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Good, Jr.

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[54] **PORTABLE FIRE EXTINGUISHER**

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[21] Appl. No.: **312,716**

[52] **U.S. Cl.**..... **169/30,** 239/154, 239/270, 239/308, 239/337, 239/375, 239/526

[51] **Int. Cl.**.. **A62c 11/00,** A62c 17/00, A62c 15/00

[58] **Field of Search**..... 169/30–33; 239/152–154, 330, 270, 308, 337, 526, 375, 351

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Primary Examiner—Robert S. Ward, Jr.
Attorney, Agent, or Firm—Leo A. Rosetta

[57] **ABSTRACT**

A back-pack water tank is connected by a hose to a hand-held gun having a discharge nozzle, and a selectively operable compressed gas-driven pump is positioned between the tank and the nozzle for pumping water at high pressure through the nozzle. The pump is driven by compressed air from a pressure bottle carried on the water tank, and connected with the pump through a valve. In one embodiment a breathing mask is provided for the fireman, and is connected with a bladder carried by the water tank and supplied with air from the air discharge of the pump, or from the pressure bottle.

20 Claims, 17 Drawing Figures

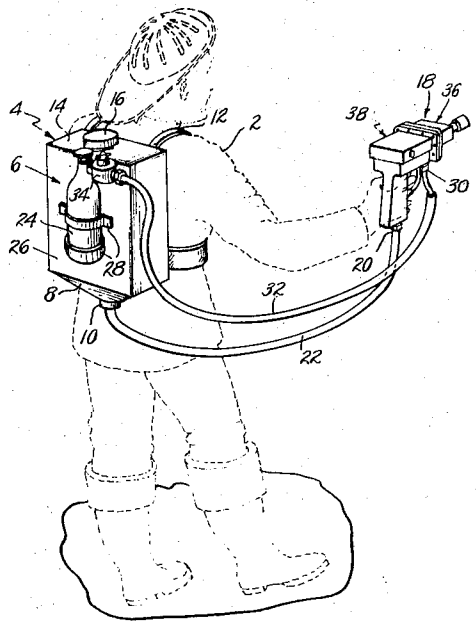
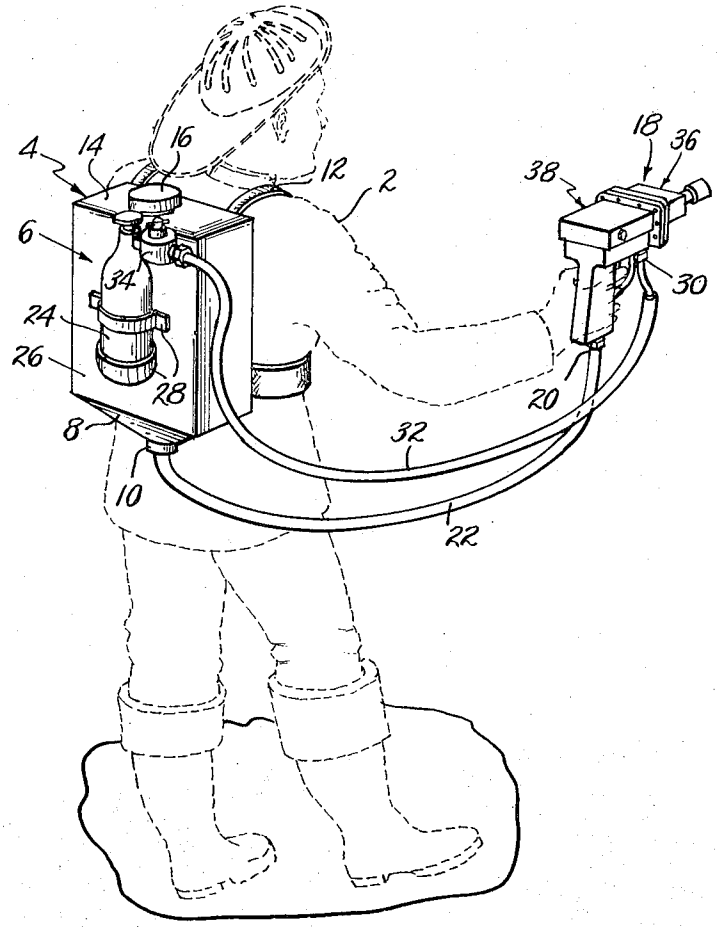


Fig. 1.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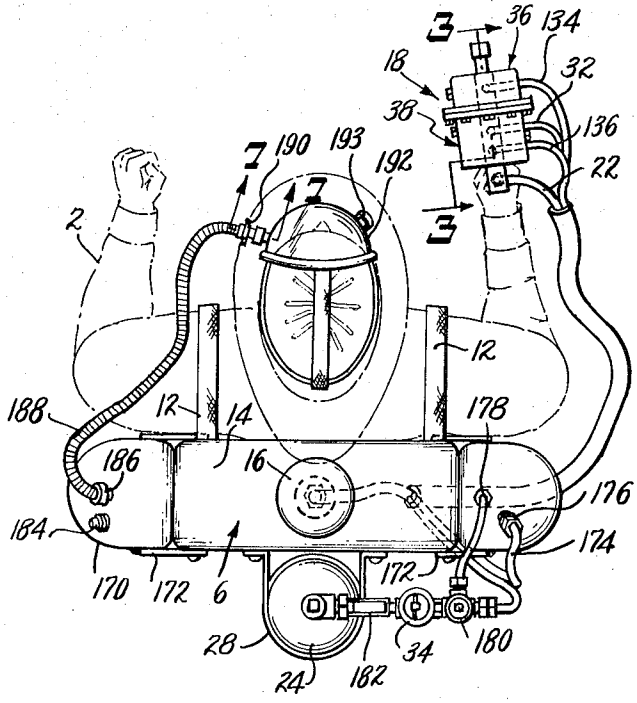
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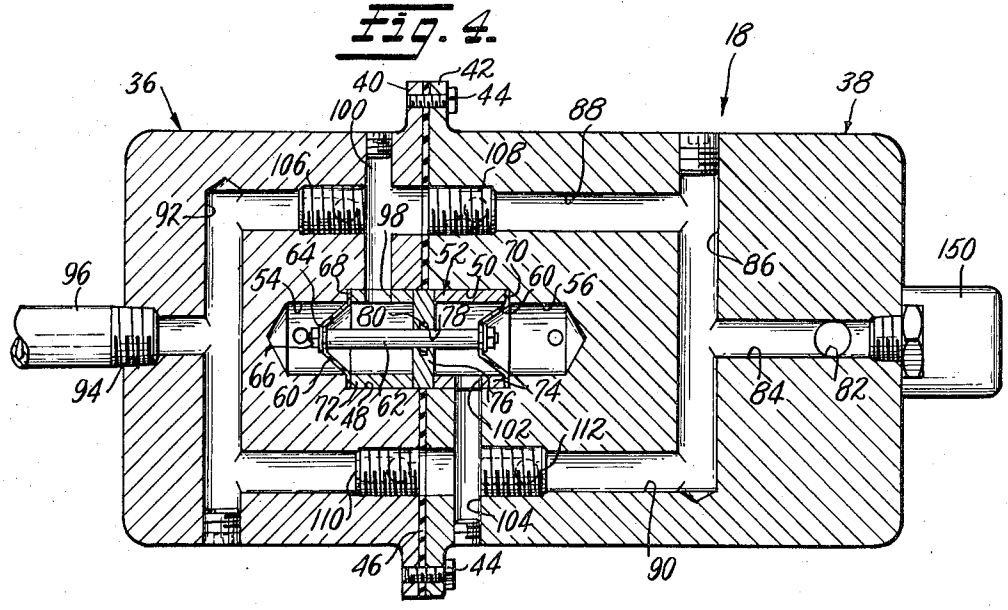
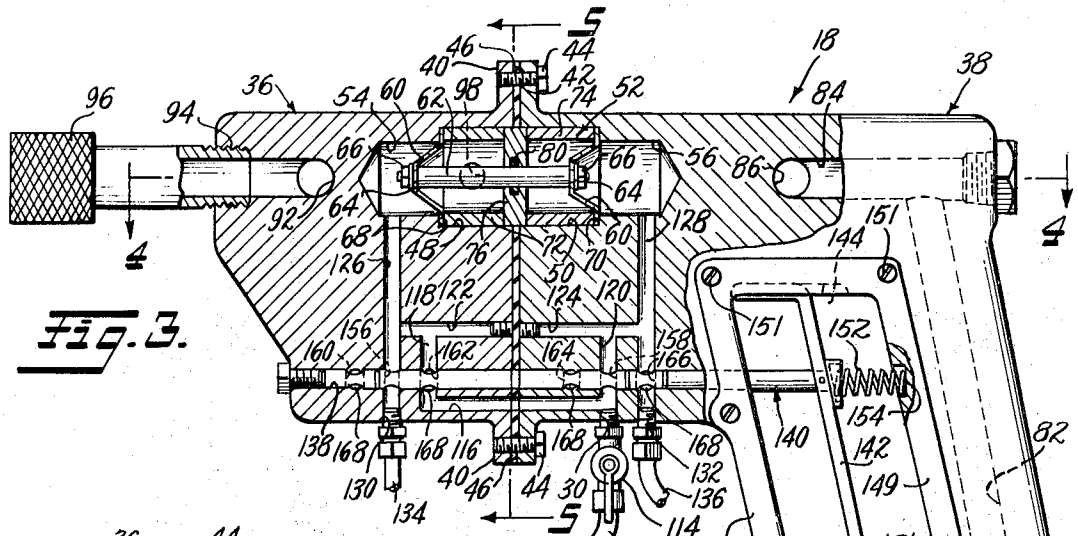
Fig. 2.

