W. P. DEPPÉ.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED AUG. 3, 1917.

1,335,665.

Patented Mar. 30, 1920.

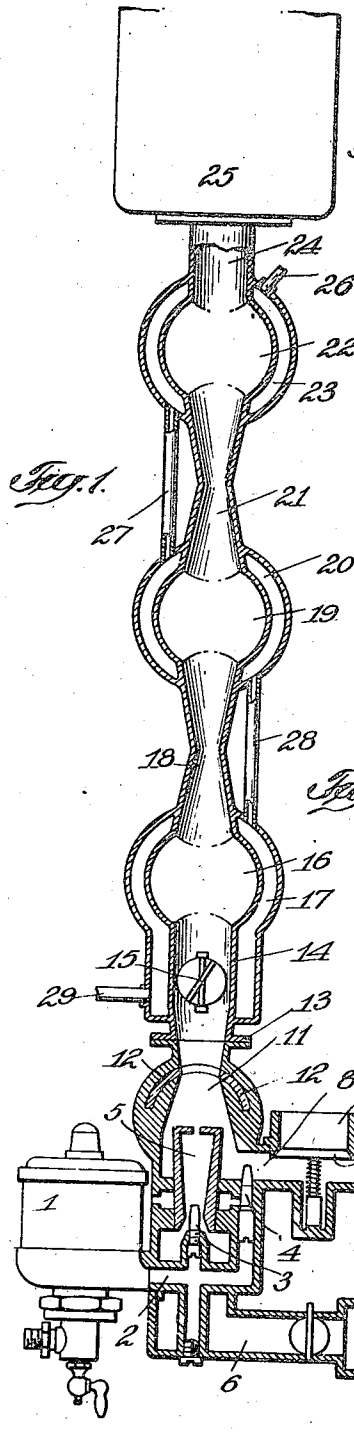


Fig. 1.

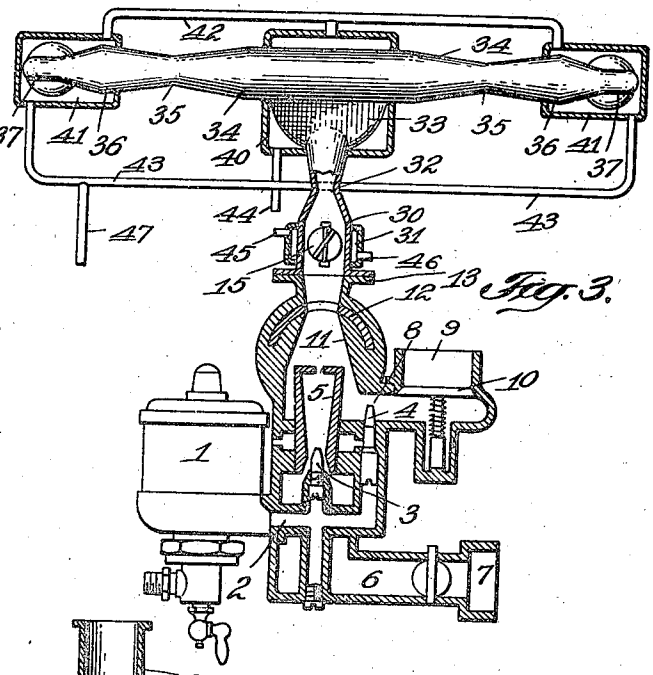


Fig. 3.

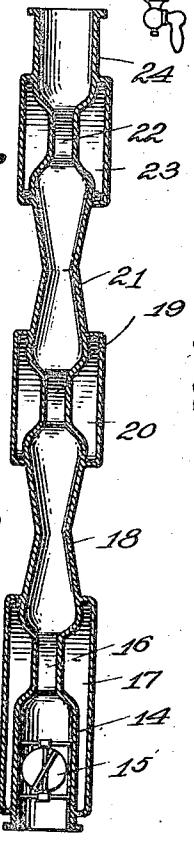


Fig. 2.

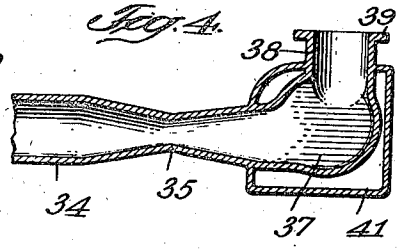


Fig. 4.

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INTERNAL-COMBUSTION ENGINE.

1,335,665. Specification of Letters Patent. Patented Mar. 30, 1920.

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To all whom it may concern:

Be it known that I, WILLIAM P. DEPPÉ, a citizen of the United States, and resident of Bay Shore, county of Suffolk, and State of New York, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates more particularly to a method of preparing a superheated dry gas for use in internal combustion engines or in combustion chambers of any suitable character wherein gas of this character is adapted to be used. The object of the present invention is to prepare a fuel mixture gas from liquid hydro-carbons mixed with air preferably at high temperature and thoroughly integrated to produce a substantially stable gas which upon introduction into the cylinders of an internal combustion engine, will remain in gaseous form.

