

[54] **SPRAYING AND SMOKE-LAYING APPARATUS**[75] Inventors: **Otto Locher; Franz Haag; Paul Bongartz**, all of Isny, Germany[73] Assignee: **Heimo Geraetebau Gesellschaft mit beschränkter Haftung**, Isny, Germany[22] Filed: **Apr. 25, 1972**[21] Appl. No.: **247,296**[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**..... **252/359 CG, 60/39.77**[51] **Int. Cl.**..... **B01d, B01f, B01j 13/00**[58] **Field of Search**..... **252/359 CG, 305; 43/129; 47/2; 239/4, 102, 337, 398; 60/39.77, 39.78, 248, 249**[56] **References Cited****UNITED STATES PATENTS**

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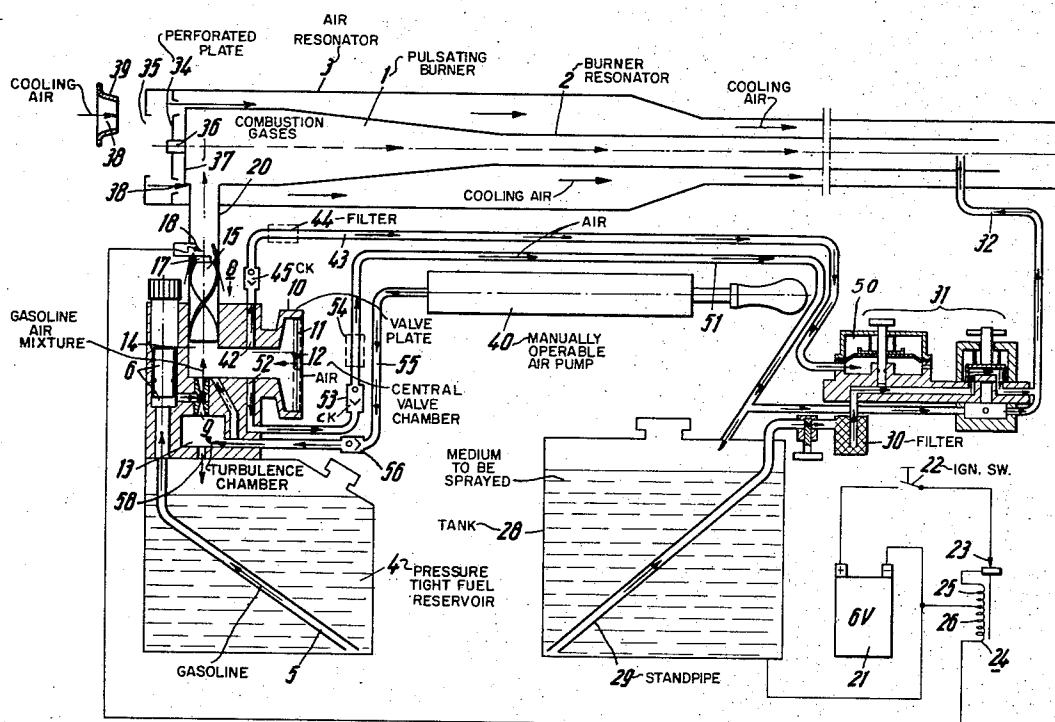
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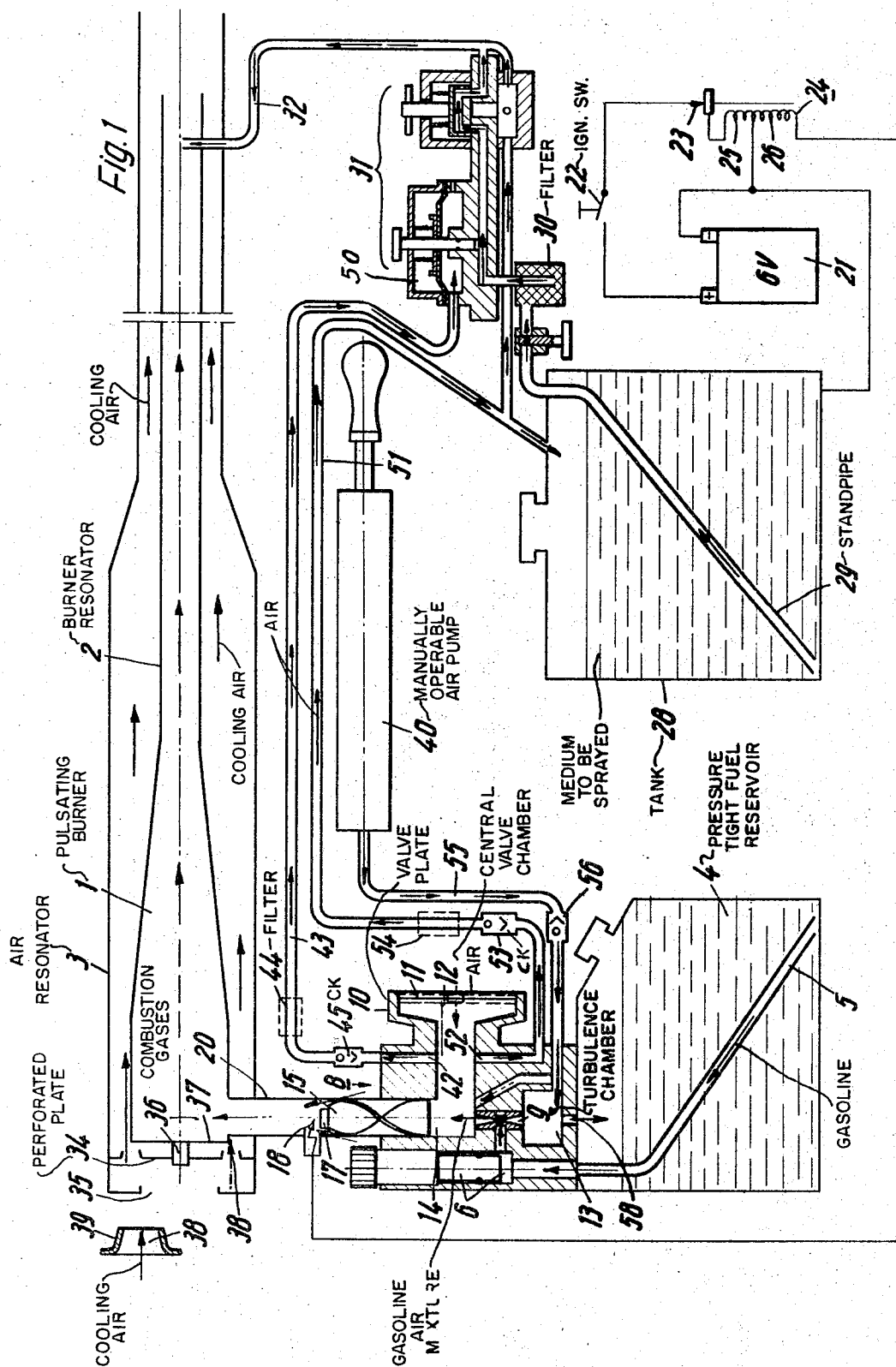
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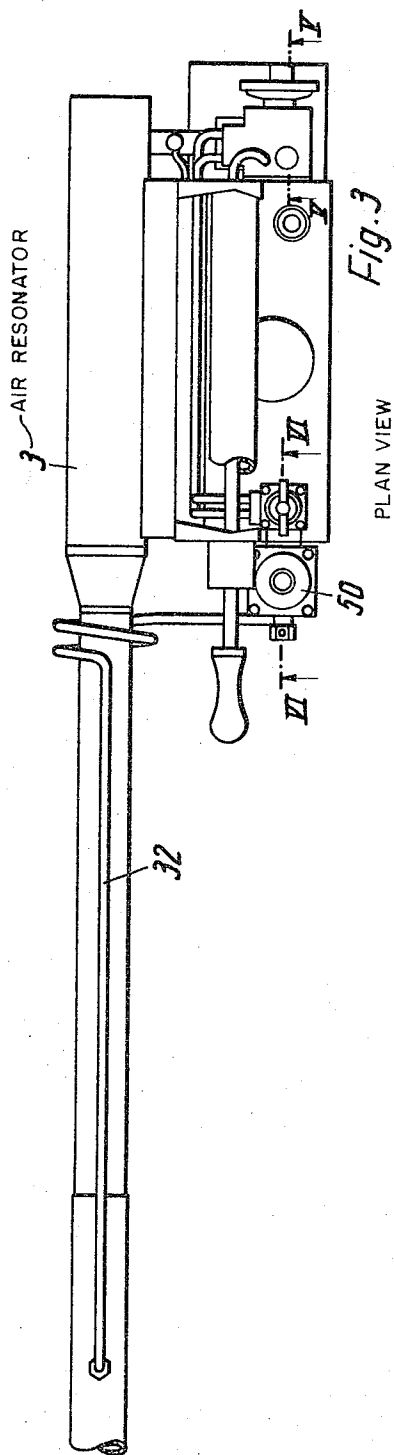