Fig. 4.





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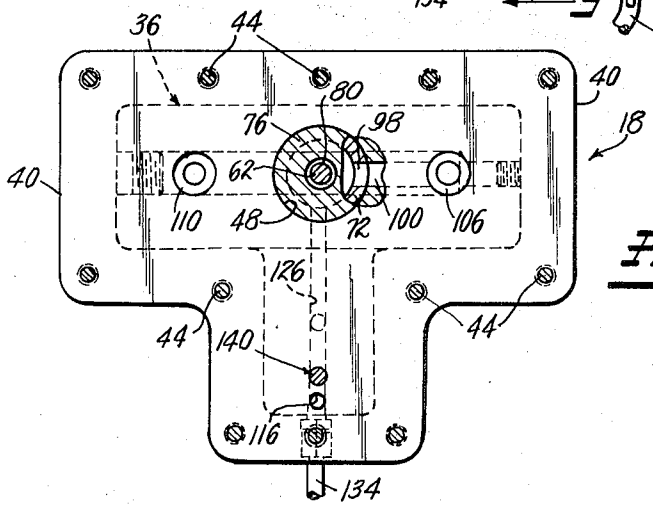

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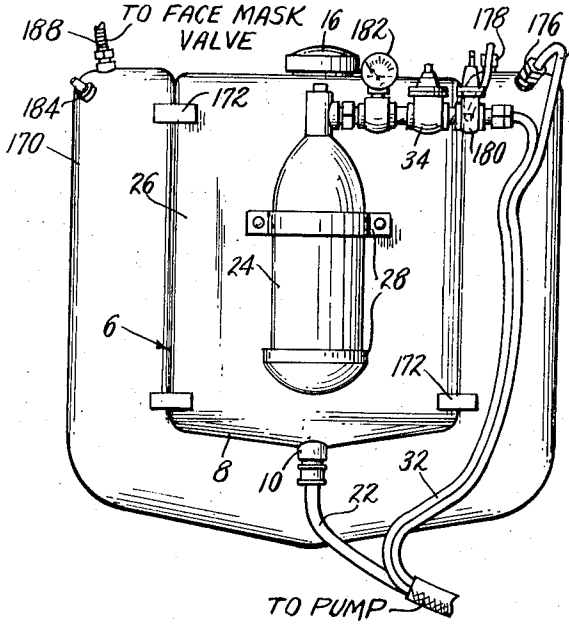


Fig. 6.

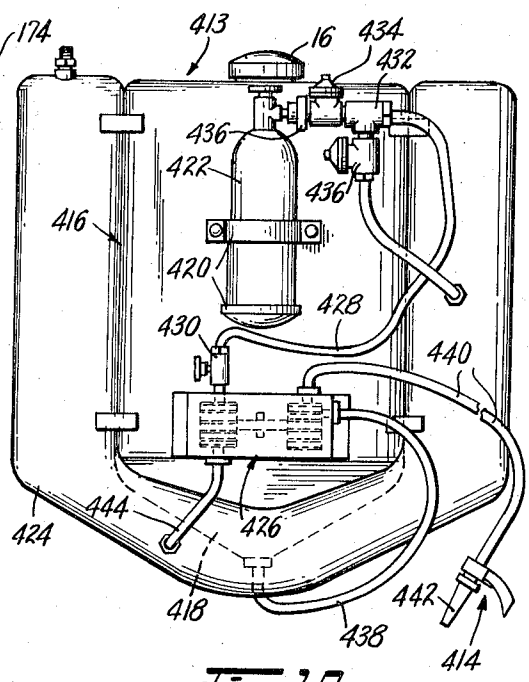
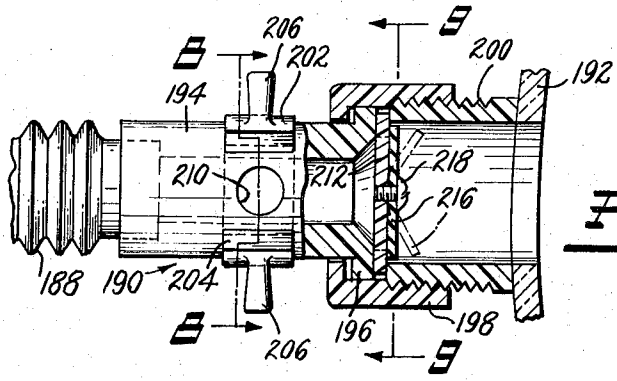


Fig. 10.



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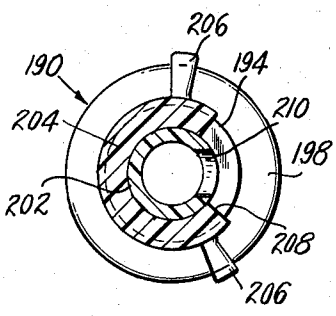


Fig. 8.

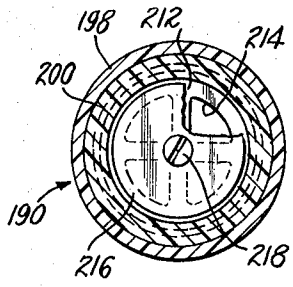
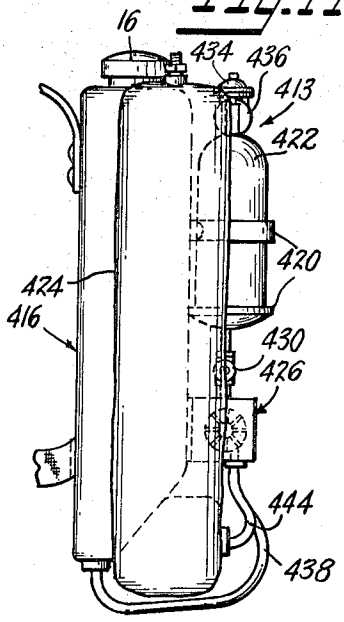


Fig. 9.

Fig. 11.



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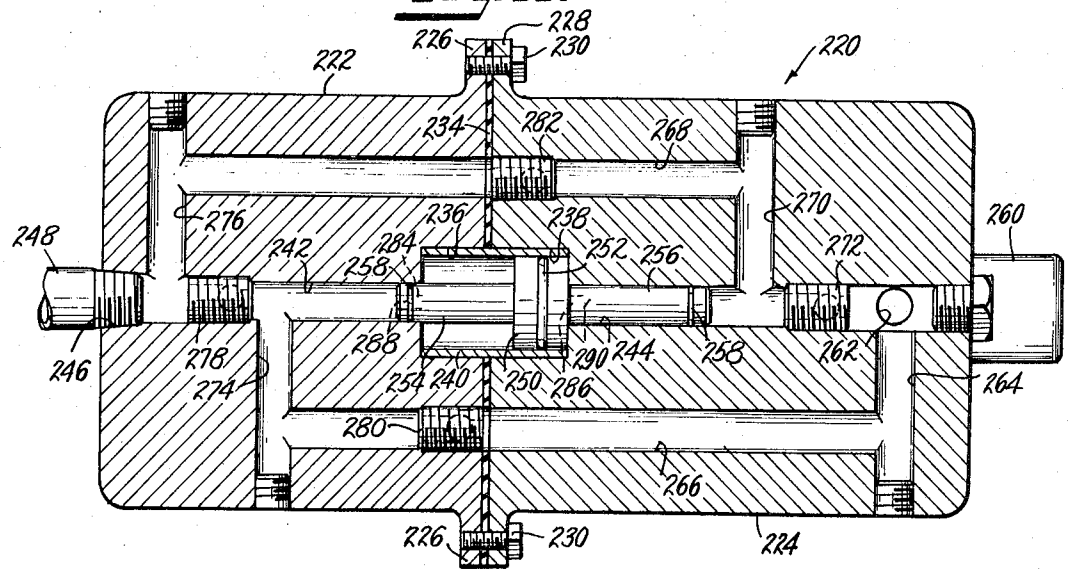

