ABSTRACT: A differential pressure-responsive signalling device, such as a pressure indicator, and a filter assembly incorporating it, are provided, having locking means for holding the indicator in its actuated position until the indicator is released by the locking means automatically upon the removal of the filter element from its position in the assembly.
DIFFERENTIAL PRESSURE-RESPONSIVE SIGNALLING DEVICE AND A FILTER ASSEMBLY HAVING SAME

This invention is a continuation-in-part of application Ser. No. 812,166, filed Apr. 1, 1966. In fluid systems wherein fluids such as lubricating oil, coolants, or fuel, are passed through a filter to remove contaminants in the fluid, it is frequently desirable to provide a signalling mechanism to indicate when the filter is clogged, or is about to become clogged, so that the filter can be cleaned or replaced before the mechanical components are starved for lack of fluid flow, or the operation of the system is halted.

As the filter becomes obstructed with contaminants, the pressure differential across it increases. Consequently, magnetic indicators and switches which are responsive to a predetermined pressure differential across the filter have been provided, to detect the occurrence of a predetermined pressure differential, and signal in response thereto that the filter is clogged and should be serviced. One such magnetic pressure indicator is shown in U.S. Pat. No. 2,942,572 to Pall. A magnetic switch suitable for such use is shown in U.S. Pat. No. 3,077,854 to Pall.

Devices of the general type shown in these patents employ a magnetic pressure-responsive piston which is exposed to the pressure differential across the filter. In response to the occurrence of a predetermined pressure differential, the piston moves either toward or away from a partition, on the other side of which an indicator button or electrical switch is positioned. The movement of the magnetic piston causes the button to be moved into indicating position or the switch to be actuated, either by magnetic force directly, or by a mechanical linkage which is actuated by movement of the magnetic piston and actuates a switch or button mounted into a position in which it is visible, or the switch contacts are closed, actuating a signal, such as a light or buzzer, which signals that the filter is, or is about to become, clogged. Devices of this type have been widely used, and have proven in general to operate which provides satisfactorily.

Difficulties have arisen, however, due to the fact that in many instances it is possible for the signalling device to be reset without the filter element being replaced. For example, filter assemblies having indicators of the type described above are often used on aircraft. If during flight the filter element becomes clogged, the indicator is actuated and fluid is normally bypassed either completely around the filter element, or through a reserve filter which provides only coarse filtration. When the filter element is clogged, the magnetic pressure-responsive device does not function, because the pressure-sensitive elements in the filter assemblies, and the following discussion of the invention is particularly directed to such assembly.

This invention provides a differential pressure-responsive signalling device and a filter assembly having such a device in which the signalling device can only be reset if the filter element is removed from its position and in which resetting occurs automatically upon removal of the filter element from its position in the housing. Thus, the indicator cannot be inadvertently reset unless the filter assembly is serviced first, and it is not possible to inadvertently leave the indicator locked in its actuated position if the filter has been serviced.

The differential pressure-responsive signalling device of the invention comprises, in combination, a housing having first and second fluid passages therein communicating with opposite sides of a removable fluid-permeable means, such as a filter, any blocking of which increases the pressure differential between the passages; differential pressure-responsive signalling means movably mounted in the housing in a position to sense a pressure differential across the fluid permeable means between the first and second passages and adapted to move in indicating response to a predetermined pressure differential therewith; and reciprocable locking means operatively associated with the signalling means and movable between first and second positions, in the first position engaging and retaining the signalling means in an indicating position, and in the second position releasing the signalling means to return a nonindicating position, said locking means being responsive to movement of the fluid permeable means from its position to release the signalling means.

The differential pressure-responsive signalling device of the invention can be a differential pressure switch, a differential pressure indicator, a differential pressure gauge or the like which, when actuated, signals, or informs the operator that locking means are normally provided in the signalling device for connecting the signalling device with the upstream and downstream sides of the fluid permeable component with which the pressure-responsive signalling device is to be used.

