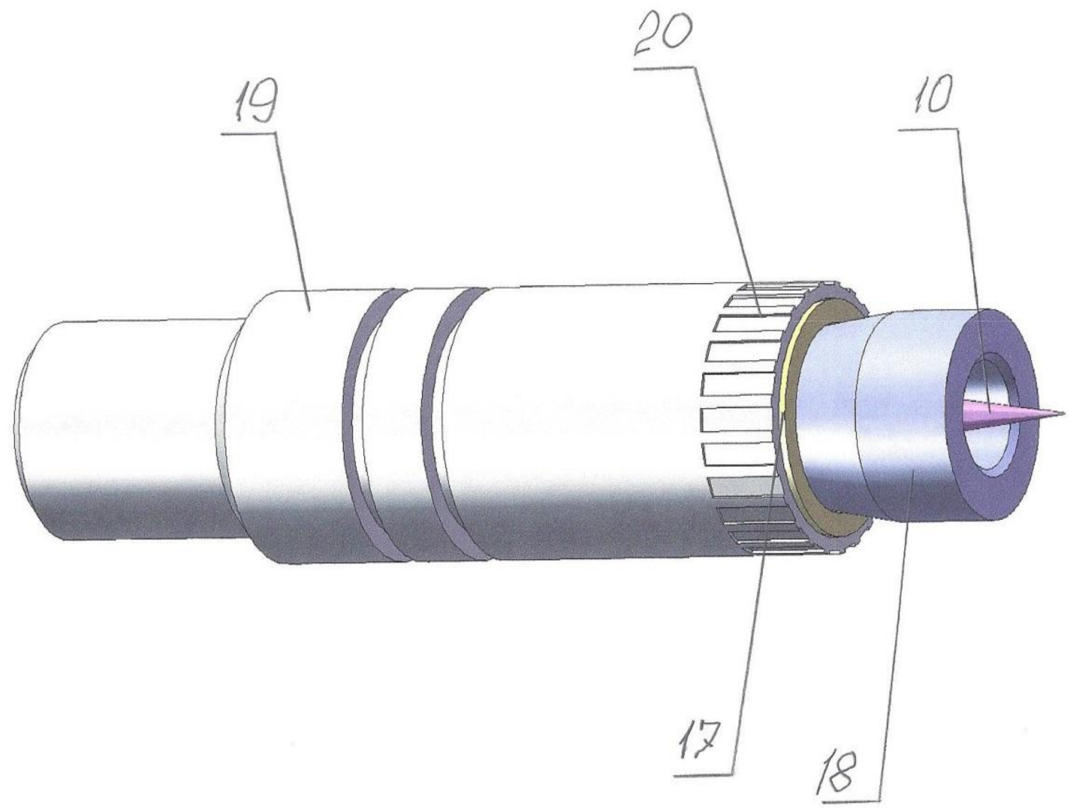


**Diagram 4**

Diagram 4 shows the zone of the integrated interface included in the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases.

The numbers in diagram 4 indicate:

10 - the second conical reflector along the movement of the components of the mixture, depending on the nature of the components of the mixture being part of either the hydrodynamic or aerodynamic interface; The top of the conical surface of the reflector is directed in the opposite direction from the top of the reflector 9.

17 - direct element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

18 - multifunctional hydrodynamic or aerodynamic section of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

19 - input channel of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

20 - a system of uniformly distributed channels through which stream 3 of the mixture component, it can be water or methanol or ethanol (stream 3 is shown in diagram 2) is introduced into the zone of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases, designed functionally for intensive dynamic mixing and homogenization of the mixture components in terms of turbulence.