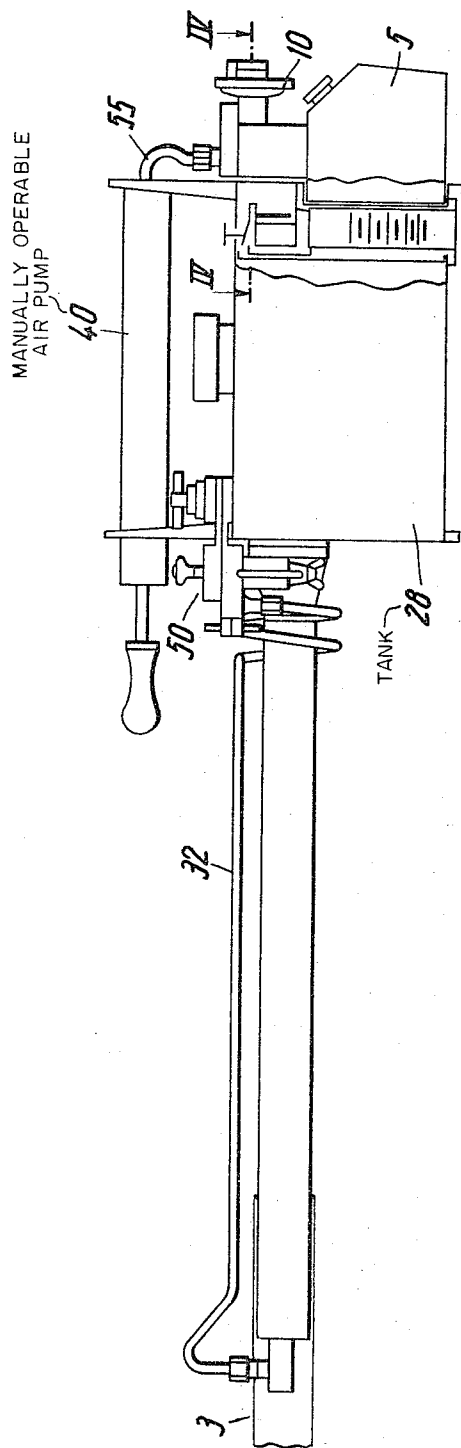
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[57] **ABSTRACT**

An apparatus for injecting a flowable medium such as a liquid while simultaneously breaking up or vaporizing the medium in which a pulsating burner is provided with a resonating tube with the medium being supplied to the burner resonating tube for being conveyed outwardly by the discharge from the burner resonating tube. An air resonating tube coaxially surrounds the burner resonating tube for the flow of air therethrough in the same direction as the products of combustion from the burner passed through the burner resonating tube and the tubes are tuned to a frequency of about 50 to 160 Hertz and are so tuned relative to each other that the frequencies therein are about one-half cycle apart.

