

[54] **LEAKAGE INDICATOR FOR A FIRE EXTINGUISHER**[75] Inventors: **Jack M. Kermer**, Los Angeles;
Abdul N. Sitabkhan, El Monte, both
of Calif.[73] Assignee: **HTL Industries, Inc.**, Monrovia,
Calif.[22] Filed: **Mar. 5, 1971**[21] Appl. No.: **121,452**[52] U.S. Cl. **340/242**, 169/23, 200/83[51] Int. Cl. **A62c 39/02**, H01h 35/34[58] Field of Search 200/81, 83; 340/240,
340/242; 169/23, 28; 116/70[56] **References Cited****UNITED STATES PATENTS**

3,576,412	4/1971	Jollien-Davin	200/83
3,302,269	2/1967	Cooper et al.	200/83
3,624,627	11/1971	Evans	340/242
3,505,791	4/1970	Breslin	200/83 N
3,140,368	7/1964	Young et al.	340/240 X
3,441,695	4/1969	Stedfeld	200/81
3,290,466	12/1966	Oliveau	200/83

Primary Examiner—John W. Caldwell*Assistant Examiner*—Scott F. Partridge*Attorney*—Harold L. Jackson, Stanley R. Jones,
Robert M. Vargo and Eric T. S. Chung

[57]

ABSTRACT

A temperature compensated alarm mechanism for a fire extinguisher suitable for use on aircraft or other vehicles for determining whether the pressure of the fire extinguishing fluids within the main container has dropped below a predetermined value due to leakage or to other conditions. The mechanism includes, in addition to the main container, a miniaturized container which may be inserted into the main container and is filled with like fluids and arranged so that a diaphragm effectively separates the fluids of the two containers from each other. The diaphragm may be actuated in response to a predetermined droppage of the pressure of the main container to produce a signal indicating that the fire extinguisher may have been rendered incapable of responding with sufficient force to a condition requiring prompt attention for extinguishing or suppressing a fire. The mechanism is substantially non-responsive to wide variations in the temperature of the media external to the fire extinguisher.