The pressure-responsive signalling device normally has a pressure-responsive means such as a diaphragm, or a piston, which moves in response to a change in fluid pressure between the two lines either to directly signal, or cause actuation of a signalling mechanism, indicating that the pressure differential across the fluid permeable means exceeds a predetermined amount. The signalling mechanism, which can be a pushup indicator button, a switch, a dial arm, or the like, can be actuated magnetically, mechanically, or electrically. Typical pressure-responsive devices are examples of the pressure-responsive devices contemplated by the instant invention are shown in U.S. Pat. Nos. 2,942,572, to Pall; 3,077,176 to Pall et al.; 3,077,854 to Pall; 3,212,471 to Willis; 3,011,470 to Stoermer; 2,948,151 to Astl; 2,843,077 to Leefer; 2,824,186 to Binford and 2,803,718 to Bloom et al. Pressure-responsive signalling devices employing magnets or magnetically attracted pistons as the pressure-movable mechanisms such as shown in U.S. Pat. No. 2,942,572 are preferred.

In all of the pressure-responsive signalling devices referred to above and contemplated by the invention in order for the signalling mechanism to be reset, the piston, diaphragm or the like must be moved back into its normal position. The instant invention takes advantage of this fact and provides a reciprocable locking means which is responsive to the movement of the piston or diaphragm, so as to engage and lock the piston or diaphragm in position until the fluid permeable means is moved from its position whereupon the locking means releases the piston or diaphragm so that the signalling mechanism can be reset. Release of the piston or diaphragm in accordance with this invention occurs upon removal of the fluid permeable means from its position in its housing as will be explained below.

The instant invention is particularly suited for use with the filter elements in filter assemblies, and the following discussion of the invention is particularly directed to such assembly.
3,591,003

3. The differential pressure-responsive signalling device of the invention can be used with any fluid permeable means such as valves and particularly servo valves, which in the course of use become obstructed or worn and must be removed for servicing.

As noted, however, the invention is particularly directed to filter assemblies and also provides a novel filter assembly. The filter assembly of the invention comprises, in combination, a housing having an inlet, an outlet, a filter element therein in a position in the line of flow from the inlet to the outlet such that flow from the inlet to the outlet passes through the filter element. The outlet signals different pressure-responsive device disposed communicatively with the upstream and downstream sides of the filter element so as to be exposed to the pressure differential across the filter and signal whenever the pressure differential across the filter exceeds a predetermined maximum and locking means operatively associated with the differential pressure-responsive device and movable between first and second positions so as to retain the device in signalling position when in its first position, and release the device when in its second position, said locking means operatively engaging the filter element and being responsive to the removal of the filter element from its position in the chamber so as to move its second position and release said signalling device.

The filter assembly of the invention as noted above has a housing defining an inlet and an outlet and a filter disposed therein across the line of flow between the inlet and the outlet. The filter element which can be accessible via an end plate or a cover on the housing. The filter can also be disposed in a demountable portion of the housing such as a bowl which is threadably or otherwise detachably mounted on a head portion in which the inlet and outlet are formed. The filter element is mounted in the housing in a position across the line of flow from the inlet to the outlet such that flow from the inlet to the outlet passes through the filter element. The filter element is preferably cylindrical but can be conical or dished, or a plate type filter, or can have any other desired configuration. The filter element preferably has support means such as end caps and a core or other backup support. Filter elements or cartridges of this type are well known. Typical filters of this type are shown in U.S. Pat. Nos. 3,354,012 to Foreman et al. and 3,327,886 to Pall et al.

The filter can be made from any known filter medium such as woven wire mesh made of stainless steel or other metallic wires. Fibrous filter materials such as fiberglass, asbestos, and resin impregnated and/or coated filter materials are also suitable. A particularly suitable filter medium disclosed in U.S. Pat. Nos. 3,049,796, 3,238,056, 3,241,681, 3,246,767 and 3,327,886. Sealing members such as gaskets are normally provided between the housing and the filter element so that flow cannot leak past the filter element. It is possible, if desired, as is known to those skilled in the art, to provide a bypass passage in the housing, a pressure relief valve normally closing off the passage, and a reserve filter element positioned such that when a predetermined pressure differential across the primary filter is reached, and the relief valve opens, flow bypasses the primary filter element and proceeds through the reserve filter to the outlet. Filter elements having such a bypass passage and reserve filter are shown in U.S. Pat. Nos. 3,283,902 and 3,262,563.