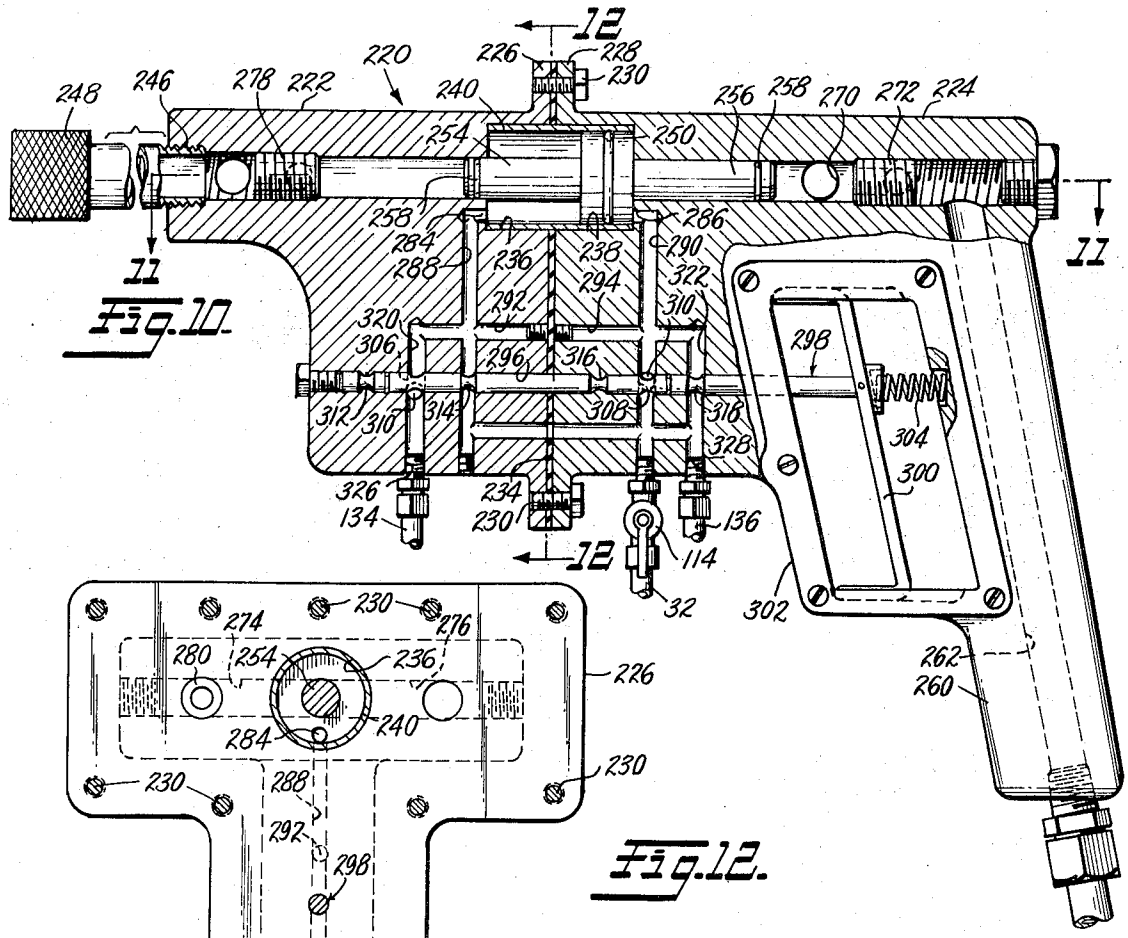

Fig. 10.

Fig. 12.

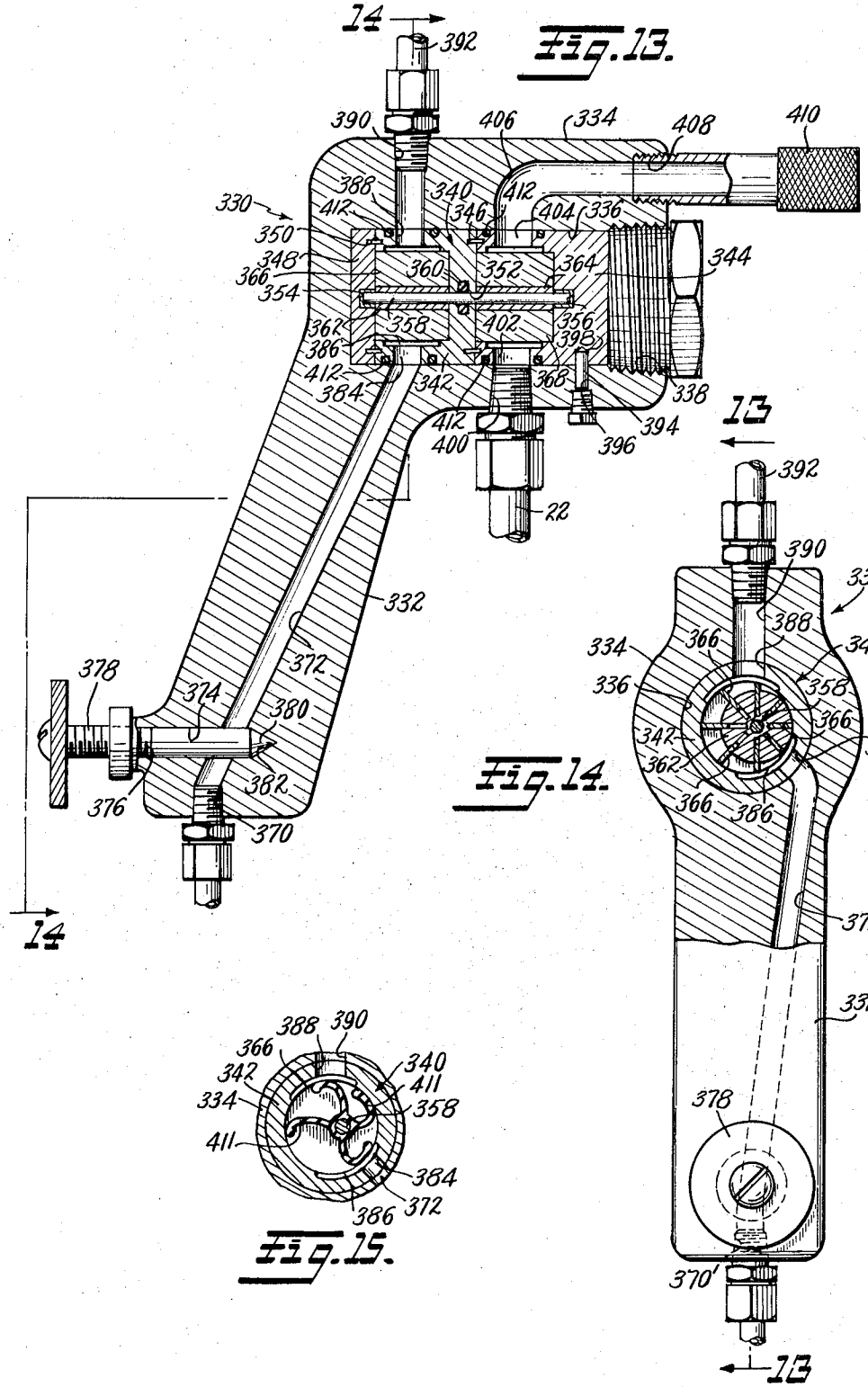

Fig. 13.

Fig. 14.

Fig. 15.

PORTABLE FIRE EXTINGUISHER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to fire extinguishers of the type normally utilized to fight brush fires and other conflagrations located away from areas that can be reached with pressure hose lines. More particularly, it relates to a novel portable fire extinguisher that can selectively provide a high pressure stream of water for prolonged periods of time, and which can also be equipped with breather apparatus for the fireman.

2. Description of the Prior Art

Over the years there have been many proposals for extinguisher apparatus for use in fighting brush fires, and other conflagrations located beyond the reach of pressure lines leading from a fire hydrant or a pumper truck. Two common types of such equipment are the self-contained pressurized extinguisher, such as the carbon dioxide bottle, and the older wall-mounted can that contains water and an internal pressurizing means that becomes activated either by simply inverting the container, or by pulling a pin or the like.

