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(54) VAPORIZING APPARATUS
(54) VAPORISATEUR

(57) Abstract:

260120

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METHOD OF AND APPARATUS FOR VAPORIZING LIQUID FUEL MIXTURES.

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:-

Be it known that I, Ernest Robert Godward, Engineer, of Christchurch, in the Dominion of New Zealand, temporarily residing at 153 West 94th Street, in the City, County and State of New York, U.S.A., having invented certain new and useful improvements in a Method of and Apparatus for Vaporizing Volatile Liquid Fuel Mixtures, do hereby declare that the following is a full, clear and exact description of the same:-

This invention has for its object to provide a method and apparatus for treating mechanical mixtures of liquid fuels (such as hydrocarbons or other volatile combustible liquids) and air in such manner, that both the heavier constituents as well as the lighter and more readily volatilized constituents of the liquid fuel are completely vaporized or converted into a desired uniform dry gaseous fuel, which is especially adapted for use as fuel for internal combustion engines. After a long study of the ordinary methods of carburetion, I have discovered and applied, in producing this invention, a certain procedure in the treatment of a moving stream of ordinary carbureted air (i.e. of air carrying in suspension atomized liquid fuel particles) whereby all the factors making for complete vaporization of the entire range of liquid fuel constituents, according to their degrees of volatility, are so combined that the lighter and readily

volatilized constituents are permitted to be immediately absorbed into the air and are unimpeded or unrestricted in their continued free movement to the place of use, while simultaneously providing for the separation of the heavier or less volatile constituents and the support thereof, for the length of time required, subject to both a treatment by heat in the nature of fractional distillation while continuing in the presence of and subject to the frictional evaporative effects of the moving fuel mixture streams from which they have been separated, and yet held ready for return to or absorption by said mixture streams immediately the volatilization point thereof is attained. This invention also has for a further object to provide an improved apparatus by means of which the method prodedure above outlined may be effectively carried out.

Other objects of this invention, not at this time more particularly enumerated, will be readily understood from the following detailed description of the same.

The invention is clearly illustrated in the accompanying drawings, in which:-

Figure 1 is a front elevation of the novel vaporizer apparatus with its outer casing wall partially broken away to disclose certain features of the internal structure and arrangement thereof; Figure 2 is a vertical longitudinal section through the vaporizer; Figure 3 is a horizontal section of the same, taken on line 3 --- 3 in Figure 2; Figure 4 is another horizontal section of the same, taken on line 4 --- 4 in said Figure 2; Figures 5 and 6 are perspective views of plate structures utilized in the vaporizer to provide a multiplicity of substantially unrestricted mixture stream passages having contiguous wall surfaces to support the separated heavier fuel constituents and delay

their passage a sufficient length of time to permit of their volatilization; and Figure 7 is a fragmentary sectional view to illustrate the manner of assembling said plates together in proper spaced and passage forming relation.

Similar characters of reference are employed in the above described views to indicate corresponding parts.

Referring first to the construction of the vaporizer apparatus illustrated in the accompanying drawings, and which embodies the preferred form thereof adapted to practice the treatment procedure involved in my novel method of vaporizing liquid fuel mixtures, the same comprises a casing or housing 1 having an open upper end normally closed by a cover member 2, which may be threaded into connection with, or otherwise suitably secured to said upper open end of said casing or housing 1. The interior of said casing or housing 1 is subdivided horizontally, by a partition 3, to provide an upper or vaporizing chamber 4 and a lower or heater chamber 5.

The fuel mixture intake which leads into the lower interior of the vaporizing chamber 4 extends through a centrally located throat member 6 which rises from the bottom wall of the casing or housing 1 through the interior of the heater chamber 5 to the partition 3. The interior of said throat member 6 is constructed to provide a slightly restricted intake passage 7 in the nature of a venturi tube, the same consisting of a fixed lower tube section 8 and a separable upper tube section 9 alined together. Said lower and upper tube sections 8 and 9 are inwardly spaced from the interior wall surfaces of said throat member 6 to thus provide an intermediate annular well 10 which communicates at its upper end with the interior of said vaporizing chamber 4. Said upper tube section 9 is provided with radially projecting spacer lugs 11, to retain the same in operative alined relation to said lower fixed tube section 8 as well as in properly spaced relation to the

interior wall surfaces of said throat member 6. The bottom wall of said casing or housing 1 is provided with an internally threaded coupling boss 12, or any other suitable coupling means, for connecting a fuel mixture supply pipe or conduit 13, leading from an ordinary liquid fuel and air mixing device, such as an ordinary atomizing or other type of carbureter, in communicating relation to the outer end of said vaporizer intake passage 7. An annular capillary mesh fabric 14, preferably made of relatively fine metallic gauge, is interposed between the meeting or adjoining ends of said lower and upper intake tube sections 8 and 9, so that the inner end of the same depends within the bottom portion of the well 10, while its opposite end is slightly projected, as an annular lip 15 (see Figure 4), into the restricted portion of said intake passage 7.