16 Claims, 6 Drawing Figures





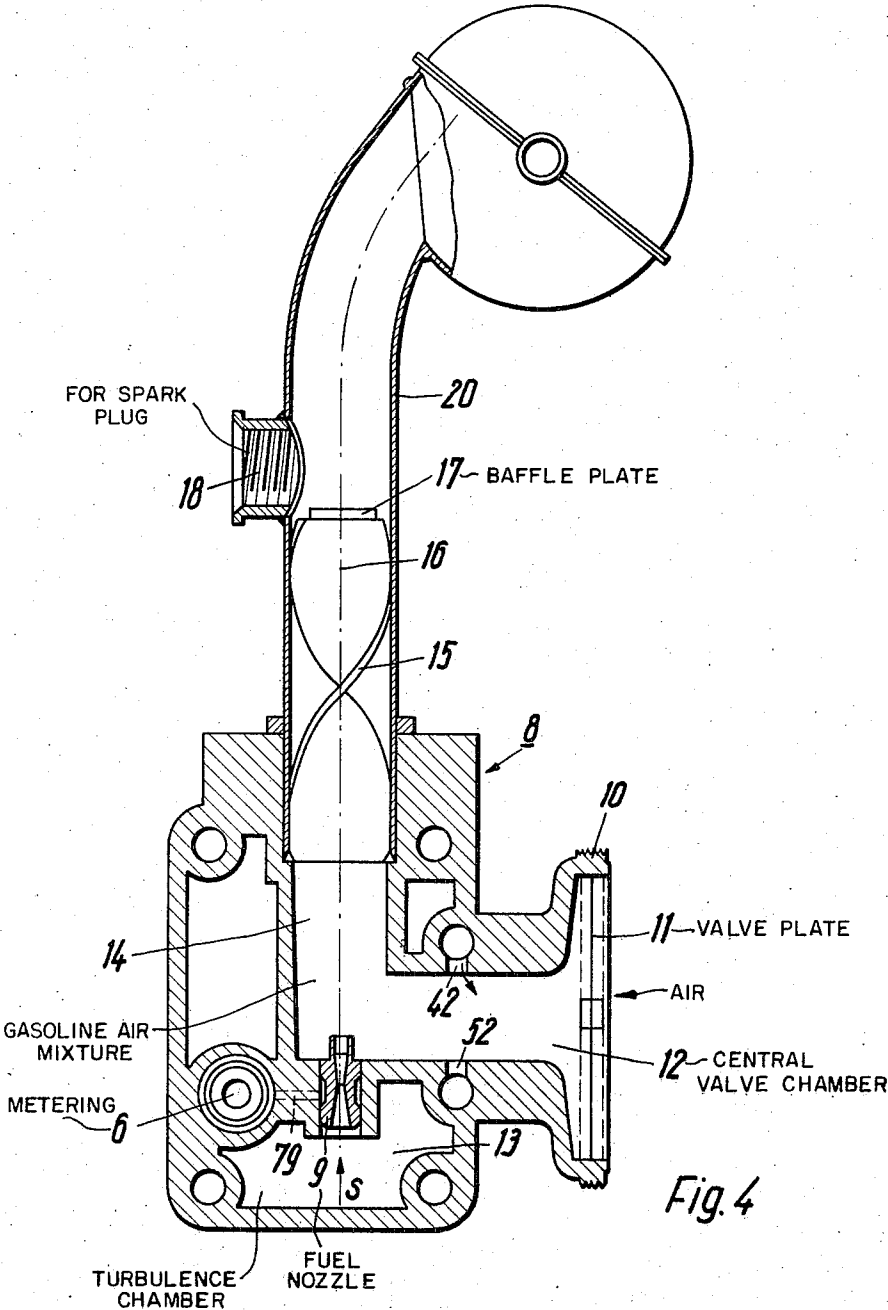


Fig. 4

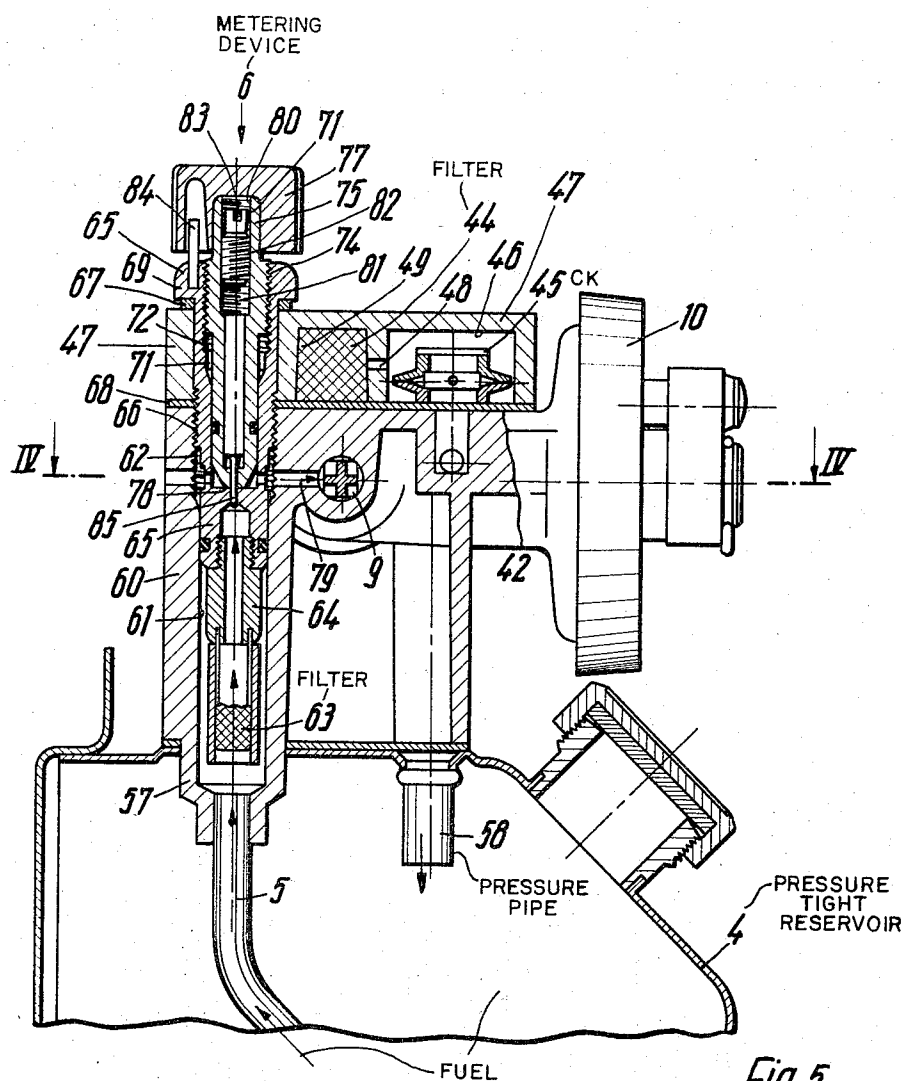
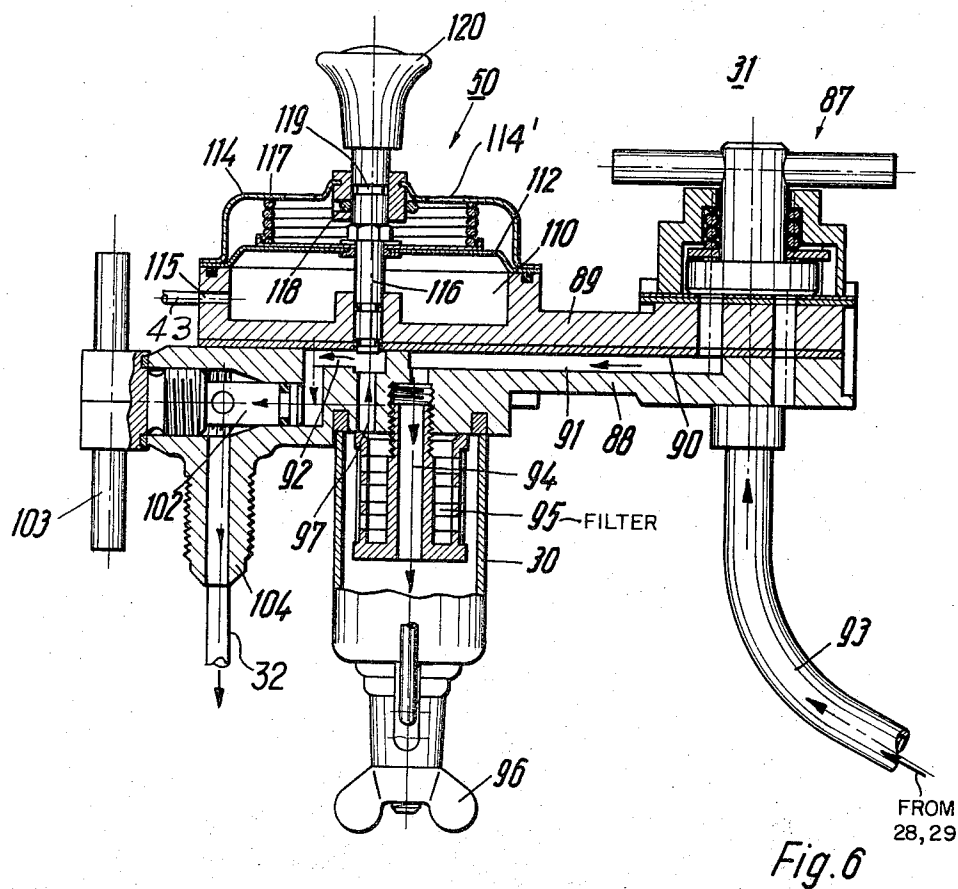


Fig. 5



SPRAYING AND SMOKE-LAYING APPARATUS

The present invention relates to a spraying or smoke-laying apparatus, especially a portable spraying apparatus with a container for a substance to be sprayed and with an oscillating fire or pulsating burner (Schwingfeuer-Brenner), which operates with pulsating combustion and is fed with liquid fuel from a reservoir, said container being connected to a discharge conduit, and said burner being connected to a burner resonator.

Devices of the above mentioned type are supposed to afford an effective employment thereof in connection with an insecticidal, acaricidal, and fungicidal treatment of hothouse culture, trees and brushes, and in connection with the elimination of flies and mosquitoes on beaches, at resort or camping places, and also in connection with the disinfection of surface and space areas, while such devices should have the ability with a low fuel consumption to dispense large quantities of the respective substance. In this connection, the staying time of the respective substance within the region of the burner exhaust gases must be short in order to prevent the substances from thermally disintegrating. Furthermore, devices of the above mentioned type should be such that they can easily be handled, have a low weight, are simple in construction, and are generally not subject to disorders while being able when incorrectly treated to shut themselves off automatically.