While such self-contained pressurized extinguishers can be effective for fighting small fires in the office, around motor vehicles, or at home, they hold only a small volume of extinguisher liquid. Thus, they are not adequate for a brush fire, or other larger conflagration. Moreover, they are difficult to recharge; some, indeed, must be returned to a recharging station, and thus cannot be reused for a long period of time. In addition, because the tank containing the extinguisher liquid must also be pressurized, a relatively expensive and heavy container usually is required for extinguishers of this type.

Another type of extinguisher that has been used consists essentially of a tank for containing water, and a hand or foot operated pump for withdrawing water from the container and converting it into a discharge stream. While such equipment can be effective for some uses, normally the fireman will soon become fatiqued from the exertion required to operate the pump. Moreover, the discharge stream generated by such apparatus normally is of low pressure, and thus is not particularly effective in fighting many fires.

The virtues of a high pressure stream of water or other fire extinguishing liquid are well known. First, of course, a high pressure stream can be directed over a longer distance, thus allowing the fireman to remain some distance away from the flames. More importantly, a high pressure stream tends to break the water into small particles which absorb heat more efficiently, and thus such a stream is simply more effective in fighting fire than is a low pressure stream.

There is thus a need for a portable fire extinguisher that can be easily carried by a fireman to wherever it is needed, which can be easily refilled with liquid and thus be used for prolonged periods, and which will direct a high pressure stream of extinguishing liquid against the flames without causing fatigue to the fireman. The present invention is directed toward satisfying that need.

There is also need in many instances for a fireman to have an auxiliary means for breathing, where smoke or other conditions make it difficult for him to obtain air suitable for sustaining life. There have been self-

contained breathing devices conceived for this purpose, but usually they are bulky and difficult to use in conjunction with portable fire ex-tinguisher equipment. The need for improved breathing equipment for use by a fireman under such circumstances is recognized, and the subject invention is also directed toward meeting this need.

SUMMARY OF THE INVENTION

The portable fire extinguisher of the present invention includes a water tank adapted to be worn on the back of a fireman, a hand-held gun that includes a discharge nozzle and which is connected to the water tank by a flexible hose, and a gas pressure-operated pump located between the water tank and the nozzle of the hand-held gun, for pumping water from the backpack tank and discharging it at high pressure through the nozzle.

The pump is operated by compressed gas from a bottle attached to the back-pack water tank, a pressure regulator and a control valve being disposed between the gas bottle and the pump. In the principal embodiments of the invention the pump is contained in the hand-held gun, and is operated either by a trigger or a control valve on the gun. In one of the principal embodiments the pump is of the diaphragm type, is another of the piston type, and in a third of the rotary vane type.

In another embodiment of the invention, the pump is attached to the water tank rather than being mounted in the gun, whereby the gun can be considerably lighter in weight.

One of the important features of the invention in all its embodiments is that the water tank itself need not be pressurized, thereby allowing it to be made of lightweight material, and making it an easy matter for the tank to be refilled while it is on the back of a fireman fighting a blaze, either by himself or someone else. Thus, the fireman is more able to carry the extinguisher to where it is needed, and need not break off contact on the fire line when he has used up the liquid in the tank.

Typically, a single bottle of compressed gas, which will normally be air, will be sufficient to pump several tanks of water, or some other fire extinguishing liquid. When a gas bottle does become empty, such can be quickly changed so that the fireman can resume his place on the fire line.

The pumps of the various embodiments of the invention all have one feature in common, and that is their ability to produce a high pressure stream of water or other extinguishing liquid from the nozzle of the hand-held gun, without requiring th fireman to exert himself and become fatigued. In the invention, such a high pressure stream is generated because of the design of the pumps themselves, and because such are powered by compressed gas. Thus, a very effective high pressure fire fighting liquid stream is produced, without in any way fatiguing the fireman by requiring him to manually operate a pump, an arrangement that in any case will normally only produce a low pressure stream that is inherently less effective in fighting a fire than a high pressure stream.

The fire extinguisher of the invention also includes as an optional feature breathing apparatus for the fireman, for use in those instances where air for breathing is not available in adequate quantities at the fire scene.

The novel breathing apparatus of the invention is integrated with the other components of the portable fire extinguisher, and makes use of compressed air discharged by the pump apparatus which would otherwise simply be exhausted to the atmosphere.

The breathing apparatus of the invention includes a large bladder that is wrapped around the back-pack water tank, and to which is connected a hose leading from the gas discharge ports of the pump. In this instance the gas bottle contains compressed air, and the spent air from the pump is received in the bladder and stored for use in the breathing apparatus. A safety valve prevents over-inflation of the bladder, and in those instances where the pump discharge is inadequate to maintain an adequate volume of air in the bladder for breathing, the bladder draws additional air directly from the gas bottle through a suitable demand regulator.

A face mask is connected to the bladder by a breather hose, the latter having a specially designed valve therein that is opened by the fireman under normal conditions so that he can inhale air from the atmosphere. When the ambient atmosphere in which he is working becomes unsuited for breathing, he closes the breather hose valve and thereafter draws air for breathing solely from the bladder. The face mask is equipped with a separate exhalator valve, and with a flap valve on the breather hose that prevent the entry of exhaled air thereinto.

The breather apparatus of the invention is light in weight, in part because it makes use of the spent air from the pump. Moreover, it forms a compact unit with the fire extinguisher, one that can be quickly put on by a fireman, and which leaves the fireman relatively free to move about.

A principal object of the present invention is to provide a portable fire extinguisher that can be used by a fireman for a prolonged period of time, and which will direct a high pressure stream of water on a fire.

Another object is to provide a high pressure fire extinguisher wherein the water tank itself is not pressurized, whereby it can be of light construction and easily refilled.

Yet another object is to provide a fire extinguisher pump apparatus that is light in weight, and which can be operated by pressure from a gas bottle to produce a high pressure stream of fire-fighting liquid.

A further object of the invention is to provide breathing apparatus for use by a fireman in a hostile ambient atmosphere, and which is operable with air discharged from an air pressure-driven pump.

Still another object is to provide a breathing apparatus that can be optionally connected for breathing air from the atmosphere, or from a storage bladder.

It is also an object of the invention to provide a portable fire extinguisher that can be operated without casuing undue fatigue to the fireman.

Other objects and many of the advantages of the present invention will become readily apparent from the following Description of the Preferred Embodiments, when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a pictorial view of a first embodiment of the portable fire extinguisher of the invention being worn by a fireman, wherein the hand-held gun contains a diaphragm pump operated by compressed gas from a bottle carried on the back-pack water tank, the spent gas from the pump being discharged into the atmosphere;

FIG. **2** is a pictorial view similar to FIG. **1**, but showing the portable fire extinguisher equipped with the breathing apparatus of the invention, the breathing apparatus including a bladder wrapped about the water tank and to which the air discharge ports of the pump are connected by flexible hoses;

FIG. **3** is an enlarged vertical sectional view of the hand-held gun of FIG. **2**, taken along the line **3—3** in FIG. **2** and showing details of the diaphragm pump, and of the air passages and the trigger arrangement for operating the same;

FIG. **4** is a horizontal sectional view taken on the line **4—4** in FIG. **3**, and showing in particular the arrangement of the water passages for the pump;

FIG. **5** is a tranverse sectional view taken on the line **5—5** in FIG. **3**, further showing details of the pump passages;

FIG. **6** is a rear elevational view of the back-pack water tank, the air bottle and the wrap around bladder of FIG. **2**, showing the arrangement thereof;

FIG. **7** is an enlarged fragmentary vertical sectional view, taken on the line **7—7** in FIG. **2**, through the breather tube valve;

FIG. **8** is a transverse sectional view taken on the line **8—8** in FIG. **7**, and showing details of the manually operable valve element for allowing the fireman to draw air for breathing from either the atmosphere or from the bladder;

FIG. **9** is a transverse sectional view taken on the line **9—9** in FIG. **7**, showing the flap valve for preventing entry of exhaled air into the breather tube;

FIG. **10** is a vertical sectional view through a second embodiment of a hand-held gun containing a pump, wherein the pump is of the piston type;

FIG. **11** is a horizontal sectional view taken along the line **11—11** in FIG. **10**, showing the water passages for the piston pump;

FIG. **12** is a transverse, vertical sectional view taken along the line **12—12** of FIG. **10**;

FIG. **13** is a vertical sectional view of another embodiment of a hand-held gun containing a pump, wherein the pump is of the rotary vane type and is driven by an air motor contained in the pump, the view being taken substantially on the line **13—13** in FIG. **14**;

FIG. **14** is an end elevational view, partly in section, of the hand-held gun of FIG. **13**, taken on the staggered line **14—14** in FIG. **13**;

FIG. **15** is a sectional view through a modified form of the air motor for the pump of FIGS. **13** and **14**, wherein flexible rotor vanes are utilized;

FIG. **16** is a rear elevational view of a modified form of the present fire extinguisher, wherein the pump is located on the back-pack water tank rather than in the hand-held gun; and

FIG. **17** is a side elevational view of the device of FIG. **16**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1**, a fireman is shown in phantom lines at **2**, wearing the preferred embodiment **4** of the fire extinguisher of the invention. The extinguisher **4** includes a generally rectagular water tank **6** having a tapered bottom **8** that terminates in an outlet **10**, and

which is equipped with shoulder straps 12 so that the fireman 2 can easily back-pack the same. The water tank 6 also includes a top wall 14 having a filling lid 16 thereon, the lide 16 being of the type that can be easily removed for filling and refilling the tank, and the opening on which the lid 16 fits being suitably large for easy filling in the field.