The locking means as noted above is reciprocably moveable between first and second positions so as to engage and retain the signalling mechanism in indicating position in its first position until the fluid permeable means e.g., the filter element, is moved from its position for servicing, whereupon the locking means automatically moves from its first position to its second position freeing the signalling mechanism.

In case of a filter assembly, the locking means extends within the filter assembly housing into the chamber in which the filter element is located so as to contact, abut, or otherwise operatively engage the filter element. The locking means can have a mechanical linkage which connects the locking means to the filter element so that when the filter element is removed, the locking mechanism is released. The locking means can have a rodlike linkage which extends through a wall of the chamber to the filter element, and is aligned such that it engages the end cap of the filter element and is biased by a spring or other bias means against the filter. When the filter element is then moved from its position, the linkage is moved by the spring and the movement of the linkage releases the locking mechanism thereby releasing the piston or diaphragm of the pressure-responsive device. A mechanical rod-type linkage as described above is not necessary however. The locking mechanism can comprise a detent or catch structure which engages or is otherwise operatively associated with the pressure-movable portion of the indicator or switch and which directly engages the filter element.

The filter element itself or its support structure can be provided with a portion of the locking means. For example, the filter end cap can be formed with a recess or groove in which a detent is captured as will be described more particularly below.

The locking mechanism can have one or more components. For example, if the locking mechanism has two components one can be attached to or associated with a moving portion of the pressure-responsive signalling device, the other can be associated with the filter element either directly or through a linkage as described above. These two elements together define the locking means which is another movably portion of the pressure-responsive device in a signalling position. For example, one of the elements of the locking mechanism can be a detent such as ball detent, a pawl or lug, and the other can be a recess, groove or other mating retainer which engages the detent so as to retain it until it is automatically released by movement of the filter.

Any type of fasteners employing members such as ball detents, dogs, ratchets, keys, lugs, clamps, couplings, and catches, which cooperate with mating surface, recesses, apertures, grooves and like retainers, all are suitable. Easily releasable fasteners are preferred. Those skilled in the art will be able to apply any such fasteners in the practice of this invention hereafter.

The automatic reciprocable movement and release of the locking means is preferably accomplished by a bias means such as a spring or a resilient member which moves a component of the fastener of a linkage associated therewith in the second position which permits the pressure-responsive mechanism to return to its nonactuated position. However, it is not necessary for the movement of the locking means which releases the pressure-responsive mechanism to be spring actuated. In fact, it is possible for such movement to be opposed by a spring and accomplished by manually overriding the force of a spring for example, by forcing or camming a spring loaded detent open in moving the filter from its position. An embodiment employing a construction of this type will be described hereinafter.

It is preferred that the signalling device be self-resetting so that as soon as the locking mechanism releases the signalling mechanism the signalling device automatically returns to its unactuated position. However, it is also possible for the signalling device to be of the type in which a further manual step is required after the locking mechanism is released for reset to be accomplished. For example in the type of indicator shown in U.S. Pat. No. 2,942,522, after the locking mechanism releases the movable piston and it moves back into its nonindicating position, if the indicator is not self-resetting, the indicator button must be manually moved back into its nonindicating position. Further features of the invention will be apparent from the following drawings in which:

FIG. 1 is a view in cross section of a filter assembly in accordance with the invention,

FIG. 2 is an enlarged view of a portion of FIG. 1 but shows the locking and indicating mechanism in actuated position,

FIG. 3 is a side view, partially broken away and partially in section of another embodiment of the invention, and
FIG. 4 is a cross sectional view taken along the line 4-4 of FIG. 3. The filter assembly shown in FIGS. 1 and 2 is composed of a housing 3 having a head 5 and a bowl 7. The head 5 has an inlet 8 and an outlet 9 which communicate with the bowl 7 via passages 8a, and 9a, in the head 5. A filter element 10 is mounted in the bowl.