The casing or housing 1 is provided at opposite sides with lateral extensions or necks 16, respectively providing inlet and outlet passages 17 and 18 leading into and out of the heater chamber 5; whereby, through suitable conduit connections with said extensions or necks 16, a heating medium (such, e.g., as the exhaust gases from an internal combustion engine) may be introduced into and circulated through the heater chamber 5, so as to transfer heat to the bottom wall of said vaporizing chamber 4 provided by said partition 3. To facilitate such transfer of heat to said partition 3, the latter may be provided on its under side with a plurality of heat absorbing fingers or tits 19, which depend within the heater chamber 5, and around which circulates the heating medium introduced into and through the latter.

Arranged within said vaporizing chamber 4, in such manner that their inner ends communicate with the central interior thereof into which said intake passage 7 leads, are a

multiplicity of substantially radial and laterally extending curved passages 20 which terminate at their outer ends in an annular vertical discharge passage 21 opening into the upper end of said vaporizing chamber. The said passages 20 are formed by a multiplicity of vertical but laterally arcuate sheet metal plates 22 so spaced apart one from another as to determine said passages 20. In practice I prefer to make said plates 22 in two forms; one having at its inner end an angular extension 23 (see Figure 5), and the other being without such angular extension (see Figure 6). These two forms of plates are assembled in alternated relation, so that the angular extensions 23 of alternate plates radially converge toward the center of the vaporizing chamber above said intake passage 7, thus providing a series of central vertical passages 7' which assist in deflecting the stream of fuel mixture entering through said intake passage 7 for equal distribution and movement through the many passages 20, and thus dividing the incoming fuel mixture stream into a multiplicity of separate and distinct streams which are individually of relatively small volume. In this manner the total volume of the incoming stream of fuel mixture is caused to traverse a substantially great surface area which is provided by the plates 22, the faces of which are contiguous to the streams of fuel mixture flowing through the passages 20 therebetween. The most convenient means for separating or spacing the assembled plates 22 to provide the passages 20, consists in providing the plates, adjacent to a lateral edge thereof, with a row of outwardly pressed or struck spacing tits 24, alternately projecting from opposite sides of the plate. In practice such an arrangement of spacing tits 24 may be provided adjacent to the upper lateral edge of one plate and adjacent to the lower lateral edge of the next or neighboring plate, as shown by the

drawings particularly in Figure 7. The plates 22, when assembled together and spaced apart as above described, may be retained in assembled relation by encircling binding hoops 25, or other suitable means. The nest of plates 22 thus constructed and assembled is disposed within the vaporizing chamber 4 so that the lower edges of the plates are supported by and in contact with the partition 3, which thus serves to close the bottom sides of the series of substantially radial and laterally extending curved passages 20. The plates 22 being each in contact with the partition 3, which is heated by the heating medium circulated beneath the same within the heater chamber 5, permits said plates to receive heat and conduct the same upwardly therethrough for purposes presently to be set forth. The top sides of the series of substantially radial and laterally extending curved passages 20 are closed by a top-plate 26 which is engaged over the upper end of the nest of plates; the same being held against lateral displacement by a keeper lug 27 which depends from its under side into the space bounded by the converging ends of the angular extensions 23 of certain of said plates 22, and being held against vertical displacement by keeper screws 28 which are threaded through said cover member 2.

Said cover member 2 is provided with an outlet passage 29, suitably formed in connection therewith, through which the dry gaseous fuel produced in the vaporizer may be discharged. Suitable conduit connections may be coupled in communication with said outlet passage for delivering the dry gaseous fuel mixture to the place of use, as e.g. the cylinders of an internal combustion engine.

The method or treatment procedure by which a mixture of liquid fuel and air may be conwerted into a uniform dry gaseous fuel mixture, and which may be practiced with the

aid of apparatus such as above described, is as follows:-

Assuming that the vaporizer apparatus is connected in communication with and between an internal combustion engine and an ordinary carbureter or liquid fuel and air mixing device, the intake or suction strokes of the engine pistons will draw from the carbureter into the vaporizing chamber, by way of the intake passage 7, a stream of air in which is admixed and entrained particles of liquid hydrocarbon or other volatile liquid fuel. This stream of liquid fuel and air enters the center of the nest of plates and is immediately divided into a multiplicity of relatively thin sheet-like streams by outward movement through the passages 20 intermediate the plates 22.

Since the plates 22 are laterally arcuate, the passages 20 bounded thereby will be curved from their inner toward their outer ends, and although said passages are very narrow relative to their height, their length approximates only about one-fourth of the circumference of the vaporizing chamber; consequently the passages offer but a minimum of impedance to the free discharge of already volatilized fuel, and, therefore, while the advantages of mechanical support and sufficient length of time for the treatment of the heavier or less volatile liquid fuel constituents in the manner subsequently explained is assured, there is, nevertheless, little or no restriction imposed on the free outward movement and discharge of the lighter or quickly volatilized fuel constituents.