In this respect the product of my improved method differs from that produced by the wet mixture method at present very largely used in connection with internal combustion engines. With the latter method, the liquid spray is carried along with the air (in most cases not pre-heated) through the manifold to the cylinders of the engine, the particles being liquid or only partially vaporized at the time they are introduced into the cylinder. A charge of this kind when drawn into the cylinder is very likely to deposit a large portion of the liquid fuel and vapor particularly on the intake stroke. Hence when the charge is ignited by the passage of the electric spark, only that portion of the charge which is in gaseous or semi-gaseous form will instantly explode, while the liquid particles which have collected on the head of the piston will be vaporized or partially vaporized by the heat of the explosion and burned after the first explosion and while the piston is on its downward stroke. This slow burning of the fuel mixture in the cylinders of an engine not only results in a loss of power and efficiency, but adds largely to the production of carbon deposits on the piston head and in the cylinder. It is also detrimental because the excessive heat produced at the wrong time in the stroke has a tendency to burn or carbonize the lubricating oil, overheat the metal walls, and therefore increase the wear between the piston and cylinder, thereby tending toward an excessive use of lubricant, loss of compression and dilution of lubricating oils with liquid fuel oils.

To obviate these difficulties, I have evolved a method whereby highly heated air is charged with the proper amount of vapor or spray of the liquid hydro-carbons and then the column of fuel mixtures is subjected to a sort of kneading process and intermittently and repeatedly heated until by the time it reaches the engine cylinders, the mixture has been developed and integrated into a substantially uniform and homogeneous superheated dry gas which will remain in this state during and after introduction into the cylinders.

It is well known that if a gas is compressed, the temperature of the gas is raised, while if the gas is permitted to expand, it will take up heat from surrounding bodies or its temperature will fall. If a gas of this character is near the saturation point, liquid particles will be deposited when slightly cooled. When a gaseous mixture is produced by my method, it is so perfectly integrated and superheated to such an extent, that upon introduction into the cylinder even though expanded in the process, it remains gaseous so that in the compression stroke it will behave as a perfect gas and become still more highly heated by compression. With gaseous mixtures produced by my method, it is therefore possible to work under higher temperatures and leaner mixtures without the danger of preignition or slow flame spread after firing.

It is becoming more apparent from day to day, that the supply of mineral oils is not increasing anywhere near in proportion to the increase in the use of internal combustion engines. The endeavor also is to find substitutes or mixtures of fuel oils with other hydro-carbon liquids in order that there may be enough materials to supply the demand for fuel. In this effort to meet the demands and keep the cost down, hybrid mixtures, as they are called, of gasolene and alcohol also benzol, are some times used, and mixtures of various grades of fuel oils, the constituents of which have widely varying boiling points.

The ordinary wet mixture methods cannot satisfactorily handle these hybrid mixtures, nor low grade fuel oil mixtures to operate like true gasolenes, but my method is particularly devised for handling mixtures of this character. I have found that by my

method the various constituents of a mixture of this character, can be vaporized and gasified from stage to stage in the passage of the mixture through a suitable apparatus adapted to alternately compel the column to expand and contract and change its form. At the same time, my method includes heating the mixture thoroughly throughout at the time it is permitted to spread out or expand.

It is a well known physical fact that gases do not take up heat readily by conduction, hence if a cylindrical column of gas or gaseous mixture is surrounded by a heating jacket, only that portion of the column in contact with the walls of the conduit will become heated. If, however, the column of gas is flattened, or the walls of the chamber or conduit brought very close together so as to form, as it were, a sheet of gas, then by heating the flat walls of the conduit, the gas or gaseous mixture between the walls can be heated throughout to much higher temperature very quickly. I have taken advantage of this property in carrying out my method to assist in vaporizing and gasifying the liquid fuel spray carried along in the column of hot air on its way to the cylinders of the engine or other combustion chamber.

It is also well known that streams of gas or vapor-charged gases, portions of which are of different densities or temperatures are likely to become stratified and remain in this condition unless physical means are used to mix or integrate them and break up the floating drops or globules of liquid. Therefore, in carrying out my method, I prefer to churn the mixtures at one stage in order to more completely atomize the liquid particles and prevent stratification. The succeeding stages in my method may be likened to a kneading process because the fuel mixture is squeezed or contracted, preferably in cylindrical form, and then spread out into sheet form and permitted to expand slightly, at the same time being heated. This treatment of the fuel mixture has the effect of completely gasifying and integrating the mixture, the last stage of heating being adapted to superheat the gaseous mixture the constituent elements of which have become gaseous, sufficiently to maintain it as such until it is used in the cylinders of the engine or in other suitable combustion chamber. In carrying out my method, it is obvious that various forms of apparatus may be utilized, and it will be understood that I do not wish to be limited to any particular device or apparatus. As an example and to illustrate my method, I have in the accompanying drawings shown forms of apparatus suitable for carrying out my method for producing a superheated dry gas for use in internal combustion engines or in combustion chambers of furnaces or the like.

In the accompanying drawings, Figure 1 represents a longitudinal section parallel with the sheeting sections of an apparatus adapted for carrying out my method; Fig. 2 represents a longitudinal section of a portion of the apparatus shown in Fig. 1, the section being transversely of the flattened portions; Fig. 3 represents an assembly view partially in section of an apparatus adapted for use in connection with an internal combustion engine, and Fig. 4 is a horizontal section of one arm of the manifold shown in Fig. 3.