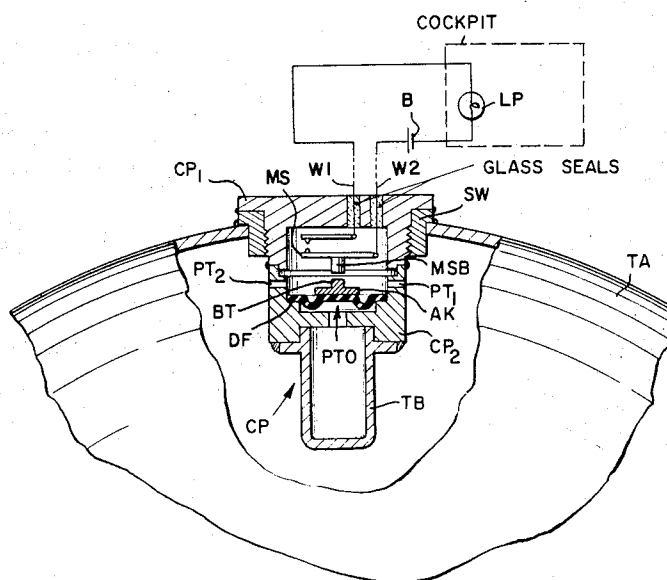
13 Claims, 2 Drawing Figures

FIG. 1

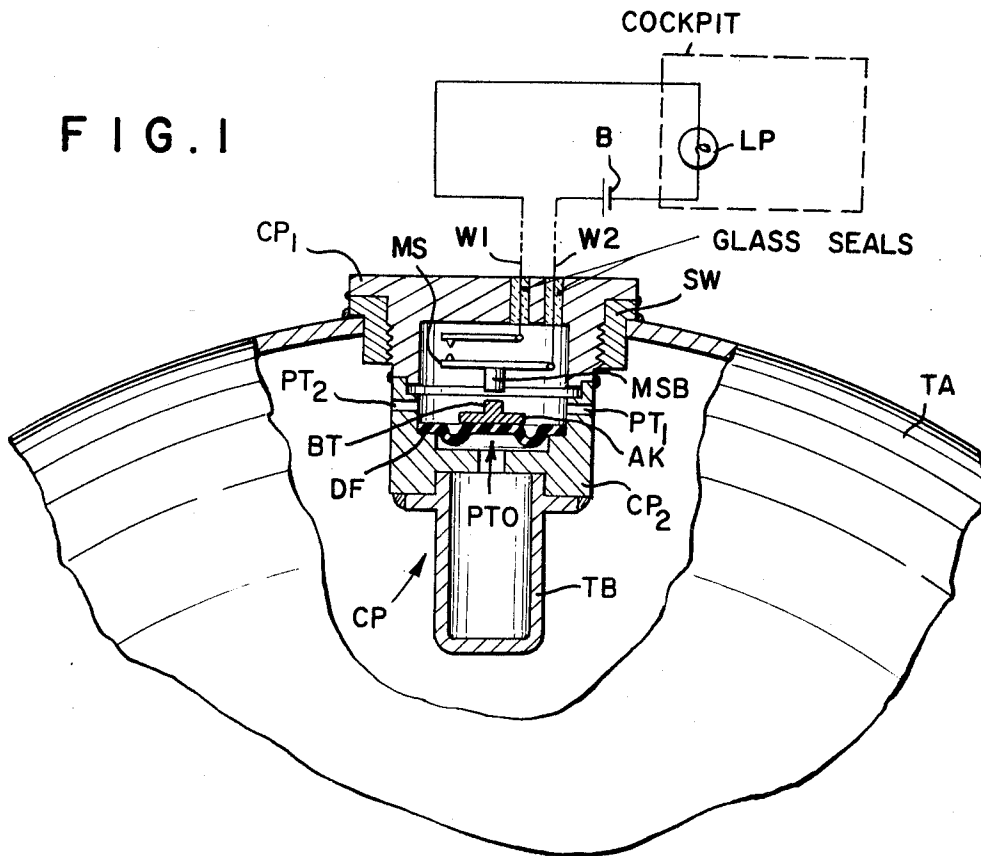
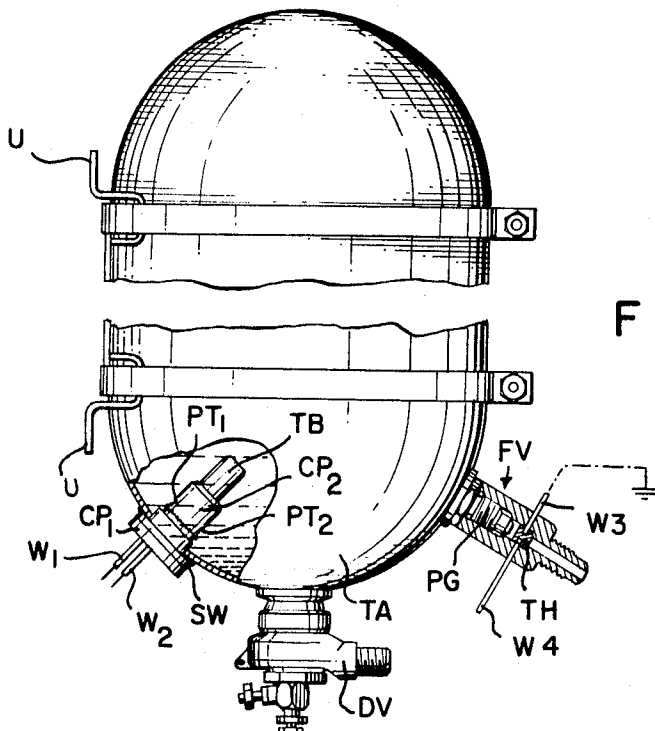


FIG. 2

INVENTORS ,
JACK M. KRAMER
ABDUL N. SITABKHAN

BY *Jefferson Ehrlich*
ATTORNEY

LEAKAGE INDICATOR FOR A FIRE EXTINGUISHER

It has been noted that a conventional fire extinguisher for use on aircraft or other vehicles, which is or may be, for example, a high-pressure type employing a pressure of say 600psi, can be subjected to losses of pressure due to leakages of the fluids in its container. Such leakages may occur due, for example, to accidental droppage of the container by a maintenance man or for numerous other reasons. Such a container may be rendered useless if its fire extinguishing fluid leaks appreciably. A hazardous condition naturally develops on account of such leakage and this would be a source of great concern to the staff in charge of the plane's operation and naturally also a matter of real danger to the passengers or the cargo on the craft.

