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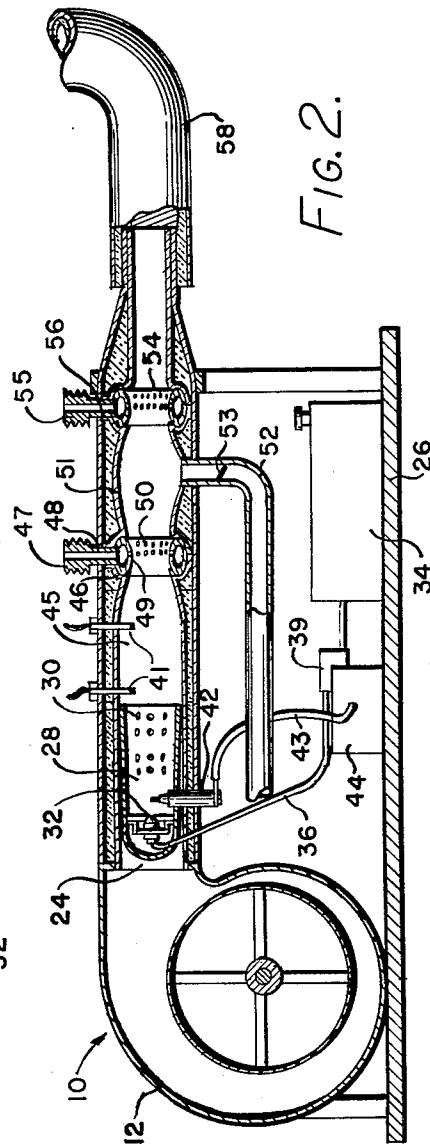
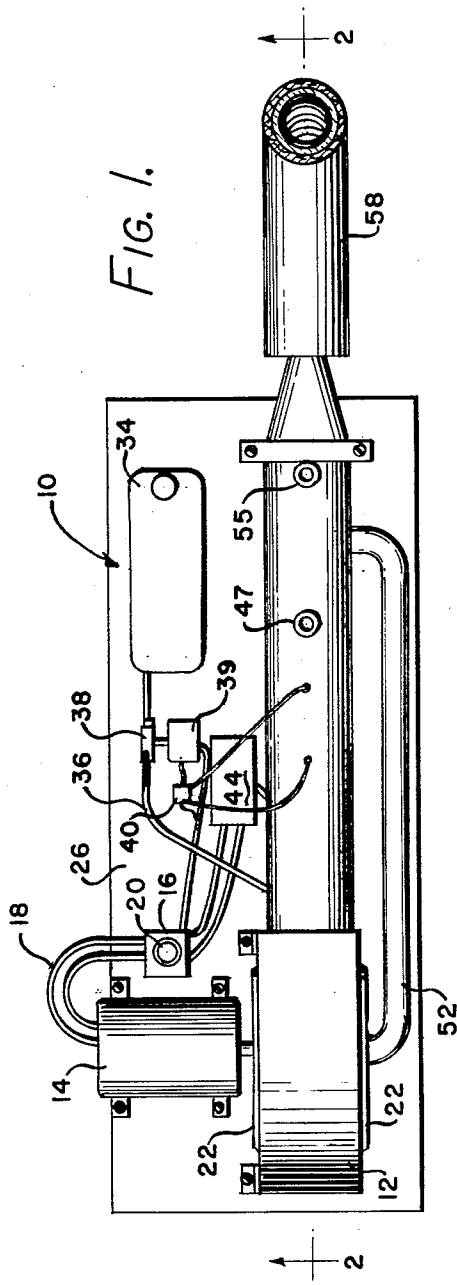
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INERT GAS GENERATOR