Referring to the drawings, particularly to Figs. 1 and 3 thereof, I have shown a carbureter substantially like that shown in my Patent No. 1,163,223, of December 7, 1915, but obviously any other suitable or preferred form of carbureter may be used to charge highly heated air with fuel spray. In this form of carbureter, 1 represents the float-tank from which the fuel oil is delivered through the channel 2 to the nozzles 3 and 4. The nozzle 3 is preferably located central of a Venturi tube 5, the lower end of which opens into a primary air passage 6 through the inlet end 7 of which highly heated air is adapted to be introduced from any suitable source. The secondary nozzle 4 is located to one side of the Venturi passage 5 and projects into an auxiliary passage 8, the inlet opening 9 of which is provided with the usual spring-controlled valve 10. The auxiliary air which is adapted to enter the opening 9, is also preferably highly heated and conducted to the opening in any suitable manner. The auxiliary current is adapted to mix with and join the primary current below the throttle valve. The apparatus for heating the air is not here shown because this is well understood in the art.

The outlet from the carbureter mixing chamber is preferably venturi-shaped at 11, a centrally opening throttle-valve 12 being located at the point of least cross-section. The upper end of the carbureter is provided with flanges at 13 by which it may be attached to the manifold in the usual manner. In the form shown in Fig. 1, the carbureter is indicated as attached to a chain of flattened conduits joined with circular conduits or Venturi tubes, the conduit being continuous and for clearness shown here as straight.

Near the throttle and preferably in the lower end of the conduit 14, I insert a mechanical mixer 15 of any suitable rotating type, such for instance as that shown in the Schlayer Patent No. 1,007,010 of October 24, 1911. This form of rotary mechanical mixer has the property of churning and breaking up the fuel particles carried along in the highly heated air and atomizing them in such a way that they can be more highly heated and completely gasified. This por-

tion of the conduit is preferably surrounded by a jacket 17, adapted to be heated by passing exhaust gases therethrough or by other suitable means.

Immediately succeeding the churning portion 14 of the conduit, there is a flattened portion 16, seen in transverse section in Fig. 2 of the drawings, which is adapted to spread out the mixture into sheet form. This flattened portion 16 of the conduit is also inclosed by a suitable jacket such as the heating jacket 17, whereby the mixture as it is sheeted is adapted to be heated at both sides.

Immediately following the sheeting section 16 of the conduit is a circular portion 18 thereof, preferably shaped venturi-like, thereby being adapted to contract the column of fuel mixture at this point. This portion of the conduit is preferably not surrounded by a heating jacket. After the fuel mixture passes the narrowest point of the Venturi tube 18, it expands slightly and enters a second flattened portion 19 which is adapted to again sheet the mixture. The sheeting section 19 is surrounded by a jacket 20 through which hot exhaust gases may be passed in order to heat the sheeted mixture on both sides. Preferably the temperature maintained at this stage of heating is higher than that maintained in the heating section 16.

The outlet from the flattened portion 19 is into another Venturi tube 21 which like the Venturi section 18 of the conduit is preferably uncovered or not surrounded by a heating jacket. The Venturi tube 21 preferably conducts the column of fuel mixture into still another flattened portion 22, which is surrounded by a heating jacket 23, through which hot exhaust gases are adapted to be passed in order to heat the sheeted mixture on both sides. From the flattened portion 22 of the conduit, the mixture column passes through a tubular portion 24 into the engine cylinder 25 or other combustion chamber with which the apparatus may be connected.

The temperature maintained within the heating jacket 23 is preferably still higher than that maintained in the heating jacket 20. This variation in temperature from stage to stage may be brought about in any suitable way and for the purpose of illustration, I have shown an inlet pipe 26 in the upper jacket 23 through which the hot exhaust gases may be introduced first, at which time they are hottest. In passing through the jacket 23, the exhaust gases will lose some of their heat and thereafter are preferably passed through a connecting tube 27 into the jacket 20, where they will be capable of heating the mixture on both sides of the sheet, but to a temperature considerably lower than that produced in the jacket 23. The hot exhaust gases from the jacket 20 are then preferably conducted by a tube or pipe 28 to the jacket 17 shown in Figs. 1 and 2 as surrounding the flattened portion 16 and the churning section 14 hereinbefore referred to. By this means, the jacket 17 is heated to a still lower temperature than that maintained in the jacket 20. The exhaust gases from the jacket 17 are adapted to pass out through an outlet tube 29 and exhaust into the air or be conducted away in any suitable manner.

As previously pointed out, the construction shown in Figs. 1 and 2 is to a certain extent illustrative in that the heating and sheeting sections alternating with Venturi tubes, connected between the carbureter flanges 13 and the engine cylinder 25 is shown as a continuous single straight conduit. Fig. 2 represents a longitudinal section transversely of the flattened portions 16, 19, and 22 of the conduit portion of the apparatus shown in Fig. 1 between the flanges 13 and the engine cylinder or combustion chamber 25.