Other sources of leakage from a container of a fire extinguisher may be due to microscopic openings in the metal of which the container is made, flaws in the welding material which are not readily detectable, fatigue of the material of the container because of its stresses and strains, etc., etc. Any or all of these factors may be co-existent and may materially affect adversely the operativeness and utility of the fire extinguisher as a servicing element for its primary and essential functions.

It has been customary in certain types of aircraft to connect the container of a fire extinguisher by means of a conduit to a so-called "discharge indicator" located on the "skin" of the aircraft so that, if the container has discharged all or a good deal of its fire extinguisher fluids through the conduit due to an abnormal condition due to temperature, the disc of this indicator would become severed or removed. Such a condition would be readily detectable to personnel but the detection is made on the ground after the aircraft has landed. An inspector at an airport might then alert the maintenance people of the inoperativeness of the fire extinguisher. The condition may be overcome by replacement or repair of the fire extinguishing equipment. But, as noted, this temperature condition is customarily detected only for abnormal temperature conditions. A leakage condition is not detectable by this means and hence leaves the fire extinguisher in an inoperative condition, the inoperative condition remaining unnoticeable and undetectable by the inspector.

In order to overcome some of the principal defects affecting the operation of a fire extinguisher, a temperature-compensated pressure switch mechanism has been developed. The pressure switch mechanism according to this invention includes, in addition to the main container of the fire extinguisher, a second container of a miniaturized size containing the same types of fluids as the main container, together with a flexible diaphragm and a microswitch, so arranged and coordinated that the diaphragm is positioned substantially at an opening or port or ports separating the two containers, so that the fluid in one of the containers will act against one side of the diaphragm while the fluid within the other container will act upon the other side of the same diaphragm. Hence, whenever the pressures of the fluids on the two sides are materially different, the micro-switch mechanism will be actuated and signal the cabin officer, for example, or others that an incipient adverse condition has developed within the main container of the fire extinguisher that requires prompt attention.

One of the primary objects of this invention is to provide a fire extinguishing container together with a miniaturized container containing the same chemical or fluidic components as the main container and subjected substantially to the same conditions of pressure and temperature, so that when a predetermined pressure differential develops between the fluids of the two containers, whether due to internal pressure or other factors, the condition will be promptly relayed to a central point or a remote point or to the cabin of an aircraft advising that a hazardous condition has developed within the fire extinguishing mechanism.

Another of the objects of this invention is to provide a relatively small chamber common to the two coupled containers so arranged that the chamber has a flexible diaphragm therein separating the fluids of the two chambers. In this arrangement, the diaphragm will respond to a sufficient pressure differential between the fluid components of the two containers and the diaphragm will actuate a switch to light a lamp or provide a signal which can be easily and promptly detectable. Such an arrangement can serve to inform the staff of an aircraft that a menacing condition has developed whereupon the staff may signal the nearest landing field that the fire extinguisher may need prompt replacement or repair.

This invention, together with its objects and features, will be better and more clearly understood from the following description and explanation hereinafter given when read in connection with the accompanying drawing in which

FIG. 1 schematically illustrates a segment of a fire extinguisher to show one form of the invention, the segment of the container apparatus of the fire extinguisher being shown in cross-section, and

FIG. 2 schematically illustrates a more complete fire extinguisher showing other valves of such an extinguisher in their relative positions.

Referring to FIGS. 1 and 2 of the drawing, two containers TA and TB are shown, container TA constituting the main container and container TB constituting a miniature container coupled, as will be explained, to the main container TA. The container TA is the container of a conventional fire extinguisher which may, for example, embody an elliptical or spherical or cylindrical metal housing and may be 12 or 15 or more inches in diameter and of any length and may contain a quantity of fire extinguishing fluid, such as freon 1301, and a quantity of nitrogen gas as a pressurizing fluid, while the second container TB may be, for example, a miniaturized container preferably cylindrical in shape, and having a much smaller diameter, for example, a diameter of about one-half inch, but filled with identical or substantially identical fluid components, namely freon 1301 and nitrogen gas, in the same general proportions. Both containers, TA and TB, may be pressurized to substantially similar or equal pressures in the range of, for example, 600 psi. If the fluid within container TA has a pressure of let's say 600 psi at normal temperature, the container TB may preferably be pressurized to a somewhat lower fluid pressure, about 580 psi, or slightly below the indicated pressure at the same temperature of the container TA. Thus, there are two containers of the same fluidic compounds and both subjected to the same parameters of the pressurized fire extinguishing fluids, both separately encased and welded or brazed in the respective containers so as to