These and other objects and advantages of the present invention will appear more clearly from the following specification, in connection with the accompanying drawings, in which:

FIG. 1 diagrammatically illustrates a spraying and smoke-laying apparatus according to the invention.

FIG. 2 illustrates the apparatus of FIG. 1 as seen from the side.

FIG. 3 is a top view of the arrangement of FIG. 2.

FIG. 4 shows a section taken along the line IV—IV of FIG. 2 through the carburetor and the burner unit of the apparatus.

FIG. 5 illustrates a section taken along the line V—V of FIG. 3 through the fuel metering device, said section through the carburetor and burner unit.

FIG. 6 represents a vertical longitudinal section taken along the line VI—VI of FIG. 3 through the valve system of the apparatus according to the invention.

The spraying or smoke-laying apparatus according to the invention is characterized primarily in that the burner is connected to a mechanical air intake valve and that the burner resonator is annularly surrounded by an at least approximately coaxial cool air resonator which at its inlet is provided with a valve, preferably an aerodynamic valve.

According to further development of the invention, it is provided that the burner resonator and the cool air resonator are tuned upon each other and coordinated to each other in such a way that at a substantially equal fundamental frequency, the oscillation or pulsation in the burner resonator has over the cool air resonator a phase displacement by one-half cycle. Advantageously, the axial length of the resonators amounts to at least approximately one-fourth of the wave length. In this way a particularly high air delivery and a considerable kinetic energy is obtained with low output losses. Therefore, it is possible with low fuel consumption to discharge large quantities of the respective substances

to be sprayed by the apparatus and to lay the smoke in a very fine atomized form.

Referring now to the drawings in detail, the spraying and smoke-laying apparatus, according to the diagrammatic illustration of FIG. 1 comprises a pulsating fire burner 1 with a burner resonator 2 formed by a cylindrical pipe and connected to said burner 1, and with an air resonator 3 coaxially arranged with said resonator 2, said resonator 3 surrounding the burner and the resonator of the burner. The burner 1 operating with pulsating combustion is adapted to be operated by gasoline which is stored in a pressure-tight reservoir 4 from which it is adapted through a stand pipe 5 and a metering device 6 which is manually adjustable to be conveyed to a carburetor 8 through a central carburetor nozzle 9.

The carburetor will be described in greater detail in connection with FIGS. 4 and 5. The carburetor according to the building principle illustrated in FIG. 1 is provided with an air intake funnel 10 having an inserted valve plate 11, a central chamber 12 and a turbulence chamber 13 communicating with valve chamber 12 through the bore of nozzle 9. The carburetor furthermore comprises a mixing neck 14 connected to the valve chamber 12, into which mixing neck 14 there is inserted a twist body 15 which comprises a twist sheet metal member twisted around the axis 16 of the mixing neck over an angle of 180°. Transverse to the axis 16 in FIG. 4 at the end of the body 15 there is provided a diaphragm plate or baffle plate 17 which with regard to the wall of the suction pipe 20 leaves free a narrow annular gap. The fuel or mixture passing through said annular gap can be ignited by a spark plug 18 which is inserted into a threaded portion (FIG. 4) welded to the suction pipe 20. The ignition energy is furnished to a high voltage buzzer igniton device which in FIG. 1 is illustrated only diagrammatically and which comprises a 6-volt battery 21, an ignition switch 22 and a high voltage coil 24 equipped with self-breaker contacts 23. With this ignition device, the end of the primary winding 25 and the start of the secondary winding 26 are together connected to the minus pole of the battery 21 and in addition thereto are connected to the metallic mass of the device through the tank 28.

The substance to be sprayed can be withdrawn from the air-tightly closed tank 28 through a stand pipe 29, and through a filter 30 and a fitting 31 described further below can be conveyed through a discharge conduit 32 which in the direct vicinity of the open end face of the burner resonator 2 leads into the latter.

In order to be able within a time unit and with finest atomization to discharge large quantities of the substance to be sprayed, the present invention additionally provides that in addition to the mechanical damming up of the fuel gas column by means of the valve plate 11 of the air funnel 10 there is also provided an aerodynamic damming up of the cooling air resonator 3. This "damming up" or tamping can be taken as blocking or "driving down" the course of a stream or flow. The length of said cool air resonator is tuned or selected with regard to the length of the burner resonator 2 in such a way that at approximately the same natural frequencies, the oscillation or pulsation in the burner resonator 2 will, over the oscillation or pulsation in the cool air resonator tube 3, be phase displaced by half a cycle while the length of the gas or air column pulsating in these resonators amounts to approximately one-

fourth of the wave length. It has been found advantageous for the burner to select a pulsating frequency of approximately 80 pulsations per second, in other words 80 Hertz.

The aerodynamic damming up with the illustrated embodiment of the invention is realized by means of a perforated plate 34 which is arranged directly downstream of the central inlet opening 35 of the cool air tube 3 and is fixedly connected to the wall of this resonator tube 3 at the outer marginal portion of said plate 34. The perforated plate 34 simultaneously serves for connecting the cool air resonator tube 3 and to this end is connected to the imperforate end face wall 37 of the burner 1 by a central bolt 36. Along its marginal zone, the perforated plate 34 has a plurality of stamped-out inlet openings 38 which have a collar-shaped extension 39 extending inwardly as will be more clearly seen from the cutout shown on an enlarged scale. These inlet openings 38 are in the illustrated embodiment of the invention designated as Borda mouths and bring about that in any inflow direction, the cooling air will encounter only low resistance, whereas the flow resistance in the opposite direction will be considerably higher. In view of this damming-up arrangement, the burner resonator 2 and the cool air resonator tube 3 oscillate almost together at their fundamental frequencies so that only low energy losses can occur. The result is a considerably higher output of substances to be sprayed and a better cooling of the burner 1.