A pressure relief valve 19 is provided in the head 5. This relief valve is positioned across a passage (not shown) which connects the inlet 8 and outlet 9. The relief valve closes off this passage and permits fluid to bypass the filter element when a predetermined pressure differential across the filter is exceeded.

The filter element 10 is composed of a corrugated stainless steel wire mesh filter material 11 formed into a cylindrical shape and supported on the downstream side thereof by an apertured cylindrical core 12. The filter element has stainless steel end caps 14a and 14b on the upper and lower ends thereof respectively the end caps close off the ends of the filter to prevent fluid from bypassing the filter and to support the filter element in the housing. The end caps are welded to the filter material so as to prevent leakage. The upper end cap 14a is formed with a flange 16, the upper end of which abuts a shoulder 17 in the head portion of the housing to axially position the filter in the housing. The shoulder 17 is formed on an annular projection 18 in the head 5 which communicates with the outlet 9 via the passage 9a. An O-ring 20 is captured between the flange 16 and the dependent portion 18 of the housing to form a seal therebetween to prevent leakage of fluid past the filter. The bottom of the filter element 10 is sealed against leakage at the bottom of the bowl by an annular gasket 22 positioned between the bottom of the bowl and the end cap of the filter element.

A differential pressure indicator assembly 25 is threadably mounted in the bottom end of the bowl and is sealed therein against leakage by an O-ring 26. In FIG. 1 the indicator assembly is shown in its unactuated position. In FIG. 2 the indicator assembly is shown in greater detail in its actuated position. The structure of the indicator is of the same general type as shown in U.S. Pat. No. 2,942,572 and comprises a housing 28 having two noncommunicating portions separated by a wall 30. A magnetic indicating button assembly 31 is mounted in the portion of the housing on the exterior side of the partition. This assembly 31 comprises a magnet 32 supported in a cap 33 which is spring biased away from the partition 30 by a coil compression spring 35. The magnet 32 is slidably mounted in a cylinder 36 formed in the exterior side of the wall 30 and is movable toward and away from the wall. The button assembly is retained in the housing by a flange or lip 34 on the housing which engages a shoulder 34a on the cap 33. On the opposite side of the wall from the indicating button assembly 31 a magnetic piston assembly 27 is provided. This magnetic piston assembly comprises a piston 37 which carries a magnet 37a. The piston is slidably mounted in a generally cylindrical chamber 38 for movement toward and away from the wall. The piston is biased under normal conditions against the wall 30 by a coil compression spring 40. The compression spring is held in position by a retainer member 41 threadably mounted on the end of the indicator housing. Communication between the upstream and downstream sides of the piston is prevented by an O-ring 39 which forms a seal against the wall of chamber 38. The upstream side of the piston communicates with the upstream side of the filter via a small bore 42 formed in the indicator housing and a bore 43 formed in the bottom of the bowl. The piston assembly 27 is exposed on its downstream side to the interior of the core 12 and it is thus exposed to the pressure on the downstream side of the filter element.

The piston assembly 27 has a shaft 44 extending therefrom on the downstream side toward the interior of the core. On the end of the shaft 44 a detent assembly 45 is located. The detent assembly comprises a housing 46 having a bore 47 therethrough. Two ball detents 48 are mounted in the bore at opposite ends of the bore 47. The ball detents 48 are restrained in the bore by lips 49 formed on the housing at the ends of the bore 47. A compression spring 49 is mounted within the bore between the ball detents 48. This compression spring 49 tends to force the ball detents 48 together, thereby aligning the piston in the bore. Lower end cap 14b, of the filter element is formed with retaining member 15 which is generally annular in shape and which cooperates with the detent assembly 45. The annular retainer 15 defines a central passage through which the detent assembly moves when the piston assembly 27 of the indicator moves away from the wall 30. The retainer member 15 has a recess 15a formed therein and a guide surface 15b against which the balls 48 rest when the indicator piston is in its normal position against the wall 30. This positioning of the detent assembly is best seen by reference to FIG. 1.