The combined cross sectional area of the multiplicity of passages 20 is considerably in excess of the cross sectional area of the liquid fuel and air intake passage 7, and consequently the first effect upon the streams of liquid fuel and air entering said passages 20 is a reduction of their velocity by expansion, while at the same time the curvature of said

passages sets up a centrifugal movement of said streams. The expansion and centrifugal movement of the streams tends to separate therefrom the heavier and unvolatilized liquid fuel constituents, which are thereupon deposited on the passage walls contiguous to the streams and principally provided by the sides of the plates 22, while the already volatilized lighter fuel constituents which are absorbed by the air travel on for discharge from the passages 20.

The thus separated heavier or less volatile liquid fuel constituents, being of relatively higher boiling points (from 200 to 500 degrees F), are most easily vaporized by a graded application of heat thereto adapted to effect fractional distillation thereof without decomposition. Treatment in such manner requires time. In my novel method the time factor is attained by providing, contiguous to the fuel mixture streams, a very great extent of plate surface area upon which the separated heavier liquid fuel constituents may be deposited and supported. The fractional distillation effect is attained by applying heat to this great supporting plate surface area in such manner that the heat is conducted upwardly through the supporting plates to meet the liquid fuel deposits which tend to run down the surfaces thereof by gravitation. By reason of this arrangement and mode of operation the heat is most intense at the bottom ends of said supporting plates and diminishes toward the top ends thereof. It follows that the separated and deposited liquid fuel constituents in traveling down the plate surfaces will meet with that degree of heat corresponding to their particular boiling points, and will consequently be progressively distilled or vaporized, and thereupon immediately returned as a gaseous element into the streams, from which they were initially separated, so as to be absorbed by the air together with the already

absorbed volatilized lighter fuel constituents.

A further feature of my novel method resides in the fact that the fractional distillation treatment above described is carried on in the presence of the contiguous moving mixture streams, so that, in addition to the vaporization effects thereof, a further assistance to and speeding up of the process of vaporizing the heavier liquid fuel constituents is attained by the frictional contact of the moving mixture streams with said heavier liquid fuel deposited on the supporting plate surfaces. The effect of this frictional contact of the moving mixture streams upon the deposited heavier fuel constituents is to cause the latter to spread out on the supporting plate surfaces in films, increasingly attenuated toward the discharge ends of the passages. The advantages of such effect is two-fold; first, it results in direct vaporization of many of the fuel constituents of grades of volatility intermediate the extreme light and heavy constituents; and, second, by thinning out the heaviest or least volatile of the fuel constituents, it aids in extending the surface thereof and thus renders the same more quickly susceptible to the fractional distillation effects of the applied heat.

In the practice of the novel treatment procedure thus far outlined, attention must be directed to the very important consideration involved in dividing the initial volume of liquid fuel and air into a multiplicity of separate narrow streams of individually small volume, which, although substantially unrestricted as to their free onward movement, are, nevertheless, permitted sufficient expansion to reduce their velocity in aid of the rapid separation therefrom of the heavier or unvolatilized liquid fuel particles by the described centrifugal action; all of which tends to hasten the final production and delivery of the desired resultant dry gaseous

fuel mixture. Attention must be further directed to the importance of providing the great extent of surface area for the support of the separated heavier or unvolatilized liquid fuel particles, especially, since it is the provision of this great extent of supporting surface area that determines the time factor whereby movement of unvolatilized liquid fuel is delayed and premature discharge thereof prevented until it too has been vaporized and absorbed into the moving dry gaseous fuel mixture to be discharged from the vaporizing chamber into the engine cylinders. I have found that it is desirable that the total area of supporting surface contiguous to the multiplicity of passages shall be preponderately in excess of the cross sectional area of the initial liquid fuel and air intake passage. In my apparatus the total supporting surface area contiguous to the outgoing passages is substantially in a ratio to the cross sectional area of the intake passage 7 of 500 to 1; in other words, in a vaporizer having an intake passage of approximately two square inches in cross sectional area I prefer to employ a total supporting or evaporating surface area contiguous to the outgoing passages of the vaporizer of approximately one thousand square inches. While I have found that in an operative apparatus the above stated ratio of evaporating surface area to cross sectional area of the initial mixture intake passage is highly efficient, I do not limit myself to such exact ratio, since the same may be diminished or increased within reasonable limits. It would seem sufficient to say that in any event the total supporting or evaporating surface area must very substantially preponderate the cross sectional area of the initial mixture intake passage of the vaporizer.