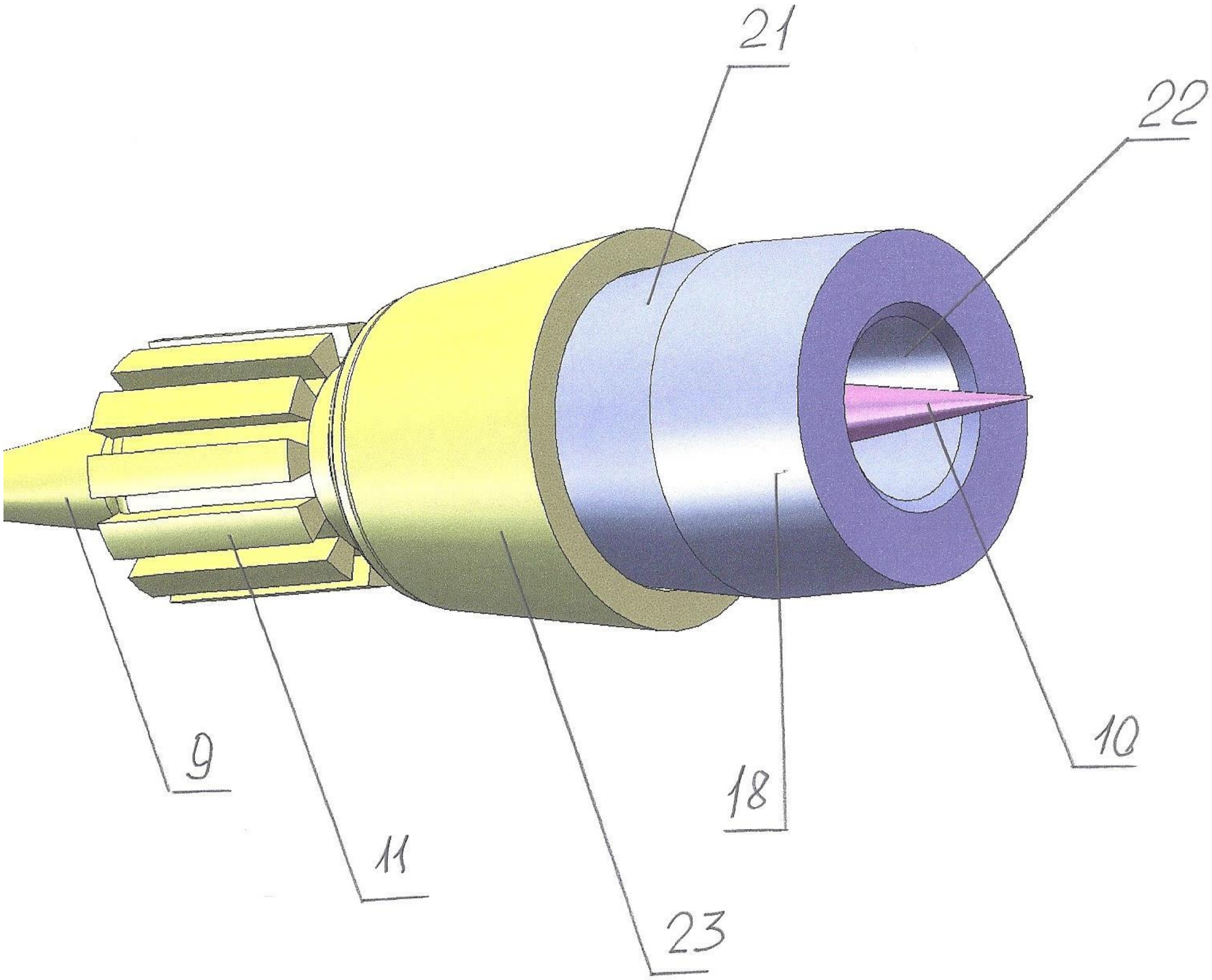


**Diagram 5**

Diagram 5 shows the main structural elements of the integrated interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases, which are structurally and functionally combined with a multifunctional hydrodynamic or aerodynamic section of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases.

The numbers in diagram 5 indicate:

9 - the first in the direction of movement of the mixture components conical reflector, which is part of the hydrodynamic interface; The specified reflector in the device acts as a transducer of the cylindrical flow of the mixture component into an annular flow with a more uniform turbulent background.

10 - the second conical reflector along the movement of the components of the mixture, depending on the nature of the components of the mixture being part of either the hydrodynamic or aerodynamic interface; The top of the conical surface of the reflector is directed in the opposite direction from the top of the reflector 9.

11 - system of linear, mainly capillary channels, uniformly distributing the annular flow of the mixture components over the annular cross section and at the same time increasing the level of turbulence and the linear velocity of the flow of the mixture components; This system refers to the integrated hydrodynamic interface of mixing device, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases.