It will be understood, however, that in actual practice, particularly in connection with internal combustion engines of more than one cylinder a manifold, something like that represented in Fig. 3 of the drawings is preferably employed. In this form of apparatus, adapted to carry out my method, the carbureter shown is the same as shown in Fig. 1 and corresponding parts are given the same characters for identification. In this construction the carbureter at the flange 13 is connected with a manifold provided with a riser, the lower end of which at 30 is surrounded by a jacket 31, the conduit at this point being adapted to contain a rotary mechanical mixer 15 of the type previously described in connection with Fig. 1. In this form of apparatus, the churning chamber 30 is followed by a Venturi tube section of the riser at 32. The upper end of the riser at 33 is flattened and connected with spreader arms 34 each of which is preferably provided at 35 with a contraction adapted to form a Venturi tube. The arms following the contraction swell to normal at 36 just before leading into a flattened portion 37 which in turn is followed by a short cylindrical portion 38 leading off at right angles to the spreader arms and provided with flanges 39 adapting the arms to be connected to the inlet openings of the cylinders of the engine.

The flattened junction 33 between the riser and spreader arms is preferably surrounded by a jacket 40 adapted to be supplied with hot exhaust gases whereby the sheeted mixture as it passes this point is adapted to be heated on both sides. Similar or suitable jackets 41 inclose the flattened sections 37 near the outer ends of the respective spreader arms, these jackets being also supplied with suitable heating fluid or hot ex-

haust gases. In sheeting and heating the mixture at the various points or stages, I preferably increase the temperature from stage to stage and between stages prefer that the mixture pass through a portion of the conduit which is not surrounded by a heating jacket.

The heating jackets 41 and 40 are preferably connected by pipes 42 and 43 adapted to conduct exhaust gases through the jackets 41 first, while exhaust gases are at their highest temperature and then through the jacket 40 and from there preferably through the jacket 31 by suitable connections between the pipe 44 and 45. After passing through the jacket 31, the exhaust gases pass out through a pipe 46. A pipe 47 connected with pipe 43 is adapted to conduct the exhaust gases from the exhaust pipe into the pipe 43 and is adapted to be connected with the exhaust pipe of the engine in the usual or any preferred manner. It will be understood, however, that the arrangement for heating the sheeting sections of the conduit may be arranged in any suitable manner, so long as the necessary step by step differences of temperature are secured. The last heating temperature is preferably sufficiently high to superheat the gaseous mixture to such an extent that it will be maintained in dry gaseous form throughout the intake and compression strokes from the engine.

In carrying out my method, I wish it to be understood that I am not limited to the particular form of apparatus shown and described for obviously various modifications in the arrangement and adaptation of apparatus may be made for the purpose of satisfactorily carrying out my improved method without departing from the spirit and scope of my claims, and in some cases the number and shape of the sheeting and round portions of the conduit may be varied.

I claim:

1. The method of preparing an explosive mixture for combustion in heat and power units which consists in charging a moving column of highly heated air with liquid fuel spray then contracting the column and increasing the rate of flow of the mixture, then churning the mixture while applying heat to further atomize the fuel particles, then kneading the mixture by alternately sheeting or flattening the column and restoring it to cylindrical form, heat being applied on both sides of the sheet at each sheeting stage at progressively increasing temperatures, whereby the mixture is converted into a homogeneous dry gas adapted to remain as such during and after delivery to the heat or power unit.

2. The method of preparing an explosive mixture for combustion in heat and power units which consists in charging a moving column of highly heated air with liquid fuel spray, expanding the mixture stream then contracting the column and increasing the rate of flow of the mixture, then churning the mixture while applying heat to further atomize the fuel particles, then kneading the mixture by alternately sheeting or flattening the column and restoring it to cylindrical form, heat being applied on both sides of the sheet at each sheeting stage at progressively increasing temperatures, whereby the mixture is converted into a homogeneous, dry gas, the final temperature of which is sufficiently high to maintain the mixture in a dry gaseous state during and after delivery to the heat or power unit.

3. The method of preparing an explosive mixture for combustion in heat and power units, which consists in mixing atomized hydrocarbons with highly heated air, churning and kneading the mixture by changing the shape, direction and rate of flow thereof, by varying the shape and dimensions of successive sections of the passages conducting the mixture, progressively raising the temperature of the mixture by uniformly heating predetermined sections of said conducting passages, the heat being applied at successively increasing temperatures, the passages and heat applied being so proportioned and adjusted that the final temperature of the mixture is above the boiling points of the fuel constituents and below the temperature of automatic ignition, thereby producing a mixture having the properties of a superheated, fixed dry gas for delivery to the heat or power unit.

4. The method of preparing an explosive mixture for combustion in heat and power units which consists in charging a moving column of highly heated air with liquid fuel spray, then contracting the column and increasing the rate of flow of the mixture, then churning the mixture while applying heat to further atomize the fuel particles, then kneading the mixture by alternately expanding and contracting the column, the column being flattened or sheeted and heated on both sides during each expanding stage, the heating temperatures at succeeding stages being increased progressively whereby the temperature of the mixture is raised progressively and the mixture converted into a superheated, homogeneous, dry gas, the final temperature of which is sufficiently high to maintain the mixture in a dry gaseous state during and after delivery to the heat or power unit.