Filed April 24, 1957

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

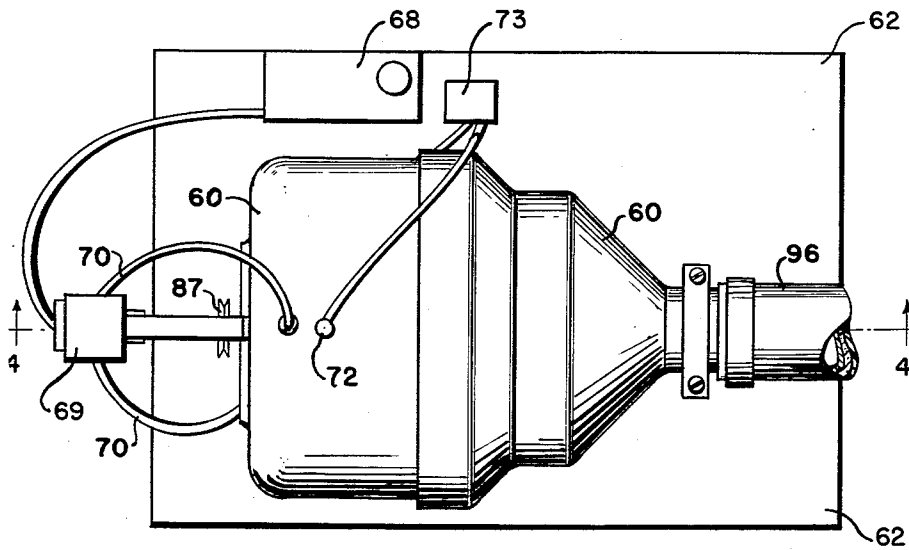


FIG. 3.

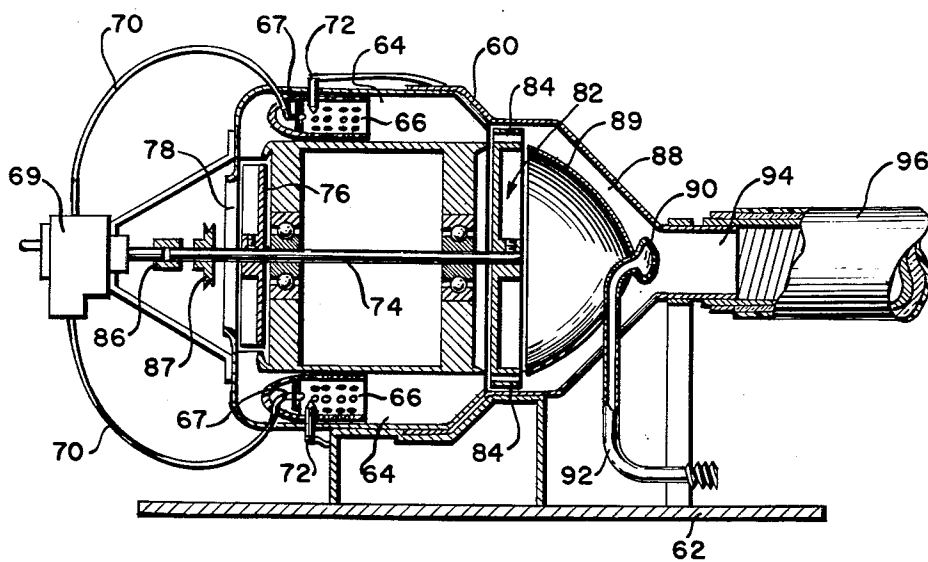


FIG. 4.

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INERT GAS GENERATOR

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6 Claims. (Cl. 169—12)

This invention relates in general to an inert gas generator and particularly to an apparatus capable of delivering the huge quantities of inert gas having very low oxygen content to remote locations.

This invention finds particular application for such uses as fighting fires by providing an apparatus for creating an atmosphere which will not support combustion, while simultaneously clearing the area of undesirable smoke. One of the chief obstacles to effective fire fighting is the presence of smoke, which both conceals the exact location of the fire and presents a dangerous atmosphere for firemen. After the fire has been located and the atmosphere cleared means must be found to stop the combustion.

In accordance with one aspect of this invention apparatus is provided which will take air from a safe location outside a building or away from an object which is burning and substantially reduce its oxygen content by burning it under ideal combustion conditions. The gaseous products of combustion are cooled, and thereafter circulated through flexible ducts in huge quantities to the location of the fire. The gases are circulated in large enough quantities to substantially replace the atmosphere in the location of the fire and to clear the smoke therefrom. The gases thus circulated are substantially inert, containing very small percentages of oxygen, i.e. below 5%, so that when the gases are directed into a burning building the oxygen content of the building atmosphere will be quickly reduced below 15% and flames will not be sustained therein. The apparatus may be regulated to maintain the oxygen content of the gases high enough for breathing but low enough to stop flames (from 10 to 15% oxygen). Thus an apparatus constructed in accordance with this invention provides not only a means for controlling the fire by limiting its combustion, but also a means for clearing the area of smoke and replacing the smoky atmosphere with a safe one for effective fire fighting.

Smoke not only impedes fire fighting but is the cause of the majority of deaths in fires. It also causes a great deal of the financial damage in fires where the actual combustion is limited. Because of smoke, water is sprayed around inefficiently, causing much unnecessary damage, waste of water, and waste of valuable time.

Accordingly, it is an object of this invention to provide an inert gas generator of high capacity.

A further object is to provide means for circulating substantially oxygen free gases to remote locations.

