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FUEL QUALITY TESTING DEVICE

Filed July 16, 1962

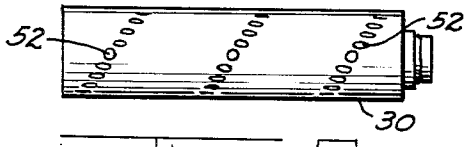


FIG. 3

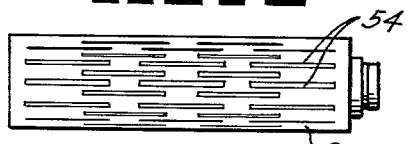


FIG. 4

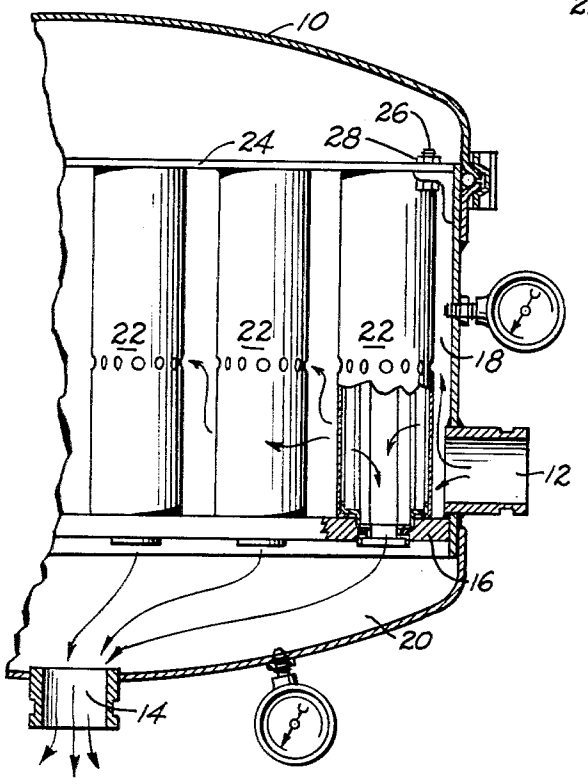


FIG. 1

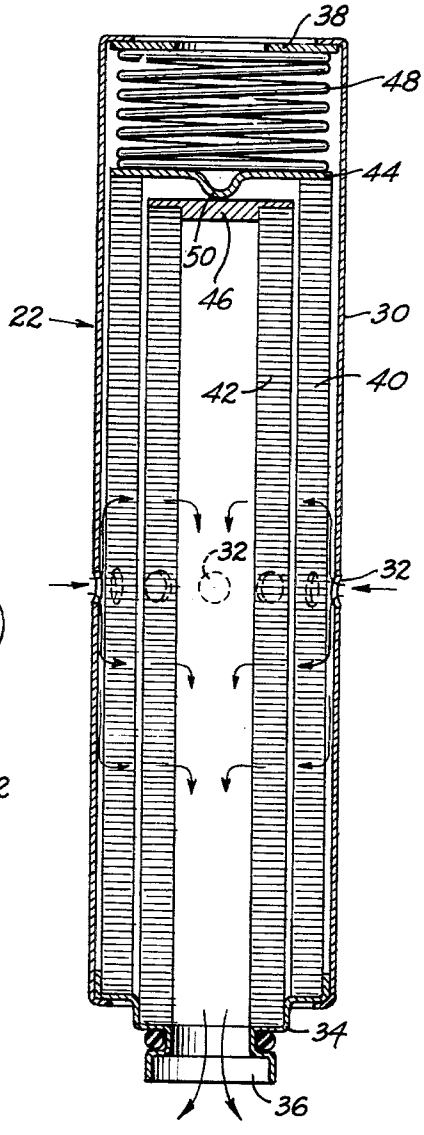


FIG. 2

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FUEL QUALITY TESTING DEVICE

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This invention relates to a fuel quality testing device of the type which utilizes an edge-type element therein and more particularly to improvements in such a device.

It is an object of this invention to provide a fuse assembly for a fuel monitoring device of greatly improved performance, particularly insofar as the prevention of water transmission is concerned.

Another object of this invention is to provide a unique construction for a compound ultrasensitive fuse to be used in sensing the presence of water and solid contamination in fuel or other hydrocarbons.

A further object of this invention is to provide a fuse assembly having two concentric washer-type elements operating in series wherein the upstream element functions independently of the downstream element and the downstream element, although capable of functioning independently of the upstream element, is controlled with respect to its water sensitivity by movement of the upstream element endcap.