When using my novel vaporizing method and apparatus in connection with an internal combustion engine, the exhaust gases from the latter are passed through the heater chamber 5,

and the heat thereof is transferred to the partition member 3 which forms the bottom of the vaporizing chamber. It will, of course, be understood that any other heating medium may be utilized as may be found convenient. The heat thus delivered to the partition member 3 will be transferred therefrom to the bottom ends of the plates 22, which are in contact with said partition member, and said plates 22 will tend to conduct the heat upwardly through their bodies in a direction opposed to the downward gravitation of liquid fuel particles deposited upon the same. It will therefore be readily understood, that, as the liquid fuel deposits descend the plate surfaces, they will progressively meet with increasing temperature so that the constituents of the liquid fuel particles will eventually meet that particular degree of heat corresponding to their particular boiling points, and consequently will be rapidly distilled or vaporized. Immediately a liquid fuel constituent is volatilized or gassified by such distillation or evaporation it is at once liberated from the mechanical support afforded by the plate surface, and, since such plate surface is contiguous to a moving gaseous fuel stream, it is at once absorbed or merged with said gaseous fuel stream as a combustible element thereof.

Upon issue of the gaseous fuel streams from the passages 20, the same again unite in the annular vertical discharge passage 21 of the vaporizing chamber, and thence flow upwardly as a uniform dry gaseous fuel mixture for discharge through the outlet passage 29 of the vaporizer, and thence through the conduits arranged to deliver the same to the cylinders of the internal combustion engine served by the vaporizer.

In my novel vaporizing apparatus, as shown in the accompanying drawings and as heretofore described, I have provided in connection with the intake for the initial mixture of

air and liquid fuel, a means for reintroducing into the incoming initial mixture any liquid fuel which by any chance has not been volatilized in the passages 20. This novel feature is of most advantage in connection with the functioning of the vaporizer when the internal combustion engine which it serves is first started. When the engine is started from a cold condition, and before the vaporizer receives the full benefit of the heat delivered to its heater chamber 5 by the products of combustion exhausted from the engine, it may happen that liquid fuel deposited on the plates 22 and gravatating on the surfaces thereof will reach the bottoms of the passages 20 before entirely volatilized or vaporized. If this occurs, the liquid accumulating in the bottom of each passage 20 will tend to flow backward therethrough, and will thus move to the mouth of the well 10 into which it will be precipitated. The thus back-drained liquid fuel, when so deposited in the well 10, will be brought into contact with the depending section of the mesh fabric 14, which by its capillary function will take up and carry said liquid fuel from the well to the annular lip 15 disposed within the restricted portion of the intake passage 7, thus presenting or exposing particles of the same to and in contact with the incoming stream of liquid fuel and air, the frictional and suctional pull of which will dislodge the said fuel particles from said lip 15, so that the same enter into and become remixed with said incoming stream for delivery again into the passages 20 of the vaporizing chamber. The advantages of the above mode of operation when starting up the engine which the vaporizer serves will be quite apparent without further amplification; and it will be further understood, once the engine is in continuous operation and the vaporizer receives an adequate supply of the heat medium in the form of engine exhaust, that the accumulation of unvolatilized liquid

fuel subject to such back- draining stops, and consequently the novel redelivering means becomes substantially inactive during the operation of the vaporizer under the established normal conditions.

Having now described the novel method of and apparatus for vaporizing volatile liquid fuel mixtures which is the subject of this invention, I declare that what I claim is:-

1. A method of producing a substantially dry gaseous fuel, which consists in dividing an initial stream of admixed volatile fuel and air containing entrained liquid fuel particles into a multiplicity of substantially unimpeded free moving streams of relatively great surface area compared to the thickness thereof; producing a centrifugal movement of said divided streams between walls of relatively great surface extent contiguous thereto to separate unvolatilized liquid fuel therefrom for deposit on said wall surfaces; supplying heat to said walls for conduction therethrough in a direction opposite to the gravity flow of liquid fuel deposited on said wall surfaces, whereby said gravitating deposited liquid fuel is subject to fractional distillation in the presence of said divided streams so as to be returned thereto as a gaseous element; and finally combining said divided streams to provide the resultant discharged volume of dry gaseous fuel.

2. A method of vaporizing the liquid elements of a mechanical mixture of volatile liquid fuel and air, which consists in separating an initially delivered stream of such mixture into a multiplicity of substantially free moving sheet-like streams by diverting said initially delivered stream through a multiplicity of laterally arcuate and substantially radially directed passages of relatively great height compared with their width, thus both diminishing the

velocity of the mixture by expansion of its initial volume while simultaneously producing centrifugal movement thereof, to thereby separate and deposit contained unvolatized liquid elements upon the walls of said passages subject to the frictional contact of said free moving sheet-like streams, so that said deposited liquid elements are spread on said walls in films increasingly attenuated toward the outlets of said passages to assist vaporization thereof; supplying heat to said walls for conduction therethrough in a direction opposite to the gravity flow of liquid elements deposited on said walls, whereby a range of temperatures progressively increasing toward the bottom ends of said walls is established, adapted to vaporize, for return to the sheet-like streams as gaseous fuel elements, the lighter or low boiling point liquid elements on the upper portions of said walls and the progressively higher boiling point liquid elements as they descend the increasingly heated lower wall portions; and finally combining said sheet-like streams with their gaseous fuel elements into a unitary volume for discharge to the place of use.