A further object is to provide a fire fighting apparatus which is capable of quickly burning large quantities of air and removing the major portion of its oxygen content, cooling the resultant gas, and circulating it in large quantities to remote locations.

A further object of this invention is to provide a fire fighting apparatus which is simple in design, rugged in construction and economical to manufacture.

In this specification and in the accompanying drawings,

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are described and shown various embodiments of the methods and apparatus of the invention and various modifications thereof are indicated, but it is to be understood that these are not intended to be exhaustive or limiting of the invention, but on the contrary, are given for the purpose of illustration in order that others skilled in the art may fully understand the invention and the manner of applying the method and apparatus for manufacturing inert gas generators, and so that they may modify and adapt the invention in various forms, each as may be best suited to the conditions of a particular use.

The various advantages and objects of the present invention may be more fully understood from a consideration of the following specification in conjunction with the accompanying drawings in which:

Figure 1 is a top plan view of a fire fighting apparatus constructed in accordance with this invention;

Figure 2 is a vertical section taken on the line 2—2 of Figure 1;

Figure 3 is a top plan view of another embodiment of fire fighting apparatus constructed in accordance with this invention; and

Figure 4 is a vertical section taken on the line 4—4 of Figure 3.

Referring to the drawings in particular, the invention as embodied in Figures 1 and 2 includes a portable, electrically actuated fire fighting apparatus generally designated 10. The fire fighting apparatus 10 includes a centrifugal compressor 12 driven by an electrical motor 14 connected to a terminal box 16 by wires 18. The terminal box 16 has a suitable electrical plug connection 20 for attachment to a source of electrical power (not shown). In this instance the apparatus is actuated by electrical energy from an outside source, but of course it is within the scope of this invention to provide for other means of driving the blower 12, such as a small gasoline engine for example. In those instances in which a gasoline or other engine is provided to drive the blower 12, a suitable generator and battery system must be incorporated therewith in order to furnish power for the other electrical apparatus of the invention.

The centrifugal blower 12 is provided with a pair of central air intake openings at each side 22, 22. Air is drawn in through these central openings 22, 22 and discharged at the periphery of the blower into a cylindrical air chamber 24. The size of the blower 12 is such that upwards of 5,000 cubic feet per minute of air is directed into the air chamber 24. The complete apparatus already described as well as the parts to be mentioned hereinafter are mounted by suitable means on a platform 26.

A substantially cylindrical combustion chamber 28 is mounted inside the air chamber 24. The combustion chamber 28 is closed at the end nearest the discharge of the blower 12 and open at the opposite end. The walls of the combustion chamber 28 are tapered in the direction of air flow outwardly toward the walls of the air chamber 24, and they are provided with a plurality of small circular holes 30 to admit air supplied from the blower 12 to the interior of the combustion chamber. The combustion chamber 28 is of a construction advantageous for the burning of fuel and air in large quantities and at high velocities.

Mounted in the closed end of the combustion chamber 28 is a fuel nozzle assembly 32 which is supplied with fuel from a fuel tank 34 through a conduit 36 under the control of a variable speed pump 38 driven by an electrical motor 39 in response to a control 40. Sensing elements 41, 41 in the flame burning path detect flame length to actuate the control 40 and change the quantity of fuel fed in accordance with flame conditions desired. Electrical connections for the motor 39 are terminated

in the electrical terminal box 16. The amount of fuel delivered through the conduit 36 to the fuel nozzle 32 is such that it will burn, with the quantities of air admitted by the blower 12, under ideal conditions and form gaseous products of combustion which are substantially free of carbon monoxide and have an oxygen content of the desired amount. The fuel nozzle 32 is arranged to discharge fuel toward the open end of the combustion chamber 28. An ignition device, such as a spark plug 42, is mounted on the bottom portion of the combustion chamber 28 downstream of the fuel nozzle 32 to ignite the fuel discharged therefrom. The spark plug 42 is connected through an electrical conduit 43 to suitable electrical actuating means 44.

Substantially all of the air delivered at the discharge of the periphery of the blower 12 passes into the air chamber 24 through the holes 30 and into the combustion chamber 28, and combines with the fuel delivered from the nozzle 32 to sustain combustion of the fuel. The fuel and air are burned under conditions insuring substantially complete combustion of the fuel and low oxygen content of the gaseous products of combustion. The gaseous products of combustion are directed outwardly from the combustion chamber 28 into a refractory chamber 45 where high temperatures are maintained by the refractory walls thereof to insure substantially complete combustion of the fuel and elimination of undesirable carbon monoxide or soot. The gases in the refractory chamber 45 contain a high amount of carbon dioxide (up to 12% or more) and less than 5% oxygen.