A still further object of this invention is to provide a fuse assembly which includes means for thoroughly dispersing large globules of water in the fuel before the fuel reaches the water sensitive components of the fuse assembly.

More specifically, it is an object of this invention to provide a port arrangement in a tubular fuse housing which will result in the thorough mixing of any water present in the fuel before the fuel flows through the washer-type elements located within the tubular housing.

The above and other objects and features of this invention will become apparent from the following description taken in connection with the accompanying drawing which forms a part of this specification and in which:

FIGURE 1 is a fragmentary view partially in section of a fuel quality testing device showing a plurality of fuse assemblies incorporating the invention;

FIGURE 2 is an enlarged sectional view of one of the fuse assemblies incorporating the invention;

FIGURE 3 is a plan view of a fuse assembly showing another embodiment of the invention; and

FIGURE 4 is a plan view of a fuse assembly showing a further embodiment of the invention.

Referring to FIGURE 1 of the drawing, it will be seen that numeral **10** indicates a tank having a fuel inlet port **12** and a fuel outlet port **14**. Suitably attached to the housing is a partition **16** which separates the interior of the housing into an inlet chamber **18** and an outlet chamber **20**. A plurality of fuse assemblies **22** (only three of which are shown) are suitably attached to partition **16** and are retained in position by a retainer plate **24** which is operatively connected to housing **10** by three bolts **26** and nuts **28** (only one of which is shown). The direction of flow through the tank is indicated by the arrows.

Each fuse assembly **22** includes a tubular housing **30** having a plurality of inlet ports **32** around the periphery thereof, a ferrule **34** having an outlet port **36** which is located at one end of the tubular housing, and a retaining member **38** which is located at the other end of the tubular housing. Located within the tubular housing **30** are two concentric porous tubular edge-type fuse elements **40** and **42** each of which is formed from a plurality of washers in registered face-to-face contact. The washers

may be formed from paper, cellulose, or other suitable fibrous or non-fibrous material and are arranged so that flow through the fuse elements **40** and **42** will be via the radially extending pores formed between the washers. In this particular arrangement flow will be from outside the fuse elements to inside the fuse elements.

One end of each of the fuse elements **40** and **42** abuts the ferrule **34** while the other ends of the elements **40** and **42** are closed off by endcaps **44** and **46**, respectively. A spring **48** is located between the retainer **38** and endcap **44** for maintaining the fuse elements **40** and **42** under a suitable calibrated precompression. A ridge **50** is formed on endcap **44** and abuts endcap **46** for reasons to be hereinafter described.

Each fuse element **40** and **42** is constructed so that it includes at least one washer formed of a hygroscopic material adjacent the pores, said hygroscopic material being capable of swelling upon contact with water and closing off the pores to thereby prevent further flow through the fuse element. In other words each fuse element includes a plurality of hygroscopic washers, at least one of which is located adjacent each pore. A more detailed description regarding fuses of this type may be found in my Patent No. 3,034,656 and my copending application Serial No. 39,101 filed June 27, 1960 and now Patent Number 3,117,925 issued January 14, 1964.

During normal operation with clean fuel containing no undissolved water, the fuel will pass through the outer fuse element **40** and thence through the inner fuse element **42**. If small traces of undissolved water are present, this water will be absorbed by the hygroscopic washers in the outer fuse. This will cause the washers to swell until the spring **48** is compressed to its solid height. Further swelling will reduce the spaces between the washers and increase the resistance to flow to thereby initially reduce the flow and eventually stop it completely. If large percentages of water are present beyond the water retention capacity of the outer washer stack, some of this water will be transmitted through the outer fuse before the flow of fuel is effectively stopped. However, with the construction shown, any water which is transmitted through the outer fuse **40** must flow through the inner fuse **42** before leaving the tank **10**. Furthermore, it will be obvious that before any water is transmitted to the inner fuse **42**, the water which has been absorbed by the outer fuse **40** will have caused an increase in the restriction to flow therethrough. This restriction to flow will of course increase the pressure differential across the fuse element **40**. Since this pressure differential acts on endcap **44**, further compression of the outer fuse will occur. At the same time, movement of endcap **44** towards the washer elements will also cause compression of the inner fuse since endcap **44** is in contact with endcap **46** through means of ridge **50**. Thus, any compression of the outer fuse also reduces the spaces between the layers of the inner fuse thereby rendering it more sensitive to water than it was in its initial condition. The inner fuse, therefore, will not only have a chance to trap the traces of water which may have been transmitted through the outer stack, but by its own further increased restriction to flow, a reduction in the "trigger" time will result. In other words, the interval of time which is necessary to completely stop flow through the fuse assembly will be reduced.