18 - multifunctional hydrodynamic or aerodynamic section of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

21 - conical surface forming the channel 8.

22 - channel for introducing the second component of the mixture, either as a 100% gas component or as 40% of the main liquid component of the mixture.

23 - conical surface forming the channel 7.

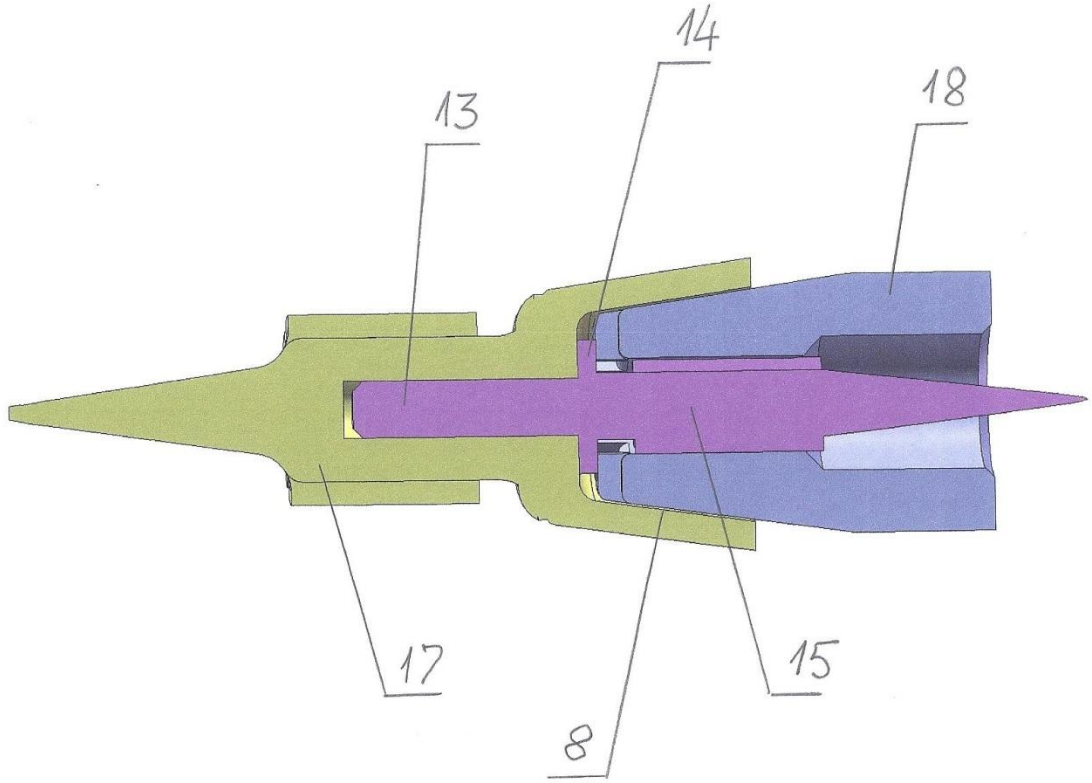


**Diagram 6**

Diagram 6 shows an axial section of the integrated interface of mixing device, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases.

The numbers in diagram 6 indicate:

8 - conical channel with a distance between the conical forming surfaces of 25 microns, which is also part of a system that homogenizes the flows of the components of the mixture in terms of turbulence, consisting of two coaxial conical ring channels of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

13 - orienting, centering, fixing and spacing pin of the integral interface of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

14 - orienting, centering, fixing and spacing flange of the integral interface of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases, by which the distance between the conical surfaces of the annular conical channel 8 is changed.