be hermetically sealed to maintain the fluids of the two containers separate and distinct from each other at all times.

Container TB, the miniaturized container, may be provided with a cap CP which may be made of two parts CP1 and CP2, both made of stainless steel, for example, which may be welded or brazed to each other and to the upper periphery of the miniature container TB as shown in the drawing. The principal container TA may be provided with an external housing structure SW located on the upper side of container TA and welded or brazed to container TA as shown and to cap segment CP1. A diaphragm DF is positioned in a cylindrical opening or cavity within the cap segment CP2 as shown. Cap segment CP2 is provided with a central port PT0 so that the fire extinguishing fluid in the miniature container TB may provide its own pressure on the underside of diaphragm DF.

The diaphragm DF may preferably be any flexible diaphragm readily responding to miniature pressure differentials of the fluids of both containers. It has a projection or projections which rest against the lower side of the cylindrical opening or cavity in the cap segment CP2, as shown. The additional housing structure is arranged so that it may be fitted into an appropriate opening in the outer wall of the larger container TA. The cap segment CP2 has two or more ports PT1 and PT2 which freely allow the fluid of the first container TA to enter therethrough and continually provide pressure against the upper side of the diaphragm DF. Hence, the diaphragm DF will be subjected to the upward pressure through a port PT0 in cap segment CP2 due to the fluid of container TB on the lower side of diaphragm DF and also the downward pressure of the fluid of the larger container TA admitted through ports PT1 and PT2 and acting against the upper side of diaphragm DF.

It will be noted that a floating actuator AK, smaller in diameter than the diaphragm DF, is rested or seated on the diaphragm DF, as shown. The floating actuator AK has a centrally positioned button BT on its upper side which is located adjacent to a microswitch button MSB of a microswitch MS. The microswitch button MSB is connectable to complete and operate an electrical circuit W1, W2, which may be powered by any source of voltage B, such as a battery or any common DC or AC source. The electrical circuit W1, W2 may include a visual indicator, such as a lamp LP, or an audible indicator (not shown), or both, and the circuit may be wired and ordinarily would be wired to the cockpit or to an attendant's position to signal a hazardous condition should it develop.

When the pressure on the lower side of the diaphragm DF exceeds the pressure on the upper side of the diaphragm DF by a significant and predetermined differential pressure, diaphragm DF will be raised to cause the floating actuator AK to move its projecting button BT to strike and move the microswitch button MSB, thereby closing the circuit W1, W2 to the lamp LP to illuminate the lamp LP and thereby signal the various personnel.

Both containers TA and TB may be subjected to normal variations in pressure due to normal variations in the ambient temperature or other external conditions. Thus, if the ambient temperature should drop, for example, to minus 65°F, this temperature being in the normal range, the pressure in the container TA may

drop correspondingly to say 180 psi, while the pressure in the second container TB may also drop to say 170 psi. In that event, the diaphragm DF will remain undeflected and the microswitch MS will remain unactuated. The lamp LP will indicate no significant change in the condition of the principal container TA. The fire extinguisher and its container TA would be expected to operate satisfactorily. External temperature variations and corresponding external pressure variations will thus be substantially non-effective in operating the signal circuit to illuminate lamp LP.