Through use of the construction described, it will be understood that the inner washer element **42** can be assembled in such a manner that it is under (a) the same, (b) lesser, or (c) greater compression than the outer washer element **40** by utilizing the same, fewer, or more washers per unit length than are used in the element **40**. Furthermore, the surfaces of the inner washers can also be identical or different from the washers in the outer

fuse or they can be treated so as to render them more or less hydrophilic or hydrophobic to achieve the degree of sensitivity towards contamination that is desired.

In the course of the development of fuel quality testing devices of the type described, it has been observed that the degree of sensitivity of the fuses to water depends to a great extent on the degree of the dispersion of the water in the fuel. For example, in a typical test in which water is added to the inlet of the pump so that by the time the water reached the fuses it was rather uniformly dispersed in the fuel, it took approximately 28 cc. of water to "trigger" the fuse. (For the particular fuses tested, an increase in the pressure drop to 100 p.s.i. was necessary to "trigger" the fuse.) In repeating this test by adding the water directly to the inlet **12** of the tank **10**, it required almost 1000 cc. of water before the same pressure drop was reached.

Although most of the time the water in fuel is rather well dispersed, it is quite possible to encounter "slugs" or large globules of water which are not dispersed. Accordingly, in order to make certain that all water in the fuel being tested is dispersed, a plurality of relatively small inlet ports **32** are placed in a single row, as shown in FIGURE 2, in order to increase the velocity of fuel flow therethrough to thereby disperse any relatively large globules of water into smaller globules prior to passage of the fuel through the washer-type fuse elements. The plurality of ports art not located over the entire surface of the tube **30**, but are arranged so that most of the fuel, after having passed through the inlet ports **32**, must pass along the surface of the fuse elements before passing therethrough. In so doing, the fuel wets the outer extremities of the washers and will cause the fuse to react more quickly to the presence of water. For very long fuses, a series of parallel rows of holes could be provided in the tube to prevent excessive pressure drop. Furthermore, a similar effect could be provided by utilizing a plurality of holes **52** which are spirally arranged around the outer tube, as shown in FIGURE 3, or by utilizing a plurality of very narrow slots **54** which are suitably arranged around the periphery of the tube.

To obtain the best results, the holes or slots in the fuse tube should be small enough so that the fuel velocity therethrough is increased sufficiently to cause dispersion of any large water globules therein without an undue high pressure drop through the fuse assemblies. As a practical matter, it has been discovered that a maximum of 5 p.s.i. pressure drop through the device is acceptable when the device is initially put into service and a maximum of 10 p.s.i. pressure drop after a satisfactory service life with what is usually considered clean fuel. The number, size, and configuration of the holes per se are not a part of the invention and are pertinent only to the extent that they cause an increase in the velocity of the fuel flowing therethrough.

Although this invention has been described in connection with certain specific embodiments, those acquainted with this art will readily understand that the invention herein set forth is not necessarily limited and restricted to the precise and exact details presented and that various changes and modifications may be resorted to without departing from the spirit of my invention.

Accordingly, applicant does not desire to be limited to the specific details described herein, primarily for purposes of illustration, but instead desires protection falling within the scope of the appended claims.

Having thus described the various features of the invention, what I claim as new and desire to secure by Letters Patent is:

1. A fuse assembly for a contamination sensitive shut-off device used in checking fuel cleanliness by passing fuel therethrough from outside said fuse assembly to inside said fuse assembly comprising a tube, a ferrule located at one end of said tube, said ferrule having an outlet port therein, retaining means located at the other end of said tube, washer-type contamination sensitive means having radially extending pores formed between the washers thereof for permitting flow of fuel therethrough, said washer-type means having one end thereof in abutment with said ferrule and including at least one washer formed of a hygroscopic material adjacent said pores capable of swelling upon contact with water and closing off said pores to thereby prevent further flow therethrough, endcap means for closing off the other end of said contamination sensitive means, spring means confined within said tube between said retaining means and said endcap means for maintaining said contamination sensitive means under compression, and a plurality of relatively small inlet ports located around the periphery of said tube, the number and size of said ports being so constructed as to increase the velocity of fuel flow to thereby disperse any relatively large globules of water into smaller globules prior to passage of said fuel through said washer-type contamination sensitive means, said inlet ports being arranged so that most of the fuel passing therethrough must pass along the surface of said contamination sensitive means before passing through said last named means.