15 - inverse element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

17 - direct element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

18 - multifunctional hydrodynamic or aerodynamic section of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

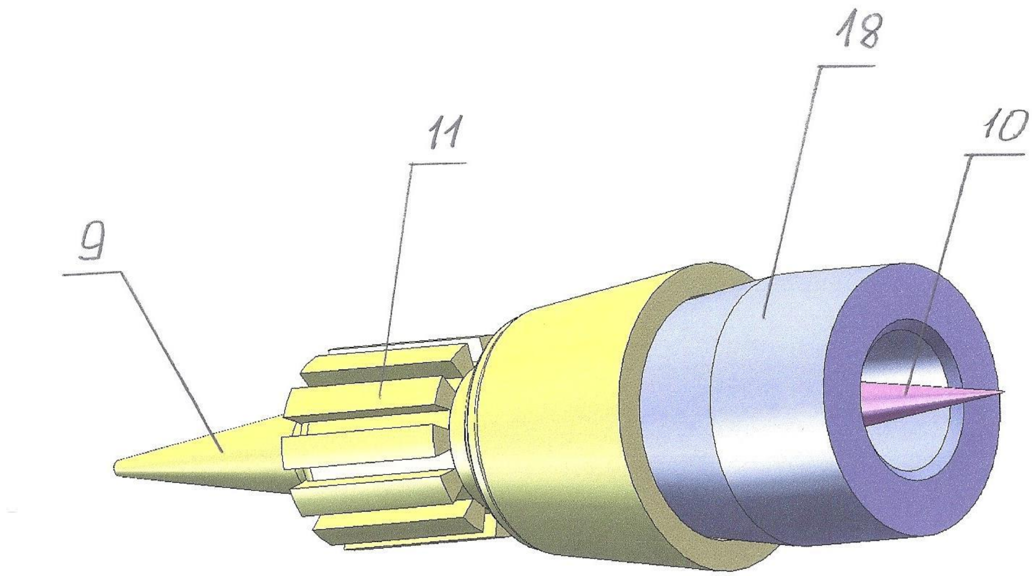


**Diagram 7**

Diagram 7 shows the integrated interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases

The numbers in diagram 7 indicate:

9 - the first in the direction of movement of the mixture components conical reflector, which is part of the hydrodynamic interface; The specified reflector in the device acts as a transducer of the cylindrical flow of the mixture component into an annular flow with a more uniform turbulent background.

10 - the second conical reflector along the movement of the components of the mixture, depending on the nature of the components of the mixture being part of either the hydrodynamic or aerodynamic interface; The top of the conical surface of the reflector is directed in the opposite direction from the top of the reflector 9.

11 - a system of linear, mainly capillary channels, uniformly distributing the annular flow of the mixture components over the annular cross section and at the same time increasing the level of turbulence and the linear velocity of the flow of the mixture components; This system refers to the integrated hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases.

18 - multifunctional hydrodynamic or aerodynamic section of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