For calibration and testing purposes, assume, for example, that the miniature container TB is disassociated from the container TA, but that the diaphragm DF and its associated mechanism remains connected to the microswitch MS, as shown in the drawing. In this condition, the only force acting on the sealed diaphragm DF will be that arising from the pressure of the fluid of container TB. Inasmuch as the force acting on the diaphragm DF is in an upward direction due to the pressurized medium in the container TB, then the microswitch MS will be actuated by the flexure of the diaphragm DF and the condition will be indicated by the operation of the lamp LP. Now consider that the ports PT1 and PT2 are then connected to a variable pressure source of fluid, that the source delivers its fluid under pressure and that the pressure is raised from a low level to an increasing value. While the pressure of the fluid admitted through ports PT1 and PT2 is initially low relatively, the microswitch MS will remain closed and the lamp LP will continue to remain lighted. As the pressure supplied through ports PT1 and PT2 is raised further, the previous condition will be continued until a level of fluid pressure, a predetermined pressure, is reached through the ports PT1 and PT2. This pressure will return the diaphragm DF to its former lower or initial position. In that case, the microswitch MS will be released, extinguishing the lamp LP.

We can now determine and establish the value of the predetermined fluid pressure delivered through ports PT1 and PT2 which will return the diaphragm DF to its initial or normal released position. This pressure may be and should be somewhat different from the prevailing pressure in the main container TA. This differential pressure will be significant in the general operation of the overall mechanism.

Now assume that the larger container TA is filled with its fire extinguishing fluid or fluids, as already described, and that the fluid pressure is brought to a value approximately equal to the value that previously returned the diaphragm DF to its released or normal position. That internal pressure within container TA will be a normal value and within the normal operating pressure range of container TA, and such a pressure will keep the container TA in good condition. Now assume that the container TA is supplied with a conventional relief valve (not shown) which permits some of the fluid contents of the container TA to be released whenever desired. This relief valve may be employed to reduce the internal pressure within the container TA so that we can bring about an operative condition by opening the relief valve, that is, a condition in which the diaphragm DF will be actuated again because the pressure on its upper side is at a lower value than the pressure on the lower side of the diaphragm. Now if the relief valve were closed or sealed so as to maintain the pressure within the container TA at its earlier normal

level, the arrangement would function so that, if the ambient temperature should vary between, for example, minus 65°F and plus 300°F, the fluid pressure resulting from any change in temperature over that entire range would maintain the diaphragm DF in its released or normal position and the lamp LP would remain extinguished. Thus, temperature changes within this normal or ambient range will be non-effective in operating the signal circuit W1, W2.

If now we open the relief valve to release an appreciable amount of the fluid within the main container TA, the pressure within the container TA will be considerably lower than previously, thereby causing the diaphragm DF to be moved upwardly to operate the microswitch MS, and thereby operate circuit W1, W2 and illuminate the lamp LP. This operation of the diaphragm DF to its upward or operating position in response to the lowering of pressure in container TA and the consequent lighting of the lamp LP will be maintained and continued regardless of any variation in the ambient temperature. In other words, the signal mechanism will be operated independently of variations in ambient temperature, whether the circuit is in its operated or released condition. This is an important fail-safe feature of the equipment. The lamp LP or other indicator or indicators may be located at remote points, such as the cockpit, etc.

Thus, the switching arrangement and the controlled signal circuit W1, W2 remain in their released condition if the fluid in container TA is held at a normal range of internal pressures substantially free of leakage. Moreover, the switching arrangement and the controlled signal circuit will be in their operated condition, and remain in their operated condition if they were previously operated, in response to leakage of fluid from container TA. As observed, these conditions are substantially free from environmental changes in the ambient temperature over a range of, for example, minus 65°F to plus 300°F. Furthermore, the switching arrangement and the controlled signal circuit will remain unchanged and unaffected even if the ambient temperature varies considerably beyond the above designated normal temperature range. In other words, this mechanism responds solely to differential pressures of sufficient magnitude between the fluids in the two containers TA and TB and is non-responsive to ambient temperature variations.

The equipment of this invention is capable of monitoring continuously and promptly any substantial deviation in the pressure of the outer container TA due to, for example, inadvertent loss of internal pressure, or due to leakages, etc.