2. A fuse assembly for a contamination sensitive shut-off device as defined in claim **1** wherein said washer-type contamination sensitive means includes first and second concentric washer-type elements and said endcap means includes a first pressure responsive endcap for closing off said first elements and a second pressure responsive endcap for closing off said second element, said first endcap being movably urged towards said first element as a result of the pressure differential between the fluid pressure upstream of said first element acting on one side of said first endcap and fluid pressure downstream of said first element acting on the other side of said first endcap, said second endcap being movably urged towards said second element as a result of the pressure differential between the fluid pressure downstream of said first element acting on one side of said second endcap and fluid pressure downstream of said second element acting on the other side of said second endcap, and means formed on said first endcap for abutting said second endcap whereby movement of said first endcap will cause concomitant movement of said second endcap and compression of said second element, said second endcap being capable of moving independently of said first endcap.

3. A fuse assembly for a contamination sensitive shut-off device used in checking fuel cleanliness by passing fuel therethrough from outside said fuse assembly to inside said fuse assembly comprising a tube having a plurality of inlet ports on the surface thereof, a ferrule located at one end of said tube, said ferrule having an outlet port therein, retaining means located at the other end of said tube, a first washer-type element having radially extending pores formed between the washers thereof for permitting flow of fuel therethrough, a second washer-type element having radially extending pores formed between the washers thereof for permitting flow of fuel therethrough located within and downstream of said first element, said first and second elements each having one end in abutment with said ferrule and each including at least one washer formed of a hygroscopic material adjacent said pores capable of swelling upon contact with water and closing off said pores to thereby prevent further flow therethrough, a first pressure responsive endcap for closing off the other end of said first element, said first endcap being movably urged towards said first element as a result of the pressure differential between the fluid pressure upstream of said first element acting on one side of said first endcap and fluid pressure downstream of said first element acting on the other side of said first endcap, a second pressure responsive endcap for closing off the other end of said second element, said second endcap being movably urged towards said second element as a result of the pressure differential between the fluid pressure downstream of said first element acting

on one side of said second endcap and fluid pressure downstream of said second element acting on the other side of said second endcap, means formed on said first endcap whereby movement of said first endcap will cause concomitant movement of said second endcap and compression of said second element for abutting said second endcap, and a spring confined within said tube between said retaining means and said first endcap.

4. A fuse assembly for a contamination sensitive shut-off device used in checking fuel cleanliness by passing fuel therethrough from outside said fuse assembly to inside said fuse assembly comprising a housing having a plurality of inlet ports on the surface thereof, ferrule-like means located at one end of said housing, said ferrule-like means having an outlet port therein, retaining means located at the other end of said housing, a first layered edge-type element having radially extending pores formed between the layers thereof for permitting flow of fuel therethrough, a second layered edge-type element having radially extending pores formed between the layers thereof for permitting flow of fuel therethrough located within and downstream of said first element, said first and second elements each having one end in abutment with said ferrule-like means and each including a hygroscopic material adjacent said pores capable of swelling upon contact with water and closing off said pores to thereby prevent further flow therethrough, a first pressure responsive endcap for closing off the other end of said first element, said first endcap being movably urged towards said first element as a result of the pressure differential between the fluid pressure upstream of said first element acting on one side of said first endcap and fluid pressure downstream of said first element acting on the other side of said first endcap, a second pressure responsive endcap for closing off the other end of said second element, said second endcap being movably urged towards said second element as a result of the pressure differential between the fluid pressure downstream of said first element acting on one side of said second endcap and fluid pressure downstream of said second element acting on the other side of said second endcap, means formed on said first endcap for abutting said second endcap whereby movement of said first endcap will cause concomitant movement of said second endcap and compression of said second element, and resilient means confined within said housing between said retaining means and said first endcap.

5. A fuse for a contamination sensitive shut-off device used in checking fuel cleanliness comprising at least one washer-type element having radially extending pores formed between the washers thereof for permitting flow of fuel therethrough, said element including at least one washer formed of a hygroscopic material adjacent said pores capable of swelling upon contact with water and closing off said pores to thereby prevent further flow therethrough, a tubular member surrounding said element and located upstream of said element, said tubular member having a plurality of relatively small ports, the number and size of said ports being so constructed as to increase the velocity of fuel flow to thereby disperse any relatively large globules of water into smaller globules prior to passage of said fuel through said washer-type element, said ports being arranged so that most of the fuel passing therethrough must pass along the surface of said washer-type element before passing through the element.

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