The water tank 6 is not pressurized, but rather need only be of sufficient weight and strength to hold the desired volume of water, or other fire extinguishing liquid. Thus, it can be made of any desired material, and should be light in weight. Similarly, the lid 16 is not of the pressure type, and thus can fit loosely so that it can be easily removed and replaced. Ideally, the lid 16 should carry a chain disposed inwardly of the water tank 6 in the normal manner, so that such cannot become lost during filling of the tank, the internal chain arrangement being utilized because an externally mounted one might catch on overhanging limbs or the like.

In addition to the water tank 6, the fire extinguisher 4 includes a hand-held gun 18 that contains a diaphragm pump. The hand-held gun 18 in FIG. 1 is identical to the gun 18 in FIG. 2, construction of the latter being shown in FIGS. 3–5, the water inlet 20 of the gun 18 being connected to the outlet 10 of the water tank 6 by a water supply hose 22. The pump within the gun 18 of FIG. 1 is operated by compressed gas withdrawn from a pressure bottle 24 detachably secured to the rear wall 26 of the water tank 6 by brackets 28, the gas inlet 30 of the gun 18 being connected with the bottle 24 by a pressure hose 32, through a pressure regulator 34.

The hand-held gun 18 of FIGS. 1–5 includes a front body portion 36 and a handle body portion 38, said body portions having mating flanges 40 and 42, respectively, thereon and being secured together by bolts 44, a sheet gasket 46 being clamped between the mating flat end faces of the body portions. The body portions 36 and 38 have enlarged, confronting cylindrical chambers 48 and 50 therein, which together form a chamber for receiving a diaphragm unit 52, there being reduced diameter gas pressure chambers 54 and 56, respectively, at the inner ends of the chambers 48 and 50.

The diaphragm unit 52 includes a pair of flexible diaphragms 60 connected at their center portions by an axial, cylindrical connecting rod 62, the ends of the rod 62 being of reduced diameter and threaded, and extending through central openings in the diaphragms 60. Washers 64 and nuts 66 are placed on the threaded outer ends of the connecting rod 62, to secure the diaphragms 60 thereto. The connecting rod 62 is of a length between the diaphragms 60 corresponding to the distance between radial shoulders 68 and 70 located at the opposite ends of the chambers 48 and 50, respectively, when the body portions 36 and 38 are assembled. The outer peripheries of the diaphragms 60 rest on the shoulder 68 and 70, and are clamped thereagainst by the opposite end faces of a pair of cylindrical sleeves 72 and 74, respectively, received in the chambers 48 and 50, the sleeves 72 and 74 having a circular plate 76 clamped therebetween provided with a central axial opening 78 through which the connecting rod 62 passes, the opening 78 carrying an O-ring seal 80.

The space within the sleeves 72 an 74 on the opposite sides of the plate 76, and bounded by the flexible diaphragms 60, constitute separate liquid pumping chambers. Referring now in particular to FIG. 4, the liquid passages associated with the diaphragm unit 52 will be described. Water or other fire extinguishing liquid supplies to the gun 18 through the inlet 20 flows upwardly through a passage 82 in the handle body portion 38, to a short passage 84 that feeds a rear transverse passage 86 leading to two parallel passages 88 and 90 disposed on opposite sides of and lying parallel with the axis of the chambers 48 and 50. The forward ends of the parallel passages 88 and 90 connect with a front transverse passage 92, which leads to a threaded outlet 94 fitted with a suitable nozzle element 96 that preferably is adjustable to provide for different spray patterns.

The forward sleeve 72 has a port 98 therein aligned with a passage 100 intersecting the parallel passage 88, and similarly the rear sleeve 74 has a port 102 therein aligned with a passage 104 connecting with the other parallel passage 90. Disposed in the parallel passage 88 on opposite sides of the passage 100 are front and rear check valves 106 and 108, respectively, the front check valve 106 allowing flow toward the nozzle 96, but preventing flow in the opposite direction, and the rear check valve 108 allowing flow from the supply passage 82, but preventing flow theretoward. A similar set of front and rear check valves 110 and 112, respectively, are positioned in the other parallel passage 90, on opposite sides of the passage 104.

The diaphragm unit 52 functions to pump liquid through the nozzle 96 in the following manner. Assume a starting point for a cycle as shown in FIG. 4, and that liquid is being supplied through the passage 82. When the rod 62 is driven to the rear, the front diaphragm 60 will move toward the fornt sleeve 72 and will reduce the volume therein, forcing any liquid within the sleeve 72 out through the port 98 into the parallel passage 88. When the thus pumped liquid reaches the parallel passage 88 it passes through the front check valve 106 to the nozzle 96, flow in the opposite direction being blocked by the rear check valve 108. Simultaneously, the volume within the rear sleeve 74 will be increasing, and liquid from the supply passage 82 will be drawn thereinto through the parallel passage 90 and the rear check valve 108. After reaching its rearmost position the diaphragm rod 62 reverses its movement, and liquid is pumped from the rear sleeve 74 while simultaneously the front sleeve 72 is recharged, to complete an operating cycle. In this manner liquid is pumped through the nozzle 96, the nozzle being adjusted to produce the type of pressure steam desired by the fire fighter.

The diaphragm assembly 52 is powered by gas pressure supplied to the hand held gun 18 through the conduit 32, a shut-off valve 114 being positioned in the conduit 32 at the gas inlet 30. The inlet 30 intersects a manifold axial passag 116 that connects at its ends to front and rear transverse supply passages 118 and 120, respectively, that in turn connect to passages 122 and 124 leading to front and rear diaphragm passages 126 and 128, respectively. One end of the front diaphragm passage 126 terminates in the front gas pressure chamber 54, and the other end thereof leads to a threaded front spent gas port 130. Similarly, the rear diaphragm passage 128 connects with the rear gas pressure chamber 56, and terminates at its outer end in a rear spent gas port 132.

In the embodiment of FIG. 1 the spent gas exhaust ports 130 and 132 are merely open to the atmosphere, while in the embodiment of FIG. 2 they are connected

to air exhaust hoses **134** and **136.** In both instances, the pots **130** and **132** serve to exhaust gas from the chambers **54** and **56.**

Intersecting the passages **126, 118, 120** and **128** in an axial working bore **138,** containing an elongated valve stem **140** the rear end of which is connected to a trigger **142.** The trigger **142** has its opposite ends slidingly seated within upper and lower slots or grooves **144** and **146** provided in a trigger guard **148** that is formed as part of a pistol grip **150** on the rear body portion **38,** the trigger guard **148** having a face plate **149** thereon secured in place by screws **151,** and which is removed to mount the ends of the trigger **142** in the slots or grooves **144** and **146.** The trigger **142,** and thus the valve stem **140,** is biased toward a fully forward position by a spring **152** connected at one end thereof centrally to the trigger **142,** and with its other end seated within a recess **154** in the pistol grip **150.** When the trigger **142** is depressed against the spring **152** until it has moved fully rearwardly, the valve stem **140** will be in its fully rearward position, upon release of the trigger **142,** the spring **152** will return the valve stem to its fully forward position.