3. A vaporizing apparatus for liquid fuel mixtures, comprising a casing having an axial initial fuel mixture intake passage; means within said casing to provide a multiplicity of laterally arcuate substantially radial passages of heights greatly in excess of their widths; said casing having an annular discharge passage terminating in an outlet means; said passages communicating at their inner ends with said axial intake passage and at their outer ends with said annular discharge passage; and means for supplying heat to the lower ends of the walls of said radial passages for conduction upwardly therethrough for the purposes described.

4. A vaporizing apparatus as characterized in Claim 3 having means to collect liquid fuel backdrained from

said radial passages, and means cooperating therewith and with said initial fuel mixing intake passage for returning said collected liquid fuel into the incoming fuel mixture.

5. A vaporizing apparatus for liquid fuel mixtures, comprising a casing subdivided to provide a heater chamber in its lower end, said heater chamber having means for the admission thereinto of a heating medium; means to provide an axial initial fuel mixture intake passage leading into the main interior of said casing; a multiplicity of laterally arcuate upstanding plates having means for spacing the same one from another in an annular group to provide a multiplicity of substantially radial passages of heights greatly in excess of their widths, said radial passages communicating at their inner ends with said axial intake passage, the lower ends of said plates engaging the top of said heater chamber so as to close the bottoms of said radial passages, a top member engaging the upper ends of said plates to close the tops of said radial passages; said plates and the intermediate passages provided thereby terminating short of the outer side walls of said casing, to thereby provide a common annular discharge passage with which the outer ends of said radial passages communicate; said casing having an outlet means with which said annular discharge passage communicates; and said heater chamber being adapted to transfer heat to the lower ends of said plates for upward conduction therethrough for the purposes described.

6. A vaporizing apparatus as characterized in Claim 5 having means to collect liquid fuel back-drained from said radial passages, and means cooperating therewith and with said initial fuel mixture intake passage for returning said collected liquid fuel into the incoming fuel mixture.

7. A vaporizing apparatus for liquid fuel mixtures comprising a casing subdivided to provide a vaporizing chamber and an underlying heater chamber; a fuel mixture receiving and treating means within said vaporizing chamber, comprising a substantially ring-like member partitioned to provide a multiplicity of transversely arcuate and radially directed vertical passages, the walls of which receive heat from said heater chamber for upward conduction therethrough; means for introducing a stream of liquid fuel mixture into the center of said ring-like member for dispersion through said passages thereof; and means for uniting and discharging from the vaporizing chamber the treated fuel mixture streams issuing from the passages of said ring-like member.

8. A vaporizing apparatus as characterized in claim 7 having means to collect liquid fuel back-drained from the passages of said ring-like member adapted to return the same into the stream of fuel mixture entering the center of said receiving and treating means.

Signed at New York, State of New York, U.S.A. the 24th day of September, 1925.

Ernest Robert Godward

Inventor.

Method of and Apparatus for Vaporizing Liquid Fuel Mixtures.

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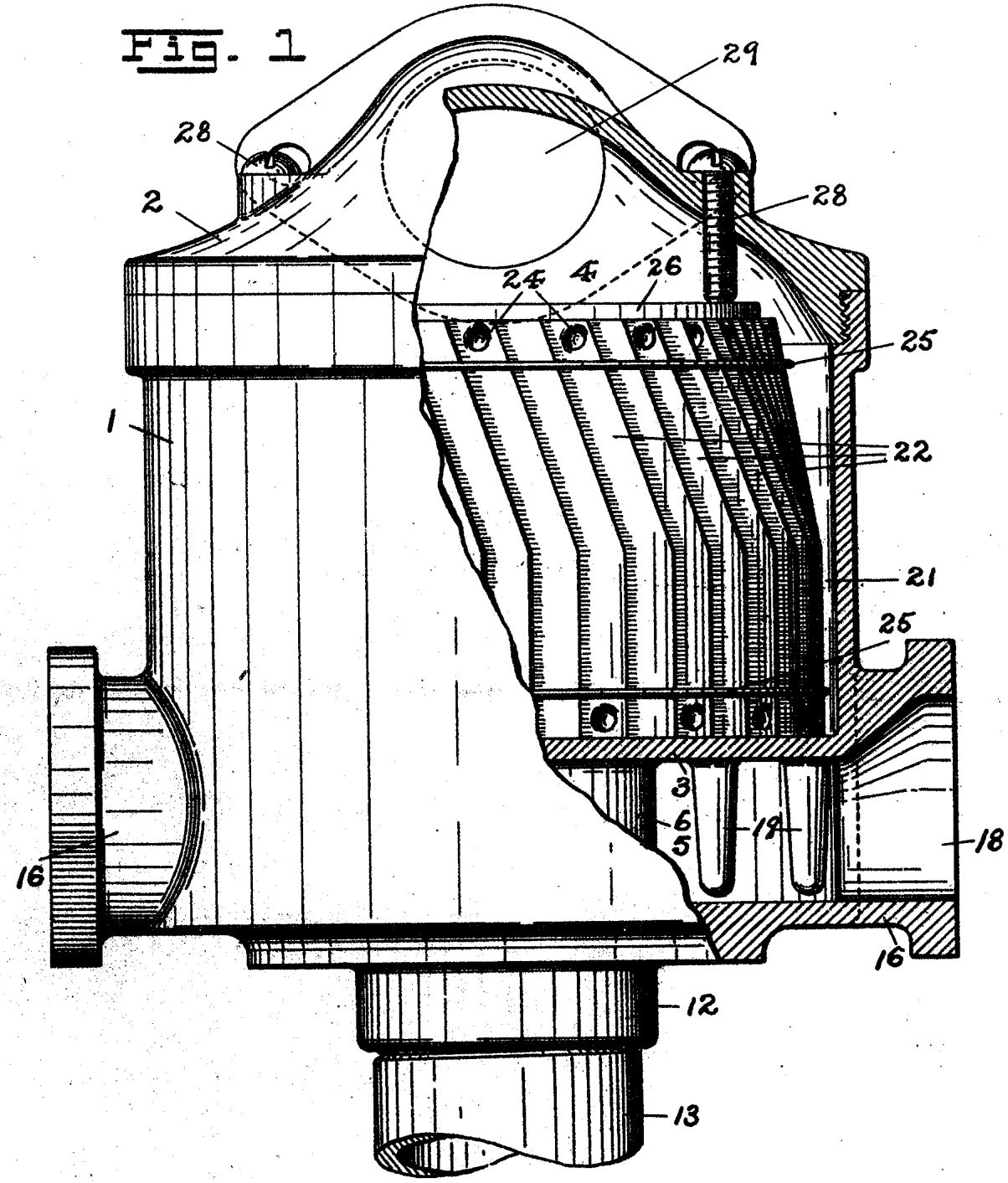
Fig. 1