**Figure 5. Photo of parts, device with a working diameter of 30 mm.**

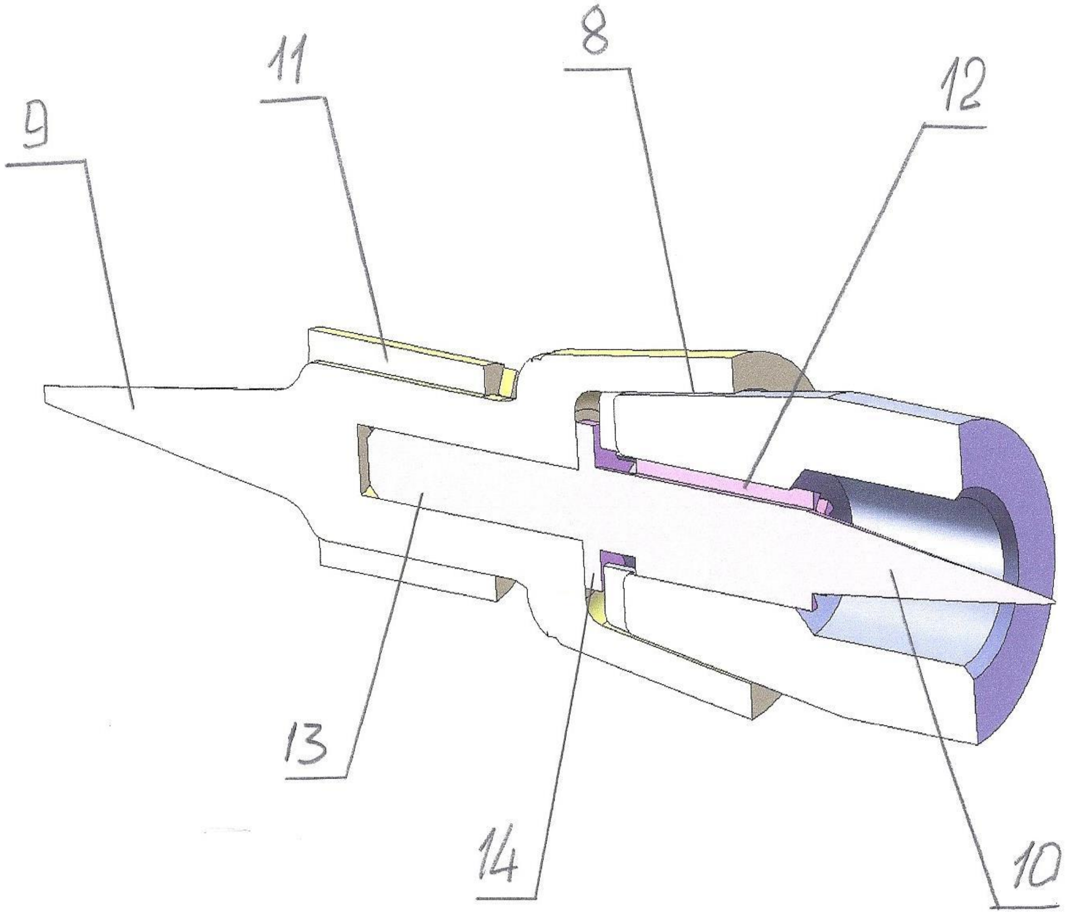


**Diagram 8**

Diagram 8 shows a three-dimensional image of the integrated interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases, in axial section.

The numbers in diagram 8 indicate:

8 - conical channel with a distance between the conical forming surfaces of 25 microns, which is also part of a system that homogenizes the flows of the components of the mixture in terms of turbulence, consisting of two coaxial conical ring channels of the

device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

9 - the first in the direction of movement of the mixture components conical reflector, which is part of the hydrodynamic interface; The specified reflector in the device acts as a transducer of the cylindrical flow of the mixture component into an annular flow with a more uniform turbulent background.

10 - the second conical reflector along the movement of the components of the mixture, depending on the nature of the components of the mixture being part of either the hydrodynamic or aerodynamic interface; The top of the conical surface of the reflector is directed in the opposite direction from the top of the reflector 9.

11 - a system of linear, mainly capillary channels, uniformly distributing the annular flow of the mixture components over the annular cross section and at the same time increasing the level of turbulence and the linear velocity of the flow of the mixture components; This system refers to the integrated hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases.

12 - a system of linear, mainly capillary channels, uniformly distributing the annular flow of the mixture components over the annular cross section and at the same time increasing the level of turbulence and the linear velocity of the flow of the mixture components; The specified system relates to the second part of the integrated hydrodynamic or aerodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

13 - orienting, centering, fixing and spacing pin of the integral interface of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

14 - orienting, centering, fixing and spacing flange of the integral interface of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases, by which the distance between the conical surfaces of the annular conical channel 8 is changed.