5. The method of preparing an explosive mixture for combustion in heat and power units which consists in charging a moving column of highly heated air with liquid fuel spray, then contracting the column and increasing the rate of flow of the mixture, then churning the mixture while applying heat

to further atomize the fuel particles, then kneading the mixture by alternately expanding and contracting the column, while applying heat at the alternate stages of expansion, the heating temperatures at succeeding stages increasing progressively until the final temperature is sufficiently high to raise the temperature of the mixture above the highest boiling point of the liquid fuel, whereby the mixture is converted into and adapted to be maintained in a superheated, homogeneous, dry gaseous state during and after delivery to the heat or power unit.

6. The method of preparing an explosive mixture for internal combustion engines or combustion chambers which consists in charging a moving column of highly heated air with liquid fuel spray, then churning the mixture while applying heat to the column, then kneading the column of mixture by alternately sheeting and squeezing or contracting the same, heat being applied on both sides of the sheet at each sheeting stage, the heating temperature at each succeeding stage being higher than the preceding one, whereby the mixture is converted into a superheated, homogeneous, dry gas, adapted for complete and substantially instantaneous combustion.

7. The method of preparing an explosive mixture for internal combustion engines or combustion chambers which consists in charging a moving column of highly heated air with liquid fuel spray, then churning the mixture while applying heat to the column, then kneading the column of mixture by alternately expanding, sheeting and squeezing or contracting the same, heat being applied on both sides of the sheet at each sheeting stage, the heating temperature at each succeeding stage being higher than the preceding one, whereby the mixture is converted into a superheated, homogeneous, dry gas, adapted for complete and substantially instantaneous combustion.

8. The method of preparing an explosive mixture for internal combustion engines or combustion chambers which consists in charging a moving column of highly heated air with liquid fuel spray, then churning the mixture while applying heat to the column, then kneading the column of mixture by alternately expanding, sheeting and squeezing or contracting the same, while raising the temperature of the mixture progressively by applying heat at predetermined intervals, the heating temperature at each succeeding stage being higher than the preceding one, whereby the mixture is converted into a superheated, homogeneous, dry gas, adapted for complete and substantially instantaneous combustion.

9. The method of preparing an explosive mixture for combustion in heat and power units which consists in charging a moving column of highly heated air with liquid fuel spray, expanding the mixture stream while adding thereto highly heated air, then metering the flow, then churning the mixture while applying heat, then kneading the mixture by alternately expanding, contracting and sheeting or flattening the stream while applying heat at intervals to raise the temperature of the mixture progressively, the heat being applied while the column is flattened, the successive temperatures increasing until the final temperature is sufficiently high to convert the mixture into and maintain it in a dry gaseous state during and after delivery to the heat or power unit.

10. The method of preparing an explosive mixture for combustion in heat and power units, which consists in charging a moving stream of highly heated air with liquid fuel spray, metering the flow, mechanically breaking up and diffusing the mixture while applying heat, thereby producing vapor and wet gas, then highly heating the mixture at predetermined successive stages to progressively raise the temperature of the mixture above the boiling points of the liquid fuels, whereby a homogeneous dry gaseous mixture in a superheated state is produced, adapted to maintain itself as such during and after delivery to the heat or power unit.

11. The method of preparing an explosive mixture for internal combustion engines or combustion chambers which consists in charging highly heated moving air with liquid fuel spray, increasing the speed temporarily by reducing the cross-sectior of the column by a venturi, then churning the mixture while applying heat, then sheeting the mixture column and heating it on both sides, restoring the column to cylindrical form and again increasing the speed by reducing the cross-section by a venturi, again sheeting and heating on both sides, then restoring to cylindrical form, the heating temperature at each succeeding heating stage being higher than the preceding one, whereby the temperature of the mixture is raised progressively to produce a superheated, homogeneous, dry gas adapted to remain as such during and after introduction into the engine or combustion chamber.

12. The method of producing a dry gaseous explosive mixture for internal combustion engines or combustion chambers which consists in charging a moving column of highly heated air with liquid fuel spray, passing it through a metering opening adapted to maintain the column of mixture central and substantially circular in cross-section, then subjecting the column to a churning action while applying heat, whereby the fuel particles in said column are further broken up and more intimately mixed

and diffused with the air, then sheeting the column in the presence of heat on both sides of the sheet, the heating temperature being higher than that applied during said churning action, then restoring the column to cylindrical form and temporarily increasing the rate of flow, again sheeting the column of mixture and applying heat on both sides of the sheet, the heating temperature being higher than that applied during the previous sheeting of the mixture, whereby the liquid fuel of the mixture, after passing through successive stages of mist, fog and vapor is converted into a dry gas adapted to form with the air a dry, superheated homogeneous explosive mixture for use in engine cylinders or combustion chambers.

13. The method of preparing an explosive mixture for internal combustion engines which consists in charging highly heated moving air with liquid fuel spray, increasing the speed temporarily by reducing the cross-section of the column by a venturi then churning the mixture while applying heat, then sheeting the mixture column and heating it on both sides, restoring the column to cylindrical form and again increasing the speed by reducing the cross-section by a venturi, again sheeting and heating on both sides, then restoring to cylindrical form, the heating temperature at each succeeding heating stage being higher than the preceding one, whereby the temperature of the mixture is raised progressively to produce a superheated, homogeneous dry gas, the final temperature of which is sufficiently high to maintain the mixture in a dry gaseous state throughout and at the completion of the intake stroke of the engine whereby all the heat superinduced by the compression stroke may be added to the mixture to raise the temperature thereof.