Certified to be the drawings referred to in the specification hereunto annexed.

September 4th 1926

New Jersey N.S.A

APPLICANT

Ernest Robert Godward

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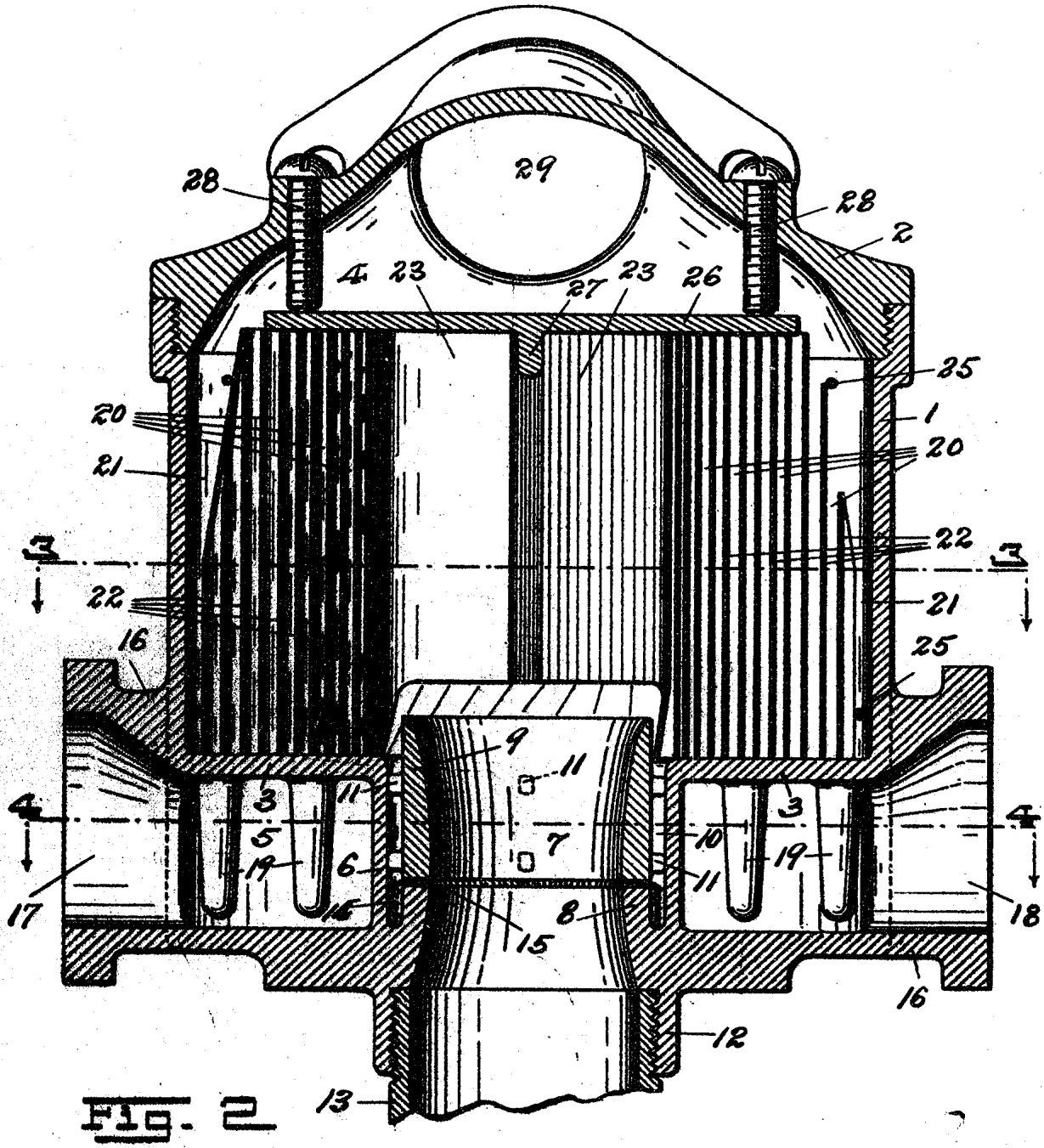