The operation of the assembly is as follows: Under normal conditions fluid enters the inlet port 8, passes through the filter element 10 and leaves the assembly via the outlet 9. In times, as the filter element becomes clogged with contaminants, the pressure differential thereacross increases. When the pressure differential across the filter exceeds a predetermined maximum value, the relief valve 19 opens, permitting fluid to bypass the primary filter element. Actuation of the indicator also occurs when this predetermine pressure differential is reached. At this pressure differential, a force on the piston sufficient to overcome the spring 49 is exerted due to the high pressure, and the piston moves away from the wall. As the piston moves away from the wall, the magnetic force holding the indicating button 31 adjacent the wall against the force of the spring 35 diminishes, and when it falls below the force exerted by the spring 35, the indicating button is then moved into indicating position. As the magnetic piston assembly 27 moves away from the wall the ball detents 48 which normally rest against the guide surfaces 15b are positioned between the bottom of the bowl and the end cap of the filter element.

When a clean filter is placed in position in the housing against the annular gasket 22 the ball detents 48 engage the guide surfaces 15b under the force of the spring 49 in the position shown in FIG. 1. Another embodiment of the invention is shown in FIGS. 3 and 4. The filter assembly 50 includes a housing 51. The housing has an inlet 68 and outlet 69. A wall 57 defines a cylindrical chamber in which is placed a primary filter element 52, and a concentrically positioned reserve filter 53. A bottom plate 54 closes off the bottom of the chamber. The filter elements are supported in the chamber by a support piece 56 held against the bottom plate 54 by a snap ring 58.

The reserve filter 53 is mounted within a canister 59 having an annular cap 60 at one end thereof and a support ring 61 at the other end thereof. The support ring 61 rests against the support piece 56 on the end plate 54. The canister has an exterior shoulder 62, which rests against the bottom end cap 55 so as to which the bottom end of the primary filter element 53. The upper end of the primary filter is closed off by upper end cap 55. The upper end cap 55 has a flange 55a which captures an O-ring 55b. The O-ring 55b seals against a shoulder 64 on the housing so as to prevent fluid from bypassing the filter 52 at the upper end thereof. The bottom end cap 55 of the filter also...
has an O-ring captured by a flange. The bottom O-ring seals against the wall of the canister 59 adjacent to the shoulder 62. The rings on the canister seats against and support a bimetallic canister cap 66 mounted on the bottom end of the reserve filter element. A spring 65, captured between a flange on the annular cap 60 of the canister and a retainer ring 66 mounted in the interior of the reserve filter element, forces the end cap 63 of the reserve filter against the ring 61. A spring-biased relief valve assembly 70 prevents fluid from passing through the center of the reserve filter. Then the bottom O-ring 55a in combination with the canister 59, the ring 61, and the valve 70 prevents fluid from passing the filter element 52 at the bottom end thereof. 

The spring normally holds the end cap 63 in a fluid tight seal against the ring 61 but the filter element 53 is reciprocally movable in the canister 59 such that when the primary filter becomes clogged, however, the pressure differential acting on the end cap 63 of the reserve filter 53 creates a force sufficient to overcome the force of the spring 65. The reserve filter then moves away from the ring 61 so that fluid can pass between the ring 61 and the end cap 63, and pass through the reserve filter to the outlet. If both the primary and reserve filters become clogged the valve 70 opens, permitting fluid to pass directly to the outlet.