14. The method of producing a dry gaseous explosive mixture for internal combustion engines which consists in charging a moving column of highly heated air with liquid fuel spray, passing it through a metering opening adapted to maintain the column of mixture central and substantially circular in cross-section, then subjecting the column to a churning action while applying heat, whereby the fuel particles in said column are further broken up and more intimately mixed and diffused with the air, then sheeting the column in the presence of heat on both sides of the sheet, the heating temperature being higher than that applied during said churning action, then restoring the column to cylindrical form and temporarily increasing the rate of flow, again sheeting the column of mixture and applying heat on both sides, the last mentioned heating temperature being higher than that applied during the previous sheeting of the mixture, whereby the temperature of the mixture is raised progressively to produce a dry gaseous superheated explosive mixture for use in the engine cylinders, the final temperature thereof being sufficiently high to maintain the mixture in a dry gaseous state throughout and at the completion of the intake stroke of the engine whereby all the heat superinduced by the compression stroke may be added to the mixture to raise the temperature thereof.

15. The method of preparing an explosive mixture for internal combustion engines or the like which consists in spraying liquid fuel into a moving column of highly heated air, then churning the mixture while applying heat, then kneading the column of mixture while progressively raising the temperature thereof by heat applied at successive stages at progressively increasing temperatures, the temperature at the final stage being above the highest boiling point of the liquid fuel, whereby the mixture is converted into a superheated, homogeneous, dry gas adapted to maintain itself as such during and after introduction into the engine and capable of complete and substantially instantaneous combustion.

16. The method of operating an internal combustion engine which comprises introducing into the cylinder of the engine on the intake stroke, a highly heated homogeneous, gaseous mixture of hydrocarbon and air having a temperature above the boiling points of the fuel constituents and sufficiently high for the mixture to have the properties of a fixed dry gas, then compressing it in the cylinder, whereby the heat of compression is utilized in superheating the mixture and raising its temperature to a point just below the point of automatic ignition, the resulting mixture being of uniform density and temperature throughout and capable of substantially instantaneous uniform and complete combustion, then firing it at or near the point of greatest compression.

17. The method of operating an internal combustion engine which comprises spraying hydrocarbon fuel into highly heated air, churning the mixture while adding heat, then kneading the mixture by alternately varying the shape of the mixture column and rate of flow and simultaneously, alternately and progressively heating the same, thereby raising the temperature of the mixture step by step until it is above the boiling points of the fuel constituents and producing a highly heated mixture having the properties of a homogeneous, fixed, dry gas, then introducing it into the engine cylinder and compressing it, the mixture remaining dry and fixed, whereby it is superheated in the cylinder and its temperature is raised to a point just below the temperature of automatic ignition, the resulting mixture being

substantially of uniform density and temperature throughout then firing it at or near the point of greatest compression.

18. The method of operating an internal combustion engine which comprises mixing predetermined quantities of highly heated air and liquid fuel hydrocarbons, in the form of spray, mechanically breaking up the spray particles and mixing them with the air while applying heat, kneading the mixture by alternately flattening and increasing the flow of the column of mixture, the column being progressively heated at the times of flattening, thereby raising the temperature of the mixture step by step until it is above the boiling points of the fuel constituents, and producing a highly heated mixture having the properties of a homogeneous, fixed, dry gas, then introducing it into the engine cylinder without substantial fall of temperature and compressing it, whereby the mixture is superheated in the cylinder and its temperature is raised to a point just below the temperature of automatic ignition, the resulting mixture being substantially of uniform density and temperature throughout, the mixture being then ignited at or near the point of greatest compression.

19. The method of operating an internal combustion engine which comprises introducing into the cylinder of the engine on the intake stroke, a highly heated homogeneous, fixed dry, gaseous mixture of air and hydrocarbons, prepared automatically externally of the engine by spraying hydrocarbons into highly heated air in predetermined proportions according to the throttle opening and speed of the engine, mixing therewith an additional predetermined amount of highly heated air, mechanically churning the mixture while applying heat, then kneading the mixture by alternately flattening and varying the flow of the column, simultaneously raising the temperature of the mixture step by step, by applying heat at progressively increasing temperatures when the column is flattened, thereby progressively raising the temperature of the mixture until it is above the boiling points of the fuel constituents, then compressing it in the cylinder, the temperature of the mixture being thereby further increased and the mixture superheated, to a temperature just below the temperature of automatic ignition, the mixture being of substantially uniform density throughout, then firing it at or near the point of greatest compression.

20. The method of operating an internal combustion engine which comprises automatically injecting a predetermined amount of hydrocarbon fuels into a predetermined amount of highly heated air, mixing therewith a predetermined additional amount of highly heated air, charged with a lesser amount of hydrocarbon fuels, churning the mixture while applying heat, kneading the mixture by alternately speeding up and flattening the column and progressively heating it when the column is flattened to raise the temperature of the mixture step by step, until it is above the boiling points of the fuel constituents, thereby producing a highly heated, homogeneous, mixture having the properties of a fixed, dry gas, then introducing the mixture into and compressing it in the cylinder of the engine, whereby it is superheated and its temperature is raised to a point slightly below the temperature of automatic ignition, the mixture being substantially of uniform density throughout, adapting it when ignited to give instantaneous flame spread with complete combustion, then igniting it at or near the point of greatest compression.