The inert gaseous products of combustion are then directed through a restricted or converging wall portion 46 into a water stream, formed by directing water from a water hose (not shown) applied to a coupling 47, at the end of a conduit 48, leading to an annular spray ring 49 located in the restricted portion 46. The annular spray ring 49 has a plurality of orifices 50 through which the water is discharged in a spray. The water spray has the beneficial effect of cooling the gases considerably and increasing the gaseous mass flow rate through the apparatus for a given input power by the electrical motor 14. The cooled gases are then passed through a collecting chamber 51 where portions of the gases are passed through a recirculating passage 52 under the control of a damper 53 back to the central opening 22 of the blower 12. The main purpose of recirculating a portion of these combustion gases is to reduce the oxygen content of the final exhaust gases without requiring excessively high temperatures which would reduce the life of the device, and to increase the efficiency of the combustion. The major portion of the gases which arrive at the collecting chamber 51 pass out through the opposite end thereof through a second water spray delivered by a spray ring 54 which is supplied with water from a hose (not shown) attached to a connection 55 at the end of a conduit 56. The water spray effects a further reduction of the temperatures of the inert gases, which are then delivered through a flexible insulated hose 58 to a place of use. The hose 58 is connected to the discharge end of the exhaust of the apparatus.

The inert gas generator may be used to fight fires by starting the unit and allowing it to come to speed in a location near the fire but outside the burning space. The end of the flexible insulated hose 58 is then pushed through a window, door or other opening of the burning building to a position as close as possible to the burning portions thereof. Since the quantities of inert gas being delivered through the flexible hose 58 is over 5,000 cubic feet or more per minute, it will not be long before the area at the discharge of the hose is free from smoke and the intensity of the fire is diminished appreciably. The gases exiting from the hose 58 will not be dangerous to fire fighting personnel. While the oxygen content will be very low, it can be maintained sufficiently high for breathing but low enough to subdue combustion and

there will be no dangerous carbon monoxide present. The hose 58 may be held by a fireman if desired and the end directed ahead of the fireman toward the densest smoke in the burning location in order to displace the smoke and make the atmosphere safe for the fire fighter. Once the smoke is cleared, the apparatus may be used to stop the fire itself by depriving it of oxygen.

Figures 3 and 4 show another form of inert gas generator which requires no prime mover such as the electrical motor 12 to keep it in operation. The apparatus includes a large housing 60 mounted on a horizontal platform 62. Arranged in cylindrical air chambers 64, at the top and bottom of the housing 60, are two combustion chambers 66 similar in design and shape to the combustion chamber 28. Of course, the unit could be designed with a number of combustion chambers 66 more or less than two. Each combustion chamber 66 contains a fuel nozzle 67 supplied with fuel from a fuel tank 68 by a pump 69 through a conduit 70. Suitable ignition means such as spark plugs 72, 72 provide for ignition. They are energized by suitable electrical apparatus 73. A shaft 74, mounted for rotation in suitable bearings in the center of the housing 60, is provided with a centrifugal blower 76 at one end, which is arranged to take in air through a central opening 78 and discharge it at the periphery of its rotors into the air chambers 64, 64.

Mounted on the opposite end of the shaft 74 for rotation therewith is a gas turbine 82 having turbine blades 84 at the periphery of its rotor. These blades 84 are positioned in the exit path of gases discharging from the combustion chamber 64. The rotation of the turbine by the gases causes air to be drawn in under pressure by the blower 76 and directed into the combustion chamber 64 for mixture with, and combustion of, the fuel therein. The pump 69 is driven by the shaft 74 through a coupling 86. The apparatus is started by hand, using a short rope attached to a pulley 87 affixed to the shaft 74.

The exhaust gases of the turbine 82 are directed through an annular converging passage 88 around a conical baffle 89, into a centrally located water spray. The water spray is effected by a nozzle 90 arranged at the apex of the conical baffle 89 and supplied with water through a conduit 92 which terminates in a connection to which a water hose may be attached. Gases which pass through the spray are directed to a central passage 94 and then into a flexible hose 96. The combustion in the chambers 64 is regulated so that the gases which enter the flexible hose 96 contain very little oxygen and very little, if any, carbon monoxide. The gases are cooled sufficiently so the a fireman may hold the hose 96 while directing the gases against a fire.

While the apparatus has been described with particular reference to its application for fire fighting, it should be realized that an inert gas generator may have various other applications. For example, in many instances it is desirable to maintain an atmosphere above a tank of certain liquids or chemicals in an oxygen free state and for such uses the apparatus is ideal.