The valve stem **140** has front and rear passages **156** and **158** therethrough, respectively, the passages **156** and **158** and the passages **126, 118, 120** and **128** being so spaced that when the valve stem **140** is in its fully forward position the front valve stem passage **156** will be aligned with the front diaphragm passage **126** while the rear valve stem passage **158** will be aligned with the passage **120,** and so that when the valve stem **140** is in its fully rearward position the front valve stem passage **156** will be aligned with the passage **118** while the rear valve stem passage **158** will be aligned with the rear diaphragm passage **128.**

The valve stem has transverse check valve bores **160** and **162** therethrough on either side of the front passage **156,** and transverse check valve bores **164** and **166** on either side of the rear passage **158,** respectively. The distance from the centerlines of the check valve bores **160** and **162** to the centerline of the front passage **156** is identical to the spacing between the centerlines of the passages **126** and **118,** and the similar distance between the bores **164** and **166** and the passage **158** is identical to the spacing between the centerlines of the passages **120** and **128.** Disposed within each of the check valve bores **160, 162, 164** and **166** is a ball check valve element **168.**

When the valve stem **140** is in its fully forward position, as shown in FIG. **3,** the ball element **168** is received in the check valve bore **162** will thus block the flow of gas pressure into the bore **118,** allowing pressure from the front gas pressure chamber **54** to be bled through the front exhaust port **130,** and the ball element **168** carried in the check valve port **166** will block the rear exhaust port **132** while gas pressure is being supplied to the rear gas pressure chamber **56.** The result is that the diaphragm rod **62** will be driven forward.

When the fireman then depresses the trigger **142** to move the valve stem **140** to its fully rearward position, the passage **158** will align with the rear diaphragm passage **128** to connect the rear pressure chamber **56** to the rear exhaust port **132,** and the ball element carried in the check valve bore **164** will block the flow of gas pressure from the manifold passage **116** into the bore **120.** At the same time, the passage **156** will align with the passage **118** to supply gas pressure to the front pressure chamber **54,** and the ball element carried in the check valve bore **160** will block the front exhaust port **130,** resulting in driving of the diaphragm rod **62** in a rearward direction. Release of the trigger **142** will then complete the cycle.

It is readily seen from the foregoing that a fireman holding the gun **18** can pump liquid through the nozzle **96** merely by alternately depressing and releasing the trigger **142** against the spring **152,** an action requiring little energy and which is not fatiguing. The liquid is pumped under pressure from the nozzle **96,** using gas pressure from the bottle **24,** which drives the diaphragm pump.

The fire extinguisher **4** in FIG. **1** can be easily placed on the back of a fireman, and thereafter the lid **16** of the tank **6** is removed to fill it with water or other liquid when required. The regulator **34** is set to the desired gas pressure for operating the hand-held pump **18,** and the bottles **24** are easily changed whenever needed. Thus, a truly portable and easy to use extinguisher has been provided, one that will not fatigue the fireman, which can be easily carried to the scene of a brush fire or other conflagration, and which will direct a high pressure stream of liquid where needed upon demand.

Referring now to FIGS. **2** and **6–9,** a modification of the invention is shown wherein the extinguisher **4** of FIG. **1** is equipped with breathing apparatus for the fireman **2.** In FIG. **2** a bladder **170** is wrapped around the bottom and sides of the water tank **6** and is connected thereto by straps **172,** the bladder serving as a reservoir for receiving and storing air for breathing. The bladder **170** is supplied with air from two sources, both ultimately coming from the gas bottle **24,** which in this instance is initially filled with compressed air suitable for breathing. The compressed air withdrawn from the bottle **24** for operation of the pump gun **18** is returned from the gun through the exhaust conducits **134** and **136** mentioned earlier, said conduits being combined into a single return conduit **174** which is connected to an inlet **176** mounted on top of one of the legs of the U-shaped bladder **170.** Thus, spent air from the gun **18** is stored in the bladder **170,** for later breathing use.

It is recognized that the volume of spent air from the gun **18** may not be sufficient for breathing, and thus a second inlet **178** mounted near the inlet **176** is connected through a demand valve **180** mounted after the regulator **34** for providing air to the gun **18,** a pressure guage **182** being placed before the gun air pressure regulator **34.** The demand valve **180** is of conventional construction, and is designed to open when air pressure in the bladder **170** drops below atmospheric, to thereby supplement the spent air flow entering the bladder **170** from the conduits **134** and **136** so that an adequate supply of breathing air is always contained in the bladder. The bladder **170** preferable contains a suitable muffling device, to absorb the sounds of air exhausting from the pump **18,** and the bladder itself can be made of inflatable rubber, plastic or any other suitable, light in weight material. In order to prevent excessive pressure within the bladder **170,** such is fitted with a uitable pressure relief valve **184,** designed to open if the pressure within the bladder **170** builds substantially beyond atmospheric.

An outlet port **186** is mounted on the upper end of the other leg of the U-shaped, wrap-around bladder **170,** and has one end of a flexible breather hose **188**

connected thereto. The other end of the breather hose **188** is connected through a breather valve **190** to a face mask **192** worn by the fireman **2**. The face mask **192** is equipped with the usual exhalator valve **193**.

The breather valve **190** is specially designed to allow the fireman to breath either air from the ambient atmosphere, or air from the bladder **170**, and such comprises a cylindrical body **194** connected at one end to one end of the breather hose **188**, and having a flange **196** on its opposite end for mounting a screw thimble **198** for connecting the valve **190** to a threaded nipple **200** on the face mask **192**.

Medially thereof the cylindrical body **194** has an annular groove **202** therein, within which a three quarter ring **204** is rotatably received, the ring **204** having prongs **206** on opposite sides of the gap **208** therein to facilitate turning thereof. The reduced diameter, annular groove portion **202** of the body **194** has a port **210** therethrough, which can be covered and uncovered by the rotatable three-quarter ring **204**.

Mounted between the abutting faces of the flanged end **196** of the valve body **194** and the end of the nipple **200** is a disc **212** having openings **214** therethrough, and fitted with a flexible flap **216** of a size to cover all of the openings **214**, and which is connected to the disc **212** by a screw **218**. The flap **216** forms a valve that blocks the openings **214** during exhalation of the fireman to thereby prevent exhaled air from entering the breather hose **188**, the flap being easily moved from inhalation to allow fresh aire to enter the face mask **192**.

The fireman **2** has a choice of breathing air from the ambient atmosphere, or air from the bladder **170**. To do the former, the ring **204** is turned to align the gap **208** with the port **210**. When it is then desired to block access to the ambient air, the ring **204** is merely turned to block the port **210**.

The breathing apparatus as just described is light in weight and easy to use, and is designed to make use of the spent air from the air operated pump gun **18** so as to require a minimum of available air for breathing. Thus, it forms with the extinguisher apparatus **4** a self-contained apparatus ideally suited for fighting fires where the available air is inadequate for breathing purposes. Obviously, the hoses and the valves can be located otherwise than as shown, to provide the maximum accessability to a fireman who wears the equipment.

Referring now to FIGS. **10–12**, a second embodiemnt for the hand-held pump of the invention is shown at **220**, wherein a piston arrangement is utilized to pump the liquid rather than the diaphragm unit **52** of FIGS. **1–9**. The gun pump **220** includes a front body portion **222** and a rear body portion **224**, respectively having flanges **226** and **228** thereon that are connected by bolts **230**, a sheet gasket **234** being clamped between the confronting faces of the two portions. The confronting faces of the body portions **222** and **224** have aligned bores **236** and **238** therein that together define a power piston-receiving cylinder, and which receive a cylindrical bushing **240**. Reduced diameter front and rear axial pumping chambers **242** and **244**, respectively, lie on the axis of the cylinder formed by the bores **236** and **238**, the front pumping chamber **242** terminating in a threaded outlet **246** fitted with a suitable nozzle element **248**.

Received within the cylindrical bushing **240** is a power piston **250** carrying a sealing ring **252** centrally thereof, and from the opposite ends of which extend reduced diameter front and rear pumping piston sections **254** and **256**, respectively, which are received in the front and rear pumping chambers **242** and **244**. The pumping sections **254** and **256** carry O-ring seals **258** thereon, and are substantially shorter in length than the pumping chambers **242** and **244** within which they are slidably received.

The rear portion **224** of the gun **220** has a grip handle **260** thereon through which a supply passage **262** extends, the lower end of the supply passage **262** being connected to the supply conduit **22** leading from the water tank **6**. The upper end of the supply passage **262** opens into the rear end portion of the rear pumping chamber **244**, and also into a transverse bore **264** leading to a passage **266** that extends parallel to the pumping chambers **242** and **244**. A similar parallel passage **268** lies on the opposite side of the chambers **242** and **244**, and is connected with the rear pumping chamber **244** by a transverse bore **270**. The intersections of the bores **264** and **270** with the rear pumping chamber **244** are spaced apart, and disposed within the chamber **244** between said intersections is a one-way check valve **272** that allows flow to occur from the supply pasage **262** into the pumping chamber **244**, but which blocks flow from the inner portion of the chamber **244** and from the bore **270** toward the supply passage **262**.