**Figure 6. Photo of parts, apparatus - device with a working diameter of 30 m**m

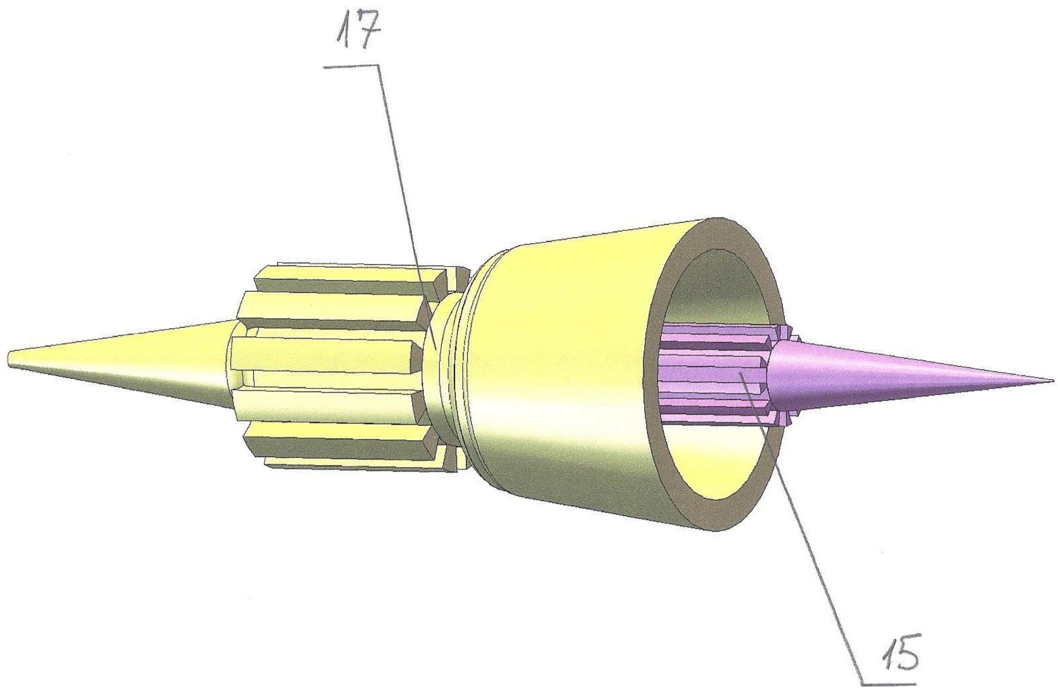


**Diagram 9**

Diagram 9 shows both basic elements of the integrated interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, or several compressed gases.

Each of the integral elements of the integrated interface has the functions of dynamic transformation of the shape and geometric structure of the flow, which are expressed in the transformation of a cylindrical flow in an annular flow and excluding from the flow exactly the central part of the flow in which the level of turbulence is the smallest.

The form and functions of the integrated interface are new and sufficient for the application of the integrated interface as an autonomous independent element in hydrodynamic systems with a cylindrical flow shape.

The numbers in diagram 9 indicate:

15 is an inverse element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

17 is a direct element of the integrated aerodynamic or hydrodynamic interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

Diagram 10 shows an axial section of the integrated interface of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases.

Both structural and functional interface elements are interconnected by a pin 13;

The flange 14 limits and fixes the relative position of both elements relative to each other.

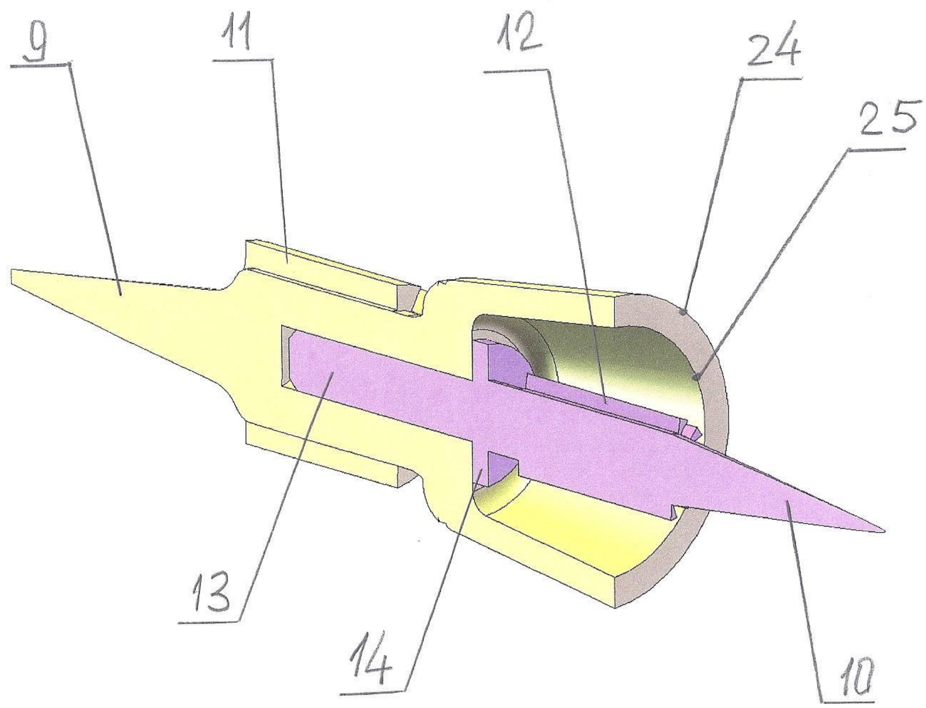


**Diagram 10**

The numbers in the diagram indicate:

24 - conical surface forming the inner surface of the outer annular conical channel, the distance between the forming surfaces of which is 100 microns.