Against the filter element by a spring 168, which is held in position by a cap, threadedly mounted in the bore 170. The operation of the magnetic switch and the detent assembly is as follows: When the primary filter element becomes clogged with contaminants, the pressure differential between the ports 112 and 122 increases. It eventually reaches the predetermined threshold at which the magnetic piston assembly 110 is moved away from the partition 105. When the magnetic piston moves away from the partition, the spring 114 forces the L-shaped lever arm 115 away from the partition, actuating the switch and signalling that the primary filter is clogged. At the same time, the shaft 151 carried on the magnetic piston assembly 110 slides through the passage 156. When the piston has moved far enough, so that the retainer cap moves past the spring-loaded tab 159, the tab on the de
tent assembly moves toward the shaft, and engages the bottom of the retainer cap on the shaft 151, thus locking the magnetic piston assembly 110 away from the partition 105.

The movement of the detent assembly toward the shaft moves cam follower 161 therewith into position abutting the cam surface 162 on the shaft. The switch 115 will remain actuated until the piston is forced away from the partition 105 and restored to its normal position against the partition. The detent assembly releases the piston when the filter element is replaced. When the primary filter element is removed, since the shaft 164 no longer rests against the end cap 55, the spring 168 forces the shaft 164 inwardly into the chamber previously occupied by the primary filter element. The cam surface on the shaft 162 engages the cam follower 161, and forces the cam follower and the detent assembly therewith back against the force of the spring 160 into its original position. The tab 159 is then clear of the retainer cap 154, and the spring 107 moves the piston assembly and the shaft 151 back through the passage 156 until the piston is against the partition 105. The tab 159 then once again rests against the retainer cap. When the primary filter is replaced, the spring-loaded shaft 164 is moved back into its original position, clear of the cam follower on the detent assembly.

In order to prevent operation of the reset loading assembly, as a result of a high pressure differential, caused for example by the high viscosity of the fluid due to its low temperature rather than by clogging of the primary filter, a thermal lockout is provided. This comprises an L-shaped bimetallic strip 175, shown in dotted lines in FIG. 4. When the fluid in the assembly is cold, the strip moves into position so as to engage the cam follower 161, to prevent the detent mechanism from trapping the piston when it moves away from the partition. Thus, although the switch may actuate when the fluid in the system is cold, it will not be necessary to disassemble the filter assembly to reset the indicator when the switch is actuated, due
to the low temperature of the fluid in the system, rather than clogging of the filter.

I claim:

1. A differential pressure-responsive signalling device comprising, in combination, a housing having first and second fluid passages therein communicating with opposite sides of a removable fluid permeable means any blocking of which increases the pressure differential between the passages; differential pressure-responsive signalling means movably mounted in the housing in a position to sense a pressure differential across the fluid permeable means between the first and second passages and adapted to move in indicating response to a predetermined pressure differential therebetween; and retaining means operatively associated with the signalling means and movable between first and second positions in the first position engaging and retaining the signalling means in an indicating position, and in the second position releasing the signalling means to return to a nonindicating position, said locking means being responsive to movement of the fluid permeable means from its position to release the signalling means.

2. A differential pressure-responsive signalling device in accordance with claim 1, in which the locking means comprises detent means operative associated with the signalling means, and linkage means operatively connecting the detent means with the fluid permeable means.

3. A differential pressure-responsive signalling device in accordance with claim 1, in which the locking means is spring-biased against the fluid permeable means.

4. A differential pressure-responsive signalling device in accordance with claim 1, in which the signalling means has a shaft extending therefrom and in which the locking means is associated with the shaft.

5. A differential pressure-responsive signalling device in accordance with claim 1, in which the locking means comprises a retainer cap on the shaft and a catch means mounted in the housing for engaging the cap so as to retain the shaft.

6. A differential pressure-responsive signalling device in accordance with claim 4, in which the locking means includes a spring loaded detent means mounted on the shaft.

7. A differential pressure-responsive signalling device in accordance with claim 1, in which the differential pressure-responsive signalling device comprises a magnetic pressure indicator.

8. A differential pressure-responsive signalling device in accordance with claim 1, in which the pressure-responsive signalling device comprises a magnetic pressure switch.