The front pumping chamber **242** is connected with the forward ends of the parallel passages **266** and **268** by axially spaced transverse bores **274** and **276**, respectively, and a check valve **278** is positioned in the chamber **242** between the intersections of said bores **274** and **276** therewith. The check valve **278** allows flow from the bore **274** and from the chamber **242** to flow to the nozzle **248**, but prevents flow from the transverse bore **276** into the chamber **242** and the bore **274**.

Disposed within the parallel passages **266** and **268** at the mating faces of the body portions **222** and **224** are check valves **280** and **282**, respectively. The check valve **280** allows flow from the transverse bore **264** towards the transverse bore **274**, but prevents such flow in the opposite direction. Similarly, the check valve **282** allows for flow from the transverse bore **270** towards the transverse bore **276**, and prevents such flow in the opposite direction.

In operation, the power piston **250** is alternately driven from one end of the power cylinder formed by the bores **236** and **238** to the other end thereof, causing the pumping piston portions **254** and **256** to reciprocate within their pumping chambers **242** and **244**. Assuming the initiation of a cycle with the power piston **250** disposed rearwardly, as shown in FIGS. **10–12**, the pump of the gun **220** functions as follows.

When the power piston **250** moves forwardly, the front pumping piston section **254** moves into the chamber **242**, reducing the volume thereof. As a result, liquid contained therein is forced through the check valve **278** to the nozzle **248**, the check valves **280** and **282** preventing flow back toward the supply passage **262**. At the same time, the rear pumping piston section **256** is withdrawn from the chamber **244**, causing liquid to be drawn thereinto from the supply passage **262** through the check valve **272**.

When the power piston **250** reaches its fully forward position, the direction of movement thereof is reversed. The rear pumping piston section **256** then moves into the rear pumping chamber **244**, reducing the volume

thereof and forcing liquid to the nozzle **246** through the passage **268** and the check valve **282.** The check valve **272** blocks flow toward the supply passage **262.**

Simultaneously, the front pumping piston **254** will be withdrawn from the front chamber **242,** causing liquid to be drawn thereinto through the parallel passage **266** and the check valve **280.** When the power piston **250** has again reached its rearmost position, the cycle is completed.

The power piston **250** in FIGS. **10–12** is driven by air pressure through a mecahnism that functions similarly to the air pressure driving mechanism of FIGS. **1–9** for the diaphragm unit **52.** The opposite ends of the chambers **236** and **238** have ports **284** and **286** leading thereinto, and which are connected to the upper end of passages **288** and **290** that correspond to the passages **126** and **128,** respectively. The vertical passages **288** and **290** intersect horizontal passages **292** and **294,** and an axial, horizontal working bore **296** corresponding to the bore **138.**

Received within the bore **296** is an elongated valve stem **298** similar to the valve stem **140,** and which is actuacted by a trigger guard **302** and biased by a spring **304,** in a manner identical to the arrangement in FIGS. **1–9.** The valve stem **298** has front and rear transverse check valve bores **306** and **308** therein, each containing a ball element **310.** On opposite sides of the front bore **306** the valve stem **298** is reduced in diameter at **312** and **314** to form passages, and similarly is reduced at **316** and **318** on both sides of the rear bore **308.**

The passages **312** and **314** and the bore **306** are so arranged that when the bore **306** is aligned with the passage **288** the passage **312** will be aligned with a vertical passage **320,** and so that when the bore **306** is aligned with the passage **320,** the passage **314** will be aligned with the passage **288.** Similarly, the rear passages **316** and **318** are arranged so that when the bore **308** is aligned with the passage **290** (which occurs while the bore **306** is in alignment with the passage **320**), the passage **318** will be aligned with a vertical passage **322,** and so that when the bore **306** is aligned with the passage **322** the passages **316** and **290** will be in alignment. The upper ends of the passages **320** and **322,** respectively intersect the horizontal passages **292** and **294,** and their lower ends have threaded outlet or discharge ports **326** and **328.**

In light of the operating description given earlier for the similar gas pressure control arrangement of FIGS. **1–9,** it is believed unnecessary to describe in detail how the control arrangement of FIGS. **10–12** functions, such being obvious from the drawings. Suffice it to note that a pumping cycle will occur each time the trigger **300** is depressed and released, and that the spent gas will leave through the ports **326** and **328,** which can either be allowed to discharge to the atmosphere as in FIG. **1,** or which can be connected to the collector hoses **134** and **136** that supply the bladder **170.**

Referring now to FIGS. **13** and **14,** a third modification of the hand-held gun of the invention is indicated at **330,** utilizing a rotary vane pump arrangement for taking the liquid from the tank **6** and discharging it through a nozzle. The arrangement of FIGS. **13** and **14** has the advantage that the trigger is eliminated, and the unit itself is somewhat lighter in weight.

The gun **330** includes a grip portion **332** having a housing **334** attached thereto, the housing **334** having an axial chamber **336** therein that is closed at its rear end and which has a threaded opening **338** at its outer end. Received within the chamber **336** is a vane pump assembly **340,** including a rearwardly facing, cup-shaped air cylinder **342** and a similarly shaped liquid cylinder **344,** the two cylinders **342** and **344** being in abutting relationship, and being secured against relative rotation by key pins **346.** An end plate **348** is received in the chamber **336** and closes the open end of the air cylinder **342,** relative rotation between the two elements being prohibited by key pins **350.** A threaded plug **352** secures the vane pump assembly **340** in place within the chamber **336.**

The end wall of the cup-shaped air cylinder **342** has an offset or eccentric bore **352** therethrough, which is aligned with sockets **354** and **356** in the end plate **348** and the end wall of the liquid cylinder **344,** respectively, said sockets being fitted with journal bearings, and receiving the opposite ends of a shaft **358** that also passes through the bore **352.** An O-ring seal **360** in the bore **352** prevents leakage between the air and liquid cylinder working chambers.

The shaft **358** has a pair of cylindrical rotors **362** and **364** keyed thereto, the rotor **362** being received in the working chamber of the air cylinder **342** and the rotor **364** being received in the working chamber of the liquid chamber **344.** The two eccentrically mounted rotors **362** and **364** have radial vanes **366** and respectively, mounted in radial slots therein, in the usual manner.

The gun **330** is supplied with gas under pressure from the bottle **24** through the supply conduit **32,** the latter being connected to a threaded inlet port **370** in the lower end of the grip portion **332** of the gun. The port **370** is at the lower end of a supply passage **372** that extends upwardly through the grip **332,** and which is intersected above the port **370** by a transverse bore **374** that includes a threaded portion **376.** Received in the bore **374** is a threaded needle valve element **378** having a conical tip **380** thereon, the tip **380** being seatable in a conical socket **382** provided in the sidewall of the passage **372.** The needle valve element **378** can thus be adjusted to block off all air flow through the air supply passage **372,** or to provide for the flow of a desired quantity of air.

The upper end of the air supply passage **372** is aligned with a supply port **384** provided in the air cylinder **342,** and which leads to a recessed arcuate supply chamber **386** within the working chamber of the cylinder **342** at the base or vane-retracted side of the rotor **362.** Located at the discharge side of the eccentric rotor **362** in the cylinder **342** is a discharge port **388,** which is aligned with a discharge bore **390** threaded at its outer end for connection, if desired, to a collector hose **392** leading to the bladder **170.** In order to assure proper alignment between the passage **372** and the port **384,** and between the discharge port **388** and the bore **390,** an alignment pin **394** is threaded into a transverser bore **396** provided in the housing **334,** and engages within a socket **398** in the liquid cylinder **344.**

It is thus seen that the shaft **358** can be caused to rotate, merely by adjusting the needle valve **378** to admit gas pressure to the supply passage **372.** Such gas pressure will engage the vanes **366** of the eccentric air rotor **362,** causing the air rotor and the attached shaft **358** to rotate. This in turn rotates the liquid rotor **364.**

Water or another liquid for fighting fire is furnished to the pump **330** through the supply conduit **22** leading

from the tank **6**, the conduit **22** being threadably connected to a port **400** provided in the housing **334**, and which is aligned with an inlet port **402** in the pump cylinder **344**. The pump cylinder **344** also has a discharge port **404**, aligned with a bore **406** in the housing **334** that terminates in a threaded discharge port **408** to which a nozzle **410** is mounted. The nozzle **410** is adjustable from zero flow upwardly, to provide a desired discharge pattern. To prevent leakage, seals **412** are carried by the assembly **340** about the ports **384, 388** and **400**, and bore **406**.