25 - conical surface forming the outer conical surface of the inner annular conical channel, the distance between the forming surfaces of which is 25 microns.

This type of interface in a mixing device, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases, performs the fundamental functions of transforming the flows of mixture components and provides all the necessary changes in the trajectory and direction of movement of flows of mixture components that homogenize the level of uniformity of turbulent properties mixtures, in terms of increasing the level of turbulence in the center of the stream and homogenizing it with the level of turbulence in the stream periphery.

Such an element is fundamentally new both from the constructive, layout and functional points of view, and from the point of view of ensuring the achievement of the whole complex of goals set in the invention:

- ensuring the implementation of the entire process of mixing and homogenization of the flows of the components of the mixture according to the level of turbulence;

- providing the ability to perform all the functions of the device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases without the use of moving parts;

- the formation of a coaxial flow of the mixed components and its transfer to the mixture flow with a homogenized level of turbulence;

- performance of all the functions of a device for mixing, homogenizing and activating liquid mixtures, liquids and compressed gases, several compressed gases with a minimum of structural components;


**Figure 7. Apparatus with a working diameter of 30 mm**

## References and patent-licensed materials:

Attachment #1

| | |
|---|---|
| **United States Patent Application** | **20170184055** |
| **Kind Code** | **A9** |
| | **June 29, 2017** |

Device for Producing a Gaseous Fuel Composite and System of Production Thereof


### Abstract

The invention relates to a gaseous fuel composite, a device for producing the gaseous fuel composite, and subcomponents used as part of the device for producing the gaseous fuel composite, and more specifically, to a gaseous composite made of a gas fuel such as natural gas and its oxidant such as air for burning as part of different systems such as fuel burners, combustion chambers, and the like. The device includes several vortex generators each with a curved aerodynamic channel amplifier to create a stream of air to aerate the gas as successive stages using both upward and rotational kinetic energy. Further, a vortex generator may have an axial channel with a conical shape or use different curved channel amplifiers to further create the gaseous fuel composite.


Attachment #2

| | |
|---|---|
| **United States Patent Application** | **20160207013** |
| **Kind Code** | **A1** |
| | **July 21, 2016** |

Device For Mixing Fluids


### Abstract

A device is provided for mixing similar or dissimilar fluids into a homogenous fluids mix. The device operates without consuming additional energy.

Attachment #3

**United States Patent Application** **20100243953**

**Kind Code** **A1**

**September 30, 2010**

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Method of Dynamic Mixing of Fluids

## Abstract

Methods are provided for achieving dynamic mixing of two or more fluid streams using a mixing device. The methods include providing at least two integrated concentric contours that are configured to simultaneously direct fluid flow and transform the kinetic energy level of the first and second fluid streams, and directing fluid flow through the at least two integrated concentric contours such that, in two adjacent contours, the first and second fluid streams are input in opposite directions. As a result, the physical effects acting on each stream of each contour are combined, increasing the kinetic energy of the mix and transforming the mix from a first kinetic energy level to a second kinetic energy level, where the second kinetic energy level is greater than the first kinetic energy level.

Attachment #4

**United States Patent Application** **20100281766**

**Kind Code** **A1**

**November 11, 2010**

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Dynamic Mixing of Fluids

## Abstract

Methods, systems, and devices for preparation and activation of liquids and gaseous fuels are disclosed. Method of vortex cooling of compressed gas stream and water removing from air are disclosed.

Attachment #5

**nited States Patent Application** **20110048353**

**Kind Code** **A1**

**March 3, 2011**

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Engine with Integrated Mixing Technology

**Abstract**

The present disclosure generally relates to an engine with an integrated mixing of fluids device and associated technology for improvement of the efficiency of the engine, and more specifically to an engine equipped with a fuel mixing device for improvement of the overall properties by inline oxygenation of the liquid, a change in property of the liquid such as cooling form improved combustion, or the use of re-circulation of exhaust from the engine to further improve engine efficiency and reduce unwanted emissions.