21. The method of operating an internal combustion engine which comprises automatically preparing a superheated, homogeneous, fixed, dry, gaseous mixture, consisting of 15 to 70 parts air to one part hydrocarbon fuel vapor, the temperature of the mixture so prepared being above the boiling points of the fuel constituents, the mixture thereby having the properties of a fixed, dry, gas, then introducing it into the cylinder, the mixture remaining dry and fixed, then compressing it and thereby superheating the mixture and raising its temperature to a point slightly below the temperature of automatic ignition, the mixture being substantially of uniform density throughout, whereby it is adapted when ignited to give instantaneous flame spread with complete combustion, then firing it substantially at the point of greatest compression.

22. The method of operating an internal combustion engine by introducing into the cylinder thereof a superheated, homogeneous, fixed, dry, explosive, gaseous mixture consisting of 15 to 70 parts air to 1 part hydrocarbon fuel vapor, the temperature of which is above the boiling points of the fuel constituents and when introduced into the cylinder is such that upon compression in the cylinder the mixture is adapted to be superheated, and its temperature raised to a point slightly below the temperature of automatic ignition, then compressing the mixture in the cylinder, and firing it at or near the point of greatest compression.

23. The method of operating an internal combustion engine which comprises mixing highly heated air and liquid hydrocarbon spray in the proportions of 10 to 15 parts air to 1 part hydrocarbon vapor, then diluting the mixture by mixing therewith additional highly heated air to raise the proportions to 15 to 70 parts air to 1 part fuel vapor, churning the mixture thus formed while applying heat, then kneading

it by alternately speeding up and flattening the column and simultaneously applying heat when the column is flattened, in a manner to progressively raise the temperature of the mixture step by step until it is above the boiling points of the fuel constituents, thereby producing a superheated, homogeneous, explosive mixture, having the properties of a fixed gas at a temperature slightly below its temperature of automatic ignition, the temperature and properties of the mixture being such that any loss of heat upon entering the cylinder is adapted to be restored and the mixture again superheated by compression therein, then introducing it into the cylinder and compressing it, then firing it at or near the point of greatest compression, whereby the mixture being of uniform density and temperature throughout, substantially instantaneous explosion and flame spread with complete combustion are obtained.

24. The method of operating an internal combustion engine on an explosive mixture consisting of air and hydrocarbons in the proportions of 15 to 70 parts air to 1 part hydrocarbons introduced into the cylinder as a superheated, homogeneous mixture having the properties of a fixed, dry, gas, the temperature of which is above the boiling points of the fuel constituents and below the temperature of automatic ignition, then compressing it in the cylinder, the mixture being substantially of uniform density throughout whereby any loss of heat by introduction into the cylinder is restored and the mixture again superheated to a temperature just below the temperature of automatic ignition, then firing it at or near the point of greatest compression.

25. The method of operating an internal combustion engine which comprises delivering to the combustion chamber thereof an explosive mixture of air and hydrocarbons having the properties of a homogeneous, fixed, dry, gas, and having a temperature above the boiling points of the fuel constituents and below the temperature of automatic ignition, for the mixture, then admitting it to the cylinder on the intake stroke, at which a slight drop in temperature may occur but without condensation or stratification, then compressing it, thereby superheating it in the cylinder and raising the temperature to a point just below the temperature of automatic ignition, then igniting it, substantially at the point of greatest compression, whereby, the mixture being substantially of uniform density throughout, instantaneous flame spread with complete combustion are obtained.

26. The method of operating an internal combustion engine which comprises preparing, exteriorly of the combustion chamber thereof, a mixture of air and hydrocarbon in the form of and having the properties of a homogeneous, fixed, dry, gas, the temperature of which is above the boiling points of the fuel constituents, delivering it into the engine cylinder on the intake stroke, then compressing it, the temperature and proportions of the mixture being so regulated that at the point of greatest compression, the temperature is below the temperature of automatic ignition, then firing it substantially at the point of greatest compression.

27. The method of operating internal combustion engines with fuel mixtures of liquid hydrocarbons and air transformed into a superheated, homogeneous mixture having the properties of a fixed gas and a temperature above the boiling points of the fuel constituents but below the temperature of automatic ignition, which is then introduced into the cylinder of the engine and compressed, whereby the mixture, being substantially of uniform density throughout is adapted to being superheated to a temperature just below the temperature of automatic ignition, then firing it at or near the point of greatest compression.

28. The method of operating internal combustion engines with hydrocarbons and air transformed into a homogeneous mixture having the properties of a fixed dry gas, the temperature of which is above the boiling points of the fuel constituents and below the temperature of automatic ignition, which when introduced into the cylinder of the engine and compressed, is adapted to be of substantially uniform density throughout and superheated to a temperature just below the temperature of automatic ignition and which when fired at or near the point of greatest compression is adapted for substantially instantaneous and complete combustion, whereby the engine cylinder is utilized as a superheater for the mixture and the engine is operated by a single substantially instantaneous explosion at or near the dead center.