The high output of the burner is considerably aided by the design of the carburetor (see FIG. 4) which comprises a one-piece housing of die-cast metal. The fuel nozzle 9 is in this instance located centrally with regard to the mixing neck 14 and is arranged between the mixing neck 14 and the turbulence chamber 13. In the turbulence chamber 13 there continuously prevails a certain overpressure which prior to the start of the operation of the burner may be provided in the manner customary for pulsating fire devices by means of a manually operable air pump 40. In view of this overpressure, a continuous flow in the direction indicated by the arrow S toward the mixing neck 14 during the intake phase which in this way is considerably improved. The die-cast metal housing furthermore comprises a connecting passage 42 which leads into the valve chamber 12 of FIG. 4 and is intended for a connecting line 43 in FIG. 1 leading to the unit 31 for the substance to be sprayed. Within the course of this connecting line 43, and more specifically at 44, there is provided a filter and a check valve 45 in FIG. 5 which will prevent a substance to be sprayed from passing from the unit 31 to the carburetor. This valve which permits the occurring repulsion pressure to pass into the unit 31 and the emergency shut-off device 50, to be described further below, is mounted in a hollow chamber 46 of a cover 47, as shown in FIG. 5, and through a bore 48 communicates with a chamber 49 which receives the filtering substance of filter 44 and acts as means to permit condensing and absorption in chamber 49.

In order to be able in the reservoir 28 to produce a sufficient delivery pressure for the substance to be sprayed or laid as smoke, the tank or reservoir 28 communicates through a pressure line 51 and a valve 53 within this line 51 and is adapted to communicate with a second connecting passage 52 which communicates with the valve chamber 12 of the carburetor 8. The valve 53 in FIG. 1, opens each time when subsequently

to an intake cycle a combustion occurs and then a repulsion pressure is created in the valve chamber 12. In the connecting line 55 for the air pump 40 there is furthermore provided a third valve 56 which, however, in contrast to the above described valves 45 and 53 will close in response to an occurring repulsion pressure and will be opened only when for purposes of starting the burner, the air pump is actuated to carry out a pressure stroke.

For purposes of increasing the safety of operation and in order to facilitate the handling of the apparatus, the fuel tank 4 is directly connected to the carburetor 8 and together with the latter forms a structural unit. In this connection, the fuel stand pipe 5 is pressed into a cylindrical extension 57 at the die-cast metal housing of the carburetor, said extension 57 extending into the interior of the fuel reservoir. Moreover, a pressure pipe 58 is folded into the tank wall and leads to the turbulence chamber 13 of the carburetor in the manner shown diagrammatically in FIG. 1.

For purposes of simplifying the handling of the apparatus and in order to obtain a long life of use for the device according to the invention, it is suggested that the die-cast metal part 60 of the carburetor housing receives the structural elements of the dosing device for the fuel as illustrated in FIG. 1 at the numeral 6. The dosing device forms an easily exchangeable structural unit which is inserted into a bore 61 extending through the die-cast metal part 60. The said bore has its upper end section provided with a thread 62. In a coaxial arrangement, the dosing device comprises a filter 63 for the entering fuel, a nipple 64 fixedly connected to the filter which is screwed into the lower section of a bushing 65 and which has its central section provided with a thread 66 by means of which it is turned into the thread 62 of the part 60, and permits firmly to clamp in the cover 47 while interposing a sealing ring 67 and a sealing plate 68 with its flange 69.

Bushing 65 has a central longitudinal bore 71 which has its upper section widened and provided with a thread 72. Turned into this thread 72 is the thread 74 of a plug of a cock 75, the upper end of which is provided with a handle 77 adapted to be withdrawn. By means of the handle 77, the plug 75 can be turned out of the illustrated closing position and into the opening position to such an extent that between the end face 78 at the tapering inner end section of said plug 75 and the bottom of the bore 71 there will be obtained a passage of sufficiently large cross section for the fuel to the transverse bore 79 which leads to the central fuel nozzle 9, as shown in FIGS. 4 and 5.

A setting bolt 81 with its thread 62 is longitudinally adjustably guided in a central longitudinal bore of the plug 75. Bolt 81 has its upper end provided with a screw slot 83 for receiving a non-illustrated screw driver and continues at its lower end section in the form of a setting needle 85 which determines the flow-through cross section for the incoming fuel. After setting the needle 85, the setting bolt 81 is arrested in its set position, and the handle 77 may be placed upon the free end of plug 75 so as to be prevented from rotation. An abutment pin 84 which is axially parallelly pressed into flange 69 serves for preventing the plug 75 from being unduly turned out of the bushing 65.

In a manner similar to the above described carburetor, also the substance containing unit 31 forms a structural unit.

As will be seen more clearly from FIG. 6, the unit 31 comprises the above mentioned emergency shut-off device 50 and a valve 87. Both members are mounted on a common lower part 88 which forms a die-cast metal device and has its end face 90 which forms the dividing plane relative to the upper portion 81 provided in a simple manner with machined-in passages 91 and 92 for the passage of material or substance to be sprayed or laid as smoke. The said substance is in contrast to the arrangement of FIG. 1 delivered from the container or tank 28 through a line 93 to the valve 87 rather than standpipe 29 of FIG. 1 and from there passes through passage 91 through the central bore 94 of an easily exchangeable filter body 95 through the central bore 94 of an easily exchangeable filter body 95 into the interior of the filter housing 30 which latter by means of a clamping nut 96 is easily detachably connected. From here the substance to be sprayed or laid as a smoke passes through a bore 97 to the passage 92 as long as the emergency shut-off device 50 occupies its illustrated operational position, and from there passes through a change nozzle 102 which for facilitating the screwing-in and out is provided with a crossbar 103. For connecting the discharge line 32, not shown in FIG. 6, there is provided a section 104.