FIG. 2

Certified to be the drawings referred to in the specification hereunto annexed.

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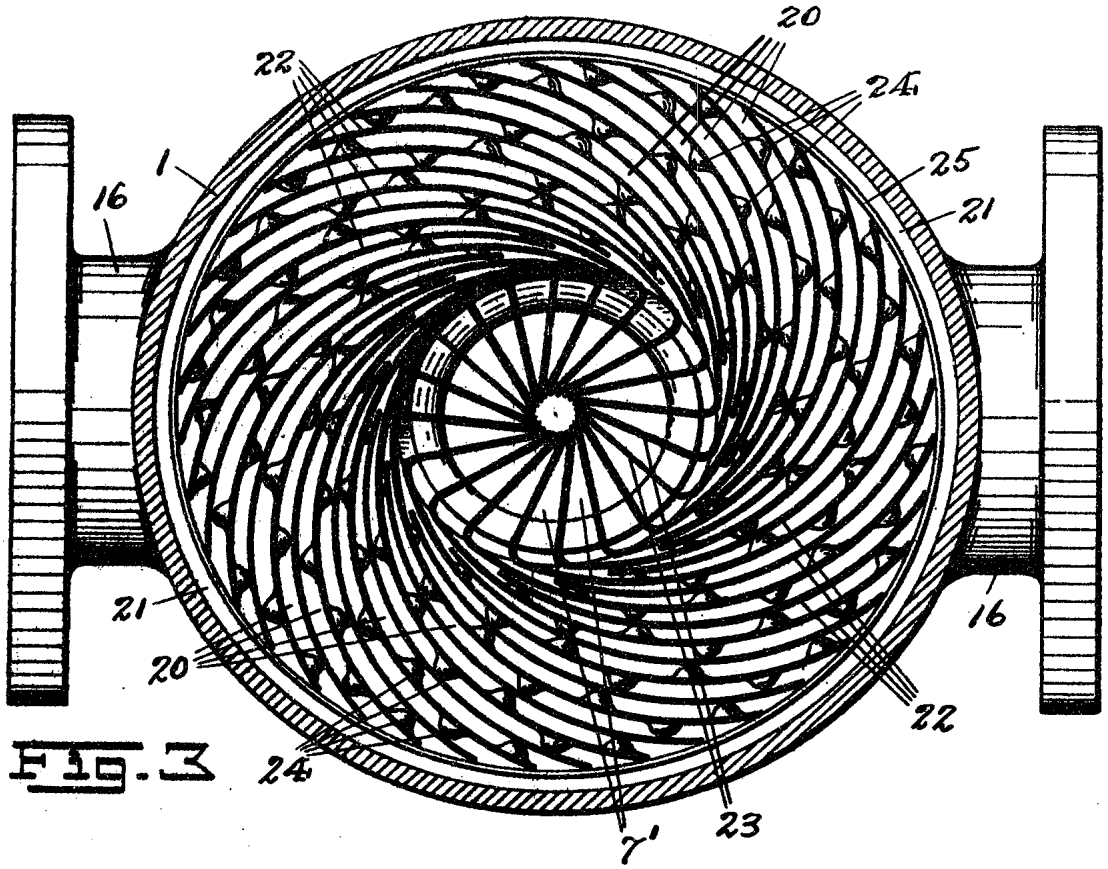