From the foregoing it will be understood that the methods and apparatus embodying the present invention described above are well suited to provide the advantages set forth, and since many possible embodiments may be made of the various features of this invention and as the method and apparatus herein described may be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and that in certain circumstances, some of the features of the invention may be used without a corresponding use of other features, or without departing from the scope of the invention.

What is claimed is:

1. A fire fighting apparatus comprising an outer tubular casing member, a substantially tubular open ended com-

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bustion chamber having an end wall and perforated side walls spaced inwardly from the interior walls of said casing member, a fan connected to said tubular casing and arranged to discharge air into said tubular casing against the closed end of said combustion chamber means for actuating said fan, said combustion chamber end walls and side walls and the perforations on said side walls being shaped and located to direct substantially all of said air into said combustion chamber, means for directing fuel into said combustion chamber in quantities to effect substantially complete combustion thereof with said combustion air whereby to generate inert gaseous products of combustion, means to maintain ignition of said fuel, means to direct a spray of cooling water into said tubular casing downstream of said combustion chamber whereby to cool said gaseous products of combustion and to add water vapor and steam thereto by heating of said water, conduit means connected to the end of said tubular casing opposite said fan for directing the resultant gases to the location of a fire, the interior of said casing including an inner wall defining with said outer wall an annular hollow chamber, and wherein there are more than one of said combustion chambers arranged in radially spaced positions in said hollow chamber, and including a turbine having blades in said annular chamber adjacent the open ends of said combustion chambers, and including a shaft extending along the length of said casing, said blades being arranged for rotation by the combustion of said fuel, said fan actuating means being said turbine and including a fan rotor connected to said turbine shaft.

2. A fire fighting apparatus comprising an outer tubular casing member, a substantially tubular open ended combustion chamber having an end wall and perforated side walls spaced inwardly from the interior walls of said casing member, a fan connected to said tubular casing and arranged to discharge air into said tubular casing against the closed end of said combustion chamber means for actuating said fan, said combustion chamber end walls and side walls and the perforations on said side walls being shaped and located to direct substantially all of said air into said combustion chamber, means for directing fuel into said combustion chamber in quantities to effect substantially complete combustion thereof with said combustion air whereby to generate inert gaseous products of combustion, means to maintain ignition of said fuel, means to direct a spray of cooling water into said tubular casing downstream of said combustion chamber whereby to cool said gaseous products of combustion and to add water vapor and steam thereto by heating of said water, and conduit means connected to the end of said tubular casing opposite said fan for directing the resultant gases to the location of a fire, an area of reduced internal

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dimension defined in said casing downstream of said combustion chamber, said means to direct a spray of cooling water into said tubular casing including a tubular ring located in the casing walls at the area of reduced dimension and including spray means around the interior periphery for directing water inwardly into said casing.

3. A fire fighting apparatus comprising a central turbine shaft; inner and outer wall means defining an annular chamber extending around said shaft, a substantially tubular open-ended combustion chamber having an end wall and perforated side walls spaced from inner and outer wall means in said annular chamber, a fan rotor connected to said shaft and arranged to discharge air into said annular chamber at the end thereof adjacent said combustion chamber end wall and around said combustion chamber side walls, said combustion chamber end walls and side walls and the perforations on said side walls being shaped and located to direct substantially all of said air into said combustion chamber, means for directing fuel into said combustion chamber in quantities to effect substantially complete combustion thereof with said combustion air whereby to generate inert gaseous products of combustion, means to maintain ignition of said fuel, a turbine rotor affixed to said shaft and including blade portion adjacent the open end of said combustion chamber and rotatable by the gaseous products of combustion to rotate said fan, and conduit means connecting said annular chamber in the downstream side of said turbine blades for directing the gaseous products to the location of a fire.

4. A fire fighting apparatus according to claim 3 including means to direct a spray of water into said conduit means.

5. A fire fighting apparatus according to claim 3 including conduit means connected to said annular chamber at locations on each side of said combustion chamber for recirculating some of the gaseous products of combustion to said combustion chamber.

6. A fire fighting apparatus according to claim 3 wherein said inner and outer wall means include wall portions which extend inwardly toward said shaft to define a converging annular chamber downstream of said turbine blades and including water spray means in said annular chamber adjacent said conduit means.

References Cited in the file of this patent

UNITED STATES PATENTS

217,477	Pattison	July 15, 1879
249,236	Garfield	Nov. 8, 1881
405,717	Rew	June 25, 1889
2,051,125	Bacon	Aug. 18, 1936
2,756,215	Burgess et al.	July 24, 1956