29. The method of operating internal combustion engines with a superheated, homogeneous, dry, gaseous mixture, prepared exteriorly of the engine cylinder by mixing spray of liquid fuel hydrocarbons with highly heated air, then churning and kneading the mixture column while progressively heating the same, the mixture, after passing through successive stages of mist, fog and invisible vapor as its temperature is raised step by step, being transformed into the homogeneous mixture having the properties of a dry, fixed gas, the temperature of which is above the boiling points of the fuel constituents, then introducing it into the engine cylinder and compressing it, whereby it is superheated and its temperature raised to a point just below the temperature of automatic ignition, then firing

it, substantially at the point of greatest compression, the cylinder being utilized as a superheater and explosion chamber.

30. The method of operating an internal combustion engine which comprises introducing into the cylinder of the engine on the intake stroke, a highly heated, homogeneous, fixed, dry, gaseous mixture of hydrocarbons and air, the temperature of which is above the boiling points of the fuel constituents, then compressing it, the heat of compression being utilized in superheating the mixture and raising its temperature to a point just below the temperature of automatic ignition, the mixture being of uniform density and temperature throughout, then firing it substantially at the point of greatest compression, the mixture being adapted for substantially instantaneous flame spread and complete combustion, the cylinder thereby being utilized as a superheater and explosion chamber.

31. The method of operating an internal combustion engine which comprises spraying hydrocarbon fuel into highly heated air, churning the mixture while adding heat, then kneading the mixture by varying the shape of sections of passage between the carbureter and the inlet to the cylinder, by change of direction of flow, and by change of rate of flow, while progressively heating the mixture at succeeding sections, thereby raising the temperature step by step and producing a highly heated, homogeneous explosive mixture having the properties of a fixed, dry, gas, the temperature of which is above the boiling points of the fuel constituents and below the temperature of automatic ignition, then introducing it into the engine cylinder, the gas remaining fixed and dry, then compressing it, whereby it is superheated and the temperature of the mixture is raised to a point just below the temperature of automatic ignition, the mixture being then ignited at or near the point of greatest compression, thereby producing instantaneous flame spread and complete combustion.

32. The method of operating an internal combustion engine which comprises spraying hydrocarbon fuel into highly heated air, churning it in a heated passage, then kneading the mixture by varying the shape of succeeding sections of the passage between the carbureter or metering device and the inlet to the cylinder of the engine and by change of direction of flow and change of rate of flow, while progressively heating the mixture as it passes through certain sections, the temperature of which step up in succession, thereby raising the temperature step by step until the temperature of the mixture is above the boiling point of the fuel constituents, thereby producing a highly heated homogeneous mixture having the properties of a fixed, dry gas, then introducing it into the engine cylinder, the gas remaining fixed and dry, then compressing it, whereby it is superheated and the temperature of the mixture is raised to a point just below the temperature of automatic ignition, the mixture then being ignited at or near the point of greatest compression, the density and temperature of the mixture being substantially uniform throughout, thereby giving a single substantially instantaneous explosion with complete combustion.

33. The method of operating an internal combustion engine with predetermined proportions of hydrocarbons and air, transformed into a superheated mixture having the properties of a fixed, dry gas, by properly proportioning the passage through which the mixture is conducted, as to shape cross-section, length and mixing facilities, with heat progressively applied at increasing temperature, until the temperature of the mixture is above the boiling points of the fuel constituents, and which when introduced into the cylinder of the engine and compressed, will remain dry and have the molecular and chemical properties of a homogeneous dry explosive gas mixture of uniform density throughout, its temperature being raised to a point just below the temperature of automatic ignition, then firing it, at or near the point of greatest compression, whereby substantially instantaneous inflammation and complete combustion are obtained at or near dead center.

34. The method of operating an internal combustion engine which consists in transforming predetermined proportions of hydrocarbons and air, by passing them through a mixer and conduits, suitably proportioned as to shape, area and length and heated at predetermined points, at progressively increasing temperatures, into a mixture having a temperature above the boiling points of the fuel constituents and having the molecular and chemical properties of a homogeneous, fixed, dry gas mixture, capable of substantially instantaneous inflammation and complete combustion when introduced into the cylinder and compressed, then introducing it into the cylinder and compressing it, then firing it at or near the point of greatest compression, whereby the engine is operated by a single, substantially instantaneous explosion at or near dead center.

35. The method of operating an internal combustion engine with predetermined proportions of hydrocarbons and air transformed into a superheated mixture having the properties of a fixed dry gas, by properly proportioning the passage, through which the mixture is conducted, in the metering and heating means, and the com-

bustion chamber, and the passages conducting and applying the heating fluid to the mixture passages, as to shape, cross-section thickness and length, with heat applied progressively at increasing temperatures in the mixture, until the temperature of the mixture is above the boiling points of the fuel constituents, and which when introduced into the cylinder of the engine and compressed will remain dry and fixed, retaining the molecular and chemical properties of a homogeneous dry explosive gas mixture of uniform density throughout, its temperature being raised to a point just below the temperature of automatic ignition, then firing it, at or near the point of greatest compression, whereby substantially instantaneous inflammation and complete combustion are obtained.

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