The emergency shut-off device 50 comprises a pressure chamber 110 which is sealed against the outer atmosphere by a diaphragm 112 and which through the pressure line 43, shown in FIG. 1, is adapted to communicate with the valve chamber 12 of the carburetor 8 and has only a very narrow connecting bore 115 toward the outside. The pressure which builds up in chamber 110 under the influence of the exhaust gases in burner 1 keeps the valve shank 116 of the emergency shut-off device 50 in space relationship to the mouth of the transverse bore 97 until the burner works properly. If, however, a disorder should occur, the pressure in chamber 110 will quickly drop through the compensating bore 115. In such an instance the pressure spring 117 which rests against the housing cover 114 is adapted to press the diaphragm 112 together with the valve shank 116 into the chamber 110 to such an extent that the valve shank closes the transverse bore 97. In order to secure this locking position, there is provided an eccentrically arranged annular spring 118 which in such an instance of disorder engages an annular groove 119 on the valve shank 116 and secures the turned-off position. From this locking position, the valve shank 116 can be returned into operational position only by pulling on the handle 120 mounted on the valve shank. For purposes of obtaining a very fast turning off in response to the disappearance of the working pressure in the pressure chamber 110, it is expedient when on the back side of the diaphragm 112 which faces away from the pressure chamber 110 the outer air pressure acts fully and therefore sufficiently large openings 114' are provided in the housing cover 114.

With the embodiment illustrated in the drawings, a high voltage buzzing ignition device is provided for igniting the fuel air mixture, which high voltage buzzing ignition device may, however, also be replaced by other heretofore known ignition systems. In each instance, however, it is expedient so to arrange the ignition device, in the manner shown in FIG. 2, that the ignition device is surrounded by the container or tank 28 and the gasoline tank 4 and in this way is protected against mechanical damage from the outside.

It is, of course, to be understood that the present invention is, by no means, limited to the particular showing in the drawings, but also comprises any modifications within the scope of the appended claims.

What is claimed is:

1. In an apparatus for fuel consumption and ejecting a flowable medium, as for spraying or smoke laying: a container for said medium, a pulsating burner having an intake end for admission of a combustible mixture and a discharge end, and a burner resonator having one end connected to the burner discharge end and the other end open to form a discharge orifice, conduit means leading from said medium container to said burner resonator to supply said medium thereto, an air resonator tube coaxial with and surrounding said burner and burner resonator and having an air inlet upstream of the intake end of said burner resonator and open at the other end to form a discharge orifice adjacent the discharge end of said burner resonator, an air inlet connected to said burner, valve forming means connected to the air inlet end of said air resonator tube, said burner including an end section forming a mixing passage leading substantially at right angles into said one end of said resonator, the length of said passage bearing a predetermined ratio to the length of said air resonator tube, said conduit means leading from said medium container to said burner resonator being connected to the latter near the discharge end thereof, said burner including a carburetor having a turbulence chamber spaced from the end of said mixing passage opposite the burner end of the passage, a fuel nozzle coaxial with the mixing passage and interposed between the mixing passage and turbulence chamber and spaced from the adjacent end of the mixing passage, a helical strip in the end of said end section, and a baffle plate at the downstream end of said strip defining an annular space with said mixing passage, said air inlet communicating with the space between said mixing passage and said nozzle, and ignition means on the downstream side of said baffle plate for igniting the fuel-air mixture in said passage.

2. An apparatus according to claim 1 in which said valve forming means at the air inlet end of said air resonator tube is located upstream from said one end of said burner and comprises a plate having perforations therein which taper inwardly toward said air resonator tube.

3. An apparatus according to claim 2 in which said resonator tubes are tuned relative to each other such that at a natural frequency on the order of from about 60 to about 150 Hertz the oscillations in said burner resonator are displaced about a half cycle from the oscillations in said air resonator tube.

4. An apparatus according to claim 1 which includes a shut-off device with valve and a filter in series in said conduit means leading from said medium container to said burner resonator, a control valve in series with said shut-off device with valve and filter, a housing member in which said valve and filter are mounted to form a unit, said control valve being spring biased toward closing position and including a movable diaphragm surface within an expansible pressure chamber responsive to pressure to urge the control valve in opening direction, a conduit leading from said carburetor to said surface to supply pressure thereto and including a check valve opening toward the surface, communication means connecting said surface to the atmosphere, and

lock means for releasably holding said control valve in closed position.

5. An apparatus according to claim 1 which includes a fuel tank and a fuel conduit leading therefrom to said nozzle, said carburetor and fuel tank forming a unitary structure.

6. An apparatus according to claim 5 which includes a first conduit leading from the space between the said nozzle and the said passage to said medium container to supply pressure thereto and having a check valve opening toward the medium container, a control valve in said conduit means leading from said medium container and spring-urged toward closed position and having a movable surface within an expansible pressure chamber responsive to fluid pressure to open the control valve, a second conduit leading from said space to said expansible chamber and having a check valve opening toward said expansible chamber, communication means connecting to the atmosphere to permit said control valve to close upon interruption of the supply of pressure from said second conduit to said expansible chamber, and fuel flow metering means in said fuel conduit to control the flow of fuel from said tank to said nozzle.