It will be observed that the flexible diaphragm DF is retained in a location where it is unable to move too far either in a downward direction or in an upward direction. When it is moved in an upward direction, its upward movement is limited by the location of the floating actuator AK within cap segment CP. On the other hand, when the diaphragm DF is moved in a downward direction due to excessive pressure on the upper side of the diaphragm DF, it will be restrained by the lower inner wall of the chamber within cap segment CP₂ in which the diaphragm DF is positioned. Moreover, the two limiting positions will define the relative positions of diaphragm DF. This travel distance can be carefully adjusted for any desired or pre-assigned values. The diaphragm DF may be made rather sensitive and respon-

sive to differential pressures of 10, 15, 20, 25 psi or less or more, as may be desired. On the other hand, diaphragm DF, which may be made of corrugated stainless steel, is able to withstand the available pressures under all operating conditions developed either within the container TA or container TB or both.

The diaphragm DF is a flexible diaphragm as already indicated, made either of rubber or corrugated stainless steel and of any desired thickness and rigidity so that it may be moved or expanded in response to predetermined pressure variations. The diaphragm DF is hermetically sealed against the cap segment CP₂ so as to completely isolate the fluid within the miniature container TB and maintain that fluid isolated.

The miniature chamber TB is fully sealed as noted and may be sealed hermetically by welding, brazing or other means, so that the contents thereof may not be leaked out or altered. It may therefore remain a permanent standard for maintaining a condition of balance or equilibrium throughout the fire extinguishing system. Variations in the internal pressure of the outer container TA are always compared with the internal pressure of the standard miniature container TB and significant changes are detected by the upward flexure of diaphragm DF and the operation of the signal circuit.

Although the structure shows the employment of two ports PT1 and PT2 for transmitting fluid from container TA to the upper side of diaphragm DF, it will be obvious that one port may be sufficient. If desired, as already pointed out, any number of ports may be employed for this purpose. Likewise, a single port PT0 has been shown and provided on the underside of the diaphragm DF for permitting the fluid in the container TB to constantly actuate the diaphragm DF. Obviously, more than one port may also be employed for this purpose.

The diaphragm DF, by being sealed into the cap CP by welding or other means, cannot leak any of the fluidic contents of the container TB into container TA, and vice versa. This is a most important function because it always maintains the two fluids in separate and independent containers. Furthermore, the diaphragm DF is so oriented by its corrugations or other deformations that it can be flexed many times in testing or otherwise operating the equipment, without substantially affecting its long range durability and operability. It remains, therefore, intact and usable for long periods of time.

If desired, the cap structure CP and its flexible diaphragm DF and the associated equipment may be arranged to couple the containers of two complete fire extinguishers by arranging the diaphragm DF to form a seal against both containers. In such an arrangement, the fluids of both containers may be kept apart by the diaphragm, and the fluids of the two containers would normally apply pressure against opposite sides of the diaphragm. The microswitch MS, the circuit W1, W2 and lamp LP would be caused to respond to the movement of the diaphragm in response to a predetermined pressure change in either container.

Although this structure has been shown and described as a mechanism for comparing the contents of a container TA of a fire extinguisher with that of the standardized micro-container TB, the arrangement need not be embodied in or applied to a fire extinguisher, but may be embodied in any other container

whether or not employed for fire extinguishing functions.

Although the equipment has been described as a mechanism for indicating when the pressure of the fluid in the first container TA falls below the pressure of the fluid within the second container TB, the mechanism may also be used to determine and signify when the pressure of the fluid within the first container TA exceeds that of the container TB by a predetermined value. The microswitch MP will be released whenever the pressure within container TA exceeds that of container TB by a predetermined magnitude. This condition will be indicated by the absence of illumination at lamp LP. But when the pressure within container TA drops substantially so as not to provide a predetermined differential pressure, then the lamp LP will be illuminated to reveal that condition. In other words, the mechanism of this invention may be employed to signify pressure differentials in either direction — always independent of temperature variations encountered in the ambient external medium.

FIG. 2 schematically shows a fire extinguisher to which the invention may be applied. The structure of FIG. 2 includes a filler valve FV and a discharge valve DV, both mounted on container TA. This structure may be arranged and operated in accordance with the principles set forth in the patent of J. R. Fiero, U.S. Pat. No. 3,552,495, issued Jan. 5, 1971 and assigned to the assignee of the present application.

While this invention has been shown and described in certain particular embodiments merely for illustration and explanation, it will be apparent that the general principles of this invention may be readily applied to other and widely varied organizations for the practice of this invention.