Fig. 3

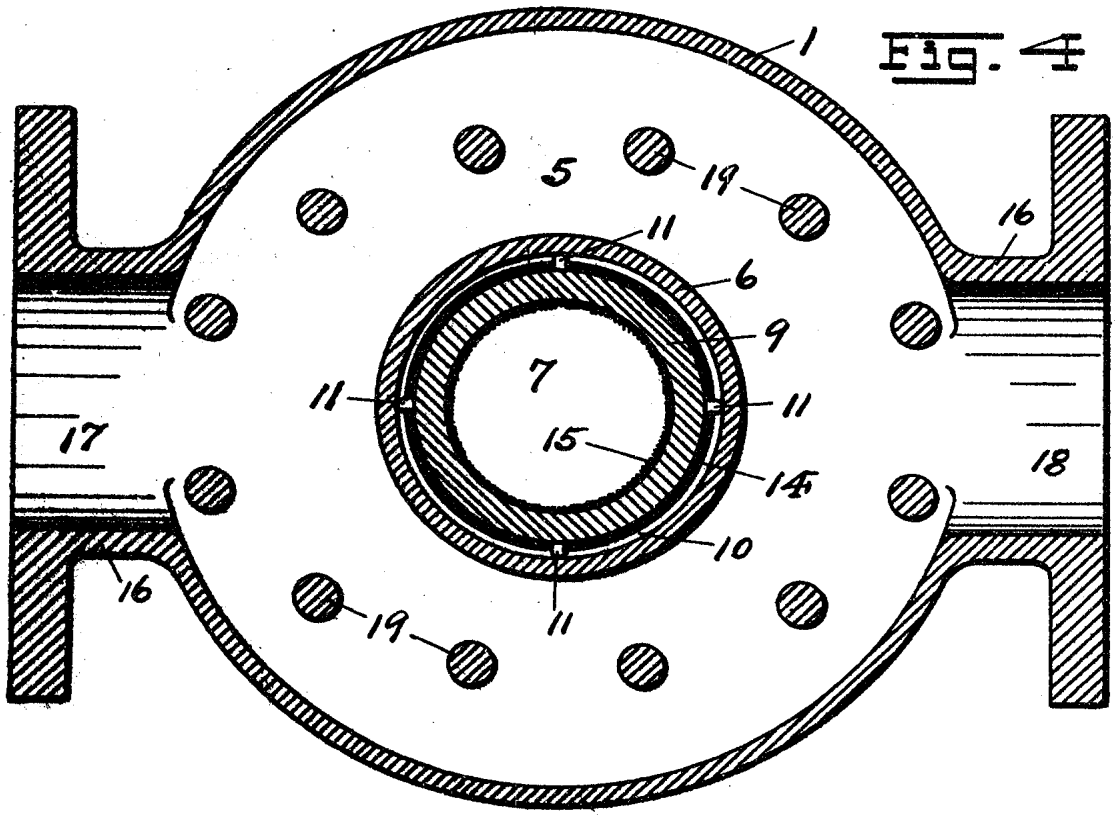

Fig. 4

Certified to be the drawings referred to in the specification hereunto annexed.

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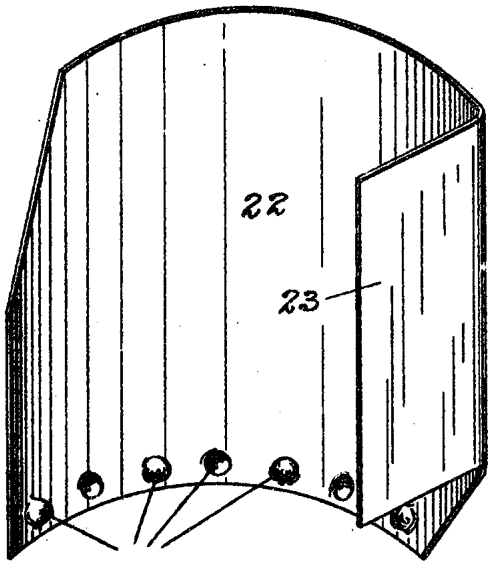


Fig. 5

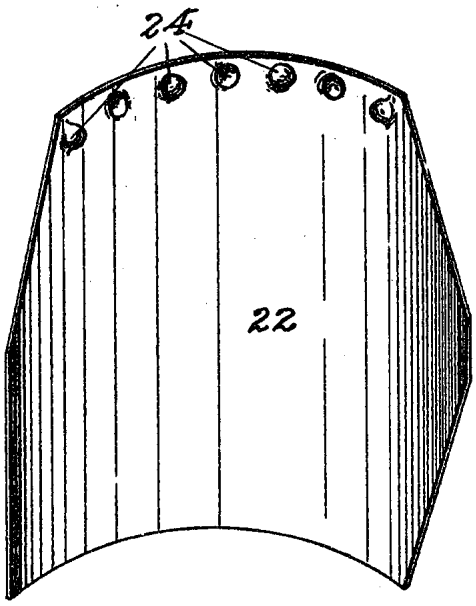
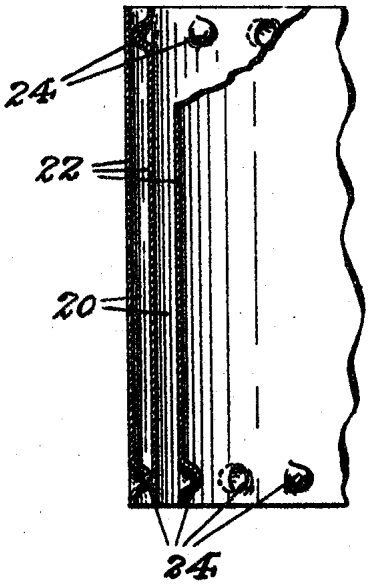


Fig. 6

Fig. 7



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