In operation, the needle valve **378** is opened to allow gas pressure to reach the air rotor **362**, which is then driven thereby and in turn drives the liquid rotor **364**, the latter being effective to draw liquid from the tank **6** and discharge it under pressure through the nozzle **410**. The needle valve **378** and the nozzle **410** can be mutually adjusted, to provide the precise discharge pattern desired. Spent air, if desired, is collected by the conduit **392** and passed to the bladder **170**.

A modification of the air and liquid rotor construction of FIGS. **13** and **14** is shown in FIG. **15**, wherein instead of sliding vanes mounted in a solid rotor, flexible vanes **412** of rubber or the like are utilized. Such flexible vanes are known in the art, and offer certain advantages like less weight and simpler construction over the vane structure of FIGS. **13** and **14**.

In all of the embodiments thus far shown, the pump is located in the hand-held gun. Referring now to FIGS. **16** and **17**, yet another embodiment of the invention is shown at **413**, wherein instead of being located in the hand-held gun **414** the pump unit is mounted on the tank **6**.

In FIGS. **16** and **17** a water tank **416** is provided, of similar construction to the tank **6**, with a tapered bottom **418** that ensures drainage of the tank even if the fireman wearing it is bending over, as is also true of tank **6**. It is to be understood that both the tanks **6** and **416** can be filled either while on the back of the fireman, or before they are so mounted, as desired.

Mounted on the tank **416** by brackets **420** is an air bottle **422**, and a bladder **424** correspondin to the bladder **170**. Below the brackets **420** a rotary pump unit **426** is mounted, the unit **426** being of similar construction to the rotary pump shown in FIGS. **13** and **14**, and being supplied with air pressure through a conduit **428** and a needle valve **430**. The conduit **428** leads from a T-fitting **432** attached to the outlet of a pressure regulator **434** that is attached to the outlet of the air bottle **422** by a fast disconnect handwheel **436**, the regulator **434** corresponding to the regulator **34**.

Liquid is supplied to the pump **426** from the tank **416** by a conduit **438**, and the discharge of the pump unit **426** is connected by a conduit **440** with the hand-held gun **414**, the latter having an adjustable nozzle **442** thereon.

Spent air from the pump unit **426** is collected by a conduit **444** and transmitted to the bladder **424**, the bladder receiving supplemental air from the bottle **422** through the regulator **434**, and an air demand valve **446** connected to the center leg of the T-fitting **448**. The fire extinguisher unit **413** is employed in a manner similar to the extinguisher shown in FIG. **2**, a face mask being connected to the bladder **424**.

In all of the embodiments of the invention, it is readily seen that a portable fire extinguisher has been provided that can be easily handled by a fire fighter, which includes a lightweight water tank that can be easily refilled, and which will provide a high pressure stream of water from a hand-held nozzle gun, without tiring the fireman to produce such a stream. Thus, it is evident that all of the objects set forth for the invention have been achieved.

Obviously, many modifications and variations of the invention are possible.

What I claim is:

1. A portable fire extinguisher, including: a tank for receiving fire extinguishing liquid, and adapted to be worn by a fireman; gun means adapted to be hand-held by a fireman, and including a discharge nozzle; liquid conducting means connecting said tank with said discharge nozzle, and including gas pressure operated pump means having an inlet or an outlet, first conduit means connecting said inlet with said tank, and second conduit means connecting said outlet with said nozzle; and a source of gas pressure operably connected with said pump means, said pump means being effective when activated to pump liquid from said tank and discharge the same under pressure through said nozzle.

2. A portable fire extinguisher as recited in claim **1**, wherein said pump means is located within said gun.

3. A portable fire extinguisher as recited in claim **2**, wherein said pump means is of the diaphragm type.

4. A portable fire extinguisher as recited in claim **2**, wherein said pump means is of the piston type.

5. A portable fire extinguisher as recited in claim **2**, wherein said pump means is of the rotary type.

6. A portable fire extinguisher as recited in claim **1**, wherein said pump means is mounted on said tank.

7. A portable fire extinguisher as recited in claim **1**, wherein said source of gas pressure includes: a gas bottle; bracket means on said tank for carrying said gas bottle; a pressure regulator connected to the outlet of said gas bottle; and a supply conduit connected between the outlet of said regulator and said pump means.

8. A portable fire extinguisher as recited in claim **1**, including additionally: a bladder carried by said tank; face mask means connected with said bladder; conduit means connected between said pump means and said bladder, and adapted to collect spent gas from said pump means and transmit said gas to said bladder, for use with said face mask means.

9. A portable fire extinguisher as recited in claim **8**, including additionally: a demand valve connected with said source of gas pressure; and a conduit connecting said demand valve with said bladder, for supplying supplemental gas to said bladder.

10. A portable fire extinguisher as recited in claim **9**, wherein said face mask means is connected with said bladder by a breather hose having a valve unit therein, said valve unit being selectively operable to connect said face mask means either with said bladder or with said atmosphere, and said face mask means including a flap valve to prevent exhaled air from entering said breather hose.

11. A portable fire extinguisher, including: a tank for receiving fire extinguishing liquid, and adapted to be worn by a fireman; gun means adapted to be hand-held by a fireman, and including gas pressure operated pump means having a liquid inlet and a liquid outlet, and nozzle means connected with said liquid outlet of said pump means; conduict means connecting said tank with said pump means liquid inlet; a pressure bottle

carried by said tank; and conduit means connecting said pressure bottle with said pump means, for transmitting operating gas pressure thereto.

12. A portable fire extinguisher as recited in claim **11,** wherein said pump means includes: a reciprocating pump assembly mounted within said gun body, said assembly being connected between said liquid inlet and said liquid outlet, and being operable by gas pressure to pump liquid from said tank to said nozzle through reciprocating motion thereof; and valve means connected between said conduit for transmitting operating gas pressure to said pump means and said pump assembly, said valve means including a valve operating stem reciprocably mounted within a working chamber, and a spring-biased trigger connected with said valve operating stem, said valve means being so arranged that when said trigger is depressed and released said pump assembly will complete one cycle.

13. A portable fire extinguisher as recited in claim **12,** wherein said reciprocating pump assembly is of the diaphragm type.

14. A portable fire extinguisher as recited in claim **12,** wherein said reciprocating pump assembly is of the piston type.

15. A portable fire extinguisher as recited in claim **11,** where said pump means includes: a rotary vane liquid pump, including a shaft having a rotor mounted thereon; and a rotary vane gas turbine, including a rotor mounted on the same shaft as the rotor of said liquid pump, the inlet of said rotary vane gas turbine being connected with said conduit means for transmitting gas pressure to said pump means, through adjustable valve means.

16. A portable fire extinguisher as recited in claim **11,** wherein said pump means also has a gas pressure inlet port and a spent gas discharge port, and wherein said fire extinguisher further includes: a bladder carried by said tank, and connected with said spent gas discharge port; face mask means; and a breather hose connected between said bladder and said face mask means, said pressure bottle being charged with breathable air.

17. A portable fire extinguisher as recited in claim **16,** including additionally: means connected between said pressure bottle and said bladder, for supplying supplemental air to said bladder.

18. A gas pressure operated pump for use in portable fire extinguishers, including: a gun having a chamber therein; a reciprocating pump assembly received within said chanber, said pump assembly including a pair of pumping chambers each having a liquid inlet port and a liquid outlet port, said gun having a liquid supply passage and a liquid discharge passage therewith, and said gun further including interconnecting passages and check valves arranged so that when said reciprocating pump assembly moves in a first direction one of said pumping chambers is connected solely to said liquid discharge passage and the other is connected solely with said liquid supply passage, and so that when said pump assembly moves in the opposite direction said one pumping chamber is then connected solely to said liquid supply passage and said other chamber is then connected solely with said liquid discharge passage; and means operable to apply gas pressure to said pump assembly to cause the same to reciprocate, said gas pressure applying means including valve means having a trigger that when depressed causes said pump assembly to move in one direction, and when released and returned to its original position will cause said pump assembly to move in the opposite direction.

19. A gas pressure operated pump as recited in claim **18,** wherein said reciprocating pump assembly is of the diaphragm type, and includes a pair of diaphragms connected by a connecting rod and against one side of which gas pressure is applied to cause said assembly to reciprocate, the opposite sides of said diaphragms constituting the end walls of pumping chambers.

20. A gas pressure operated pump as recited in claim **18,** wherein said reciprocating pump assembly is of the piston type, and includes: a power piston slidably received within a power cylinder, and against the opposite sides of which gas pressure is alternately applied to cause reciprocation thereof; and a pair of pumping piston sections, one mounted on each side of said power piston, said pumping piston sections each being received within a pumping cylinder.

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