7. An apparatus according to claim 6 which includes a passage-forming means from the space at the downstream side of said nozzle to said conduit means to assist in the flow of said medium to said burner resonator.

8. An apparatus according to claim 6 which includes a passage-forming means from the space at the downstream side of said nozzle to said fuel tank above the fuel therein.

9. An apparatus according to claim 6 in which said space at the downstream end of said nozzle is subjected to pressure when combustion takes place at the downstream side of said disc and is subjected to subatmospheric pressure between incidents of combustion, and said air inlet is disposed between the atmosphere and said space and is in the form of an opening toward said space.

10. An apparatus according to claim 6 in which said fuel flow metering means comprises a housing part having a tubular channel connecting said fuel conduit to said nozzle, a filter at the upstream end of said channel, a bushing in the channel at the downstream end of said filter having a central bore, a plug adjustable in said bushing for opening and closing the downstream end of said bore, and a needle valve adjustable in said plug for adjustably controlling the flow of fuel through said bore.

11. An apparatus according to claim 10 in which said filter and bushing and plug and needle valve are in the form of a unitary structure insertable in and removable from said channel as a unit, said housing part including a separable portion defining at least a part of said second conduit and a part of said channel, said bushing having an end flange overlying said separable portion and being threaded into said housing part thereby to clamp said portion to said housing, said portion having therein the said check valve in said second conduit and a filter element serially connected to the check valve.

12. An apparatus according to claim 10 in which said plug is threaded into said bushing and has one end protruding from the bushing, a handle removeably mounted on the protruding end of said plug, and means

on the bushing to limit the rotation of said handle when mounted on the plug.

13. An apparatus according to claim 10 which includes a manually operable air pump, and a conduit connecting the discharge side of said air pump to said turbulence chamber and including a check valve opening toward said turbulence chamber.

14. In an apparatus for fuel consumption and ejecting a flowable medium, as for spraying or smoke laying: a container for said medium, a pulsating burner having an intake end for admission of a combustible mixture and a discharge end, and a burner resonator having one end connected to the burner discharge end and the other end open to form a discharge orifice, conduit means leading from said medium container to said burner and burner resonator to supply said medium thereto, an air resonator tube coaxial with and surrounding said burner resonator and having an air inlet upstream of the intake end of said burner resonator and open at the other end to form a discharge orifice adjacent the discharge end of said burner resonator, an air inlet connected to said burner, valve forming means connected to the air inlet end of said air resonator tube, a shut off device with valve and a filter in series in said conduit means leading from said medium container to said burner resonator, a control valve in series with said shut off device with valve and filter, a housing member in which said valve and filter are mounted to form a unit, said control valve being spring biased toward closed position and including a movable diaphragm surface within an expansible pressure chamber responsive to pressure to urge the control valve in opening direction, a conduit leading from said carburetor to said surface to supply pressure thereto and including a check valve opening toward the surface, communication means connecting said surface to the atmosphere, and lock means for releasably holding said control valve in closed position, said housing member being formed of two parts in face-to-face sealed engagement and defining therebetween the portions of said conduit means leading between said valve and filter.

15. In an apparatus for fuel consumption and ejecting a flowable medium, as for spraying or smoke laying: a container for said medium, a pulsating burner having an intake end for admission of a combustible mixture and a discharge end, and a burner resonator having one end connected to the burner discharge end and the other end open to form a discharge orifice, conduit means leading from said medium container to said burner resonator to supply said medium thereto, an air resonator tube coaxial with and surrounding said burner and burner resonator and having an air inlet upstream of the intake end of said burner resonator and open at the other end to form a discharge orifice adjacent the discharge end of said burner resonator, an air inlet connected to said burner, valve forming means connected to the air inlet end of said air resonator tube, a shut-off device with valve and a filter in series in said conduit means leading from said medium container to said burner resonator, a control valve in series with said shut off device with valve and filter, a housing member in which said valves and filter are mounted to form a unit, said control valve being biased toward closed position and including a movable surface within an expansible pressure chamber responsive to pressure to urge the control valve in opening direction, a conduit leading from said burner to said surface to supply pressure

thereto and including a check valve opening toward the surface, communication means connecting said surface to the atmosphere, and lock means for releasably holding said control valve in closed position, said control valve including a reciprocable valve member and said surface being on a diaphragm connected in the center to said valve member and on one side forming said movable surface within an expansible pressure chamber, said diaphragm at the periphery being sealed to said housing member, said communication means and said conduit extending through said housing member on said one side of said diaphragm, the other side of said diaphragm having substantially free communication with the atmosphere.

16. In an apparatus for fuel consumption and ejecting a flowable medium, as for spraying or smoke laying: a container for said medium, a pulsating burner having an intake end for admission of a combustible mixture and a discharge end, and a burner resonator having one end connected to the burner discharge end and the other end open to form a discharge orifice, conduit means leading from said medium container to said burner resonator to supply said medium thereto, an air

resonator tube coaxial with and surrounding said burner and burner resonator and having an air inlet upstream of the intake end of said burner resonator and open at the other end to form a discharge orifice adjacent the discharge end of said burner resonator, an air inlet connected to said burner, valve forming means connected to the air inlet end of said air resonator tube, said burner including an end section forming a mixing passage leading substantially at right angles into said one end of said resonator, the length of said passage bearing a predetermined ratio to the length of said air resonator tube, said conduit means leading from said medium container to said burner resonator being connected to the latter near the discharge end thereof, said valve forming means at the air inlet end of said air resonator tube being located upstream from said one end of said burner and comprising a plate having perforations therein which taper inwardly toward said air resonator tube, and electrical means for supplying energy to said ignition means, said electrical means being disposed between said medium container and said fuel tank.

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