What is claimed is:

1. The combination of a fire extinguisher having a first container filled with fire extinguishing fluid, a second container filled with fluid of substantially the same composition and proportion of fire extinguishing fluid as in the first container, a protective housing having a diaphragm for coupling the two containers to each other, said diaphragm sealing the second container so that one side of the diaphragm is subjected to the pressure of the fluid of the second container, the other side of said diaphragm being exposed to the pressure of the fluid of the first container, and means responsive to a predetermined differential pressure between the fluids of the two containers to render a signal substantially independently of the ambient temperature.

2. The combination recited in claim 1 in which the diaphragm is made of flexible material and the fluid is freon and nitrogen.

3. The combination recited in claim 1 in which the diaphragm is made of corrugated stainless steel.

4. The combination recited in claim 1 including a signalling circuit responsive to the rendered signal.

5. A temperature compensated detecting apparatus for a fire extinguisher having a container filled with fire extinguishing fluid, comprising a second container mounted within the first container and filled with substantially the same fire extinguishing fluid as the first container, a flexible diaphragm for sealing the second container, one side of the diaphragm being exposed to the fluid in the second container, said diaphragm preventing the flow of fluid from either container to the other, the other side of said diaphragm being exposed

to the fluid in the first container, and apparatus responsive to the flexure of said diaphragm by a predetermined amount to produce a signal independently of the ambient temperature.

6. A temperature compensating detector apparatus for a fire extinguisher according to claim 5, in which the diaphragm between the two containers is made of corrugated stainless steel so as to be flexible and continuously responsive to changes in fluid pressure.

7. Apparatus for a fire extinguisher for detecting leakage of freon and nitrogen from a container of the fire extinguisher, comprising means for responding to a droppage in the pressure of the freon and nitrogen of said container and non-responsive to variations in the temperature of external ambient conditions, said means including a second container filled with substantially the same proportion of freon and nitrogen and positioned closely adjacent to the first container and sealed by a flexible diaphragm so that one side of said diaphragm is exposed only to the fluid of the first container and the other side of said diaphragm is exposed only to the fluid of the second container, and a signalling circuit responding to the flexure of said diaphragm to indicate that the pressure on the side of said diaphragm exposed to the fluid of the first container has substantially departed from a predetermined level.

8. Apparatus according to claim 7 in which the diaphragm is composed of corrugated stainless steel and responds promptly to pressure variations.

9. Apparatus according to claim 7 in which the signalling circuit includes a switch which is mechanically coupled to the diaphragm.

10. Apparatus for detecting leakage of freon liquid and nitrogen gas from a fire extinguisher container independently of ambient conditions, comprising a miniature container filled with the same proportion of freon liquid and nitrogen gas, a housing sealed to the fire extinguisher container and coupling the two containers to each other so that the miniature container is cantilevered from the interior of the fire extinguisher container, the housing including a diaphragm one side of which hermetically seals the miniature container, the housing including an opening so arranged that the other side of the diaphragm receives and is exposed to the fluid in the fire extinguisher container, a switch member mechanically coupled to a central portion of the surface of said diaphragm, said signalling means controlled by said switch.

11. Apparatus according to claim 10 in which the signalling means includes a remotely controlled indicator.

12. A temperature compensated detecting apparatus for a fire extinguisher having a first container filled with fire extinguishing freon liquid and nitrogen gas comprising:

a mounting plate adapted to be mounted in the first container;

a second container mounted within the mounting plate and cantilevered into the interior of the first container and filled with the same fire extinguishing proportion of freon liquid and nitrogen gas as the first container;

a flexible corrugated, steel diaphragm for sealing the second container, one side of the diaphragm being exposed to the liquid and gas in the second container, said diaphragm preventing the flow of liquid or gas from either container to the other, the other side of said diaphragm being exposed to the liquid

9

and gas in the first container, and means responsive to the flexure of said diaphragm by a predetermined amount for producing a signal independently of the ambient temperature between a temperature range of -65°F and $+300^{\circ}\text{F}$.

10

13. Apparatus according to claim 12 including a switch positioned adjacent the diaphragm and responding continually to the deflection of the diaphragm, and a circuit controlled by the switch to generate the signal.

* * * * *

5

10

15

20

25

30

35

40

45

50

55

60

65