9. A filter assembly comprising, in combination, a housing, having an inlet and an outlet, and a chamber communicating with said inlet and adapted therein in position in the line of flow of the fluid to the outlet such that flow from the inlet to the outlet passes through the filter element; differential pressure-responsive signalling device associated with the housing and communicating with the upstream and downstream sides of the filter element so as to be exposed to a pressure differential thereacross and signal whenever the differential pressure across the filter exceeds a predetermined amount; and locking means operatively associated with the differential responsive signalling device and being reciprocably movable between first and second positions so as to engage at least a portion of said device and retain said device in signalling position when in its first position and release the device when in its second position, said locking means extending into the chamber in a position to operatively engage the filter element, and being responsive to the removal of the filter element from its position in the chamber so as to move to its second position and release said signalling device.

10. A filter assembly in accordance with claim 9, in which the housing has a head and bowl portion and in which the filter element is cylindrical and mounted in the bowl portion.

11. A filter assembly in accordance with claim 9, in which the locking means comprises detent means, and retaining means adapted to engage and hold the detent means, and in which one of said detent and retaining means is carried on a movable portion of the differential pressure-responsive signalling device, and the other is associated with the filter element.

12. A filter assembly in accordance with claim 11, in which the means associated with the filter element comprises a retainer formed on an end cap of the filter.

13. A filter assembly in accordance with claim 11, in which the means associated with the filter element is associated therewith by means of a mechanical linkage mechanism.

14. A filter assembly in accordance with claim 9, in which the signalling means is a differential pressure indicator.

15. A filter assembly in accordance with claim 9, in which the signalling device is a switch.

16. A filter assembly in accordance with claim 14, in which the differential pressure indicator comprises a housing divided into two noncommunicating portions by a partition, a magnetic pressure-responsive piston assembly movably mounted in the housing on a side of the partition which communicates with the filter element, and said piston assembly being movable towards and away from the partition, and a magnetic indicating assembly mounted on the opposite side of the partition.

17. A filter assembly in accordance with claim 9, including thermally responsive means for engaging the locking means and preventing it from retaining the signalling device in its signalling position whenever a temperature is below a predetermined minimum.

18. A filter assembly in accordance with claim 9, in which the filter assembly has a relief valve for bypassing flow passed the filter element.

19. A filter assembly in accordance with claim 18, including a reserve filter element mounted in the housing in a position so as to receive flow from the inlet when the relief valve opens.

20. A filter assembly, comprising, in combination, a housing having an inlet and an outlet, a chamber in the housing communicating with the inlet and outlet; a filter element; a spring loaded catch, and a spring loaded retainer mounted in the chamber in a position such that flow from the inlet to the outlet passes through the filter element; a magnetic differential pressure signalling device associated with the housing in a manner so as to be exposed to the pressure differential across the filter element; bias means; and a spring loaded catch means holding the piston in a first position; signal means on the opposite side of the partition from the piston movable toward and away from the partition in response to movement of the magnetic piston on the opposite side of the partition from its first to its second positions to signal that a predetermined pressure differential across the filter element exists; detent means mounted for movement with the magnetic piston assembly; retaining means operatively associated with the filter element and positioned to engage and retain the detent means when the piston is in its second position, said retaining means being responsive to the removal of the filter from its position in the housing so as to release the detent means whereby the retainer holds the magnetic piston in said second position until it is released by movement of the filter element.

21. A filter assembly in accordance with claim 20 in which the detent means comprises a retainer cap on the end of a shaft extending from the piston.

22. A filter assembly in accordance with claim 20, in which the detent means comprises a spring loaded detent mounted on an extending portion of the piston.

23. A filter assembly in accordance with claim 20, in which the retainer is formed on an end cap of the filter element.

24. A filter assembly in accordance with claim 20, in which the retainer comprises a spring loaded catch, and a spring
loaded linkage means extending into the housing in a position to engage the filter element such that when the filter element is moved from its position in the housing the spring loaded linkage releases the catch means.

25. A filter assembly in accordance with claim 24, including a cam surface on the linkage for releasing the spring loaded catch.