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(56) Documents cited  
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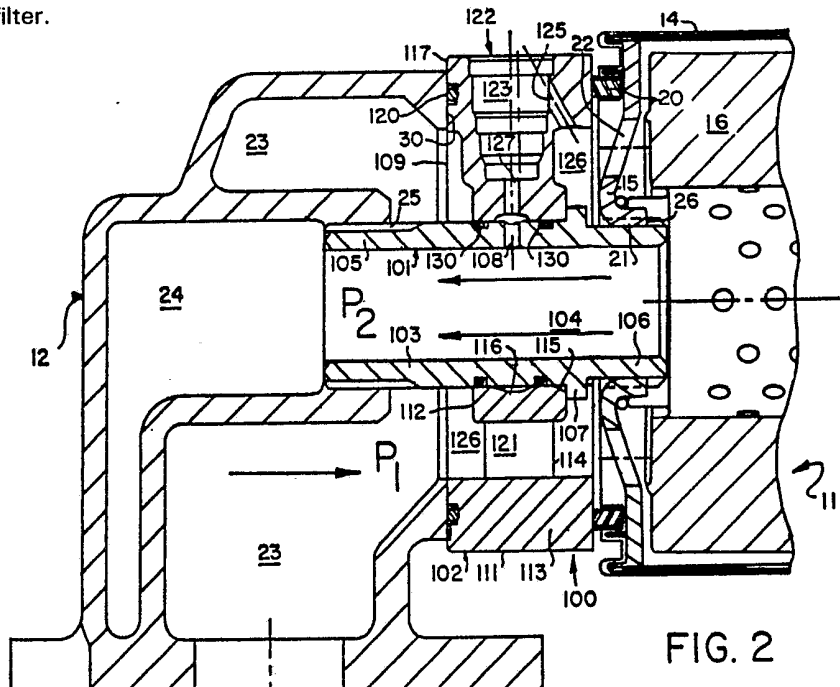
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(54) Adapter assembly for filter arrangement

(57) An adapter assembly (100) for a conventional fluid system having a filter unit (14) mounted to a filter pad (12) includes passages (108), (125) whereby the pressure differential across the filter element to be conveniently measured by a differential pressure detector. The assembly includes a fitting (122) for connecting the differential pressure detector to the adapter assembly. The adapter assembly includes at least one aperture (121) which allows fluid to flow between the inlet chamber (23) of the filter pad and the inlet of the filter unit and another aperture (104) which allows fluid to flow between the outlet of the filter unit and the outlet chamber (24) of the filter pad. In another embodiment the axis of fitting (122) is parallel with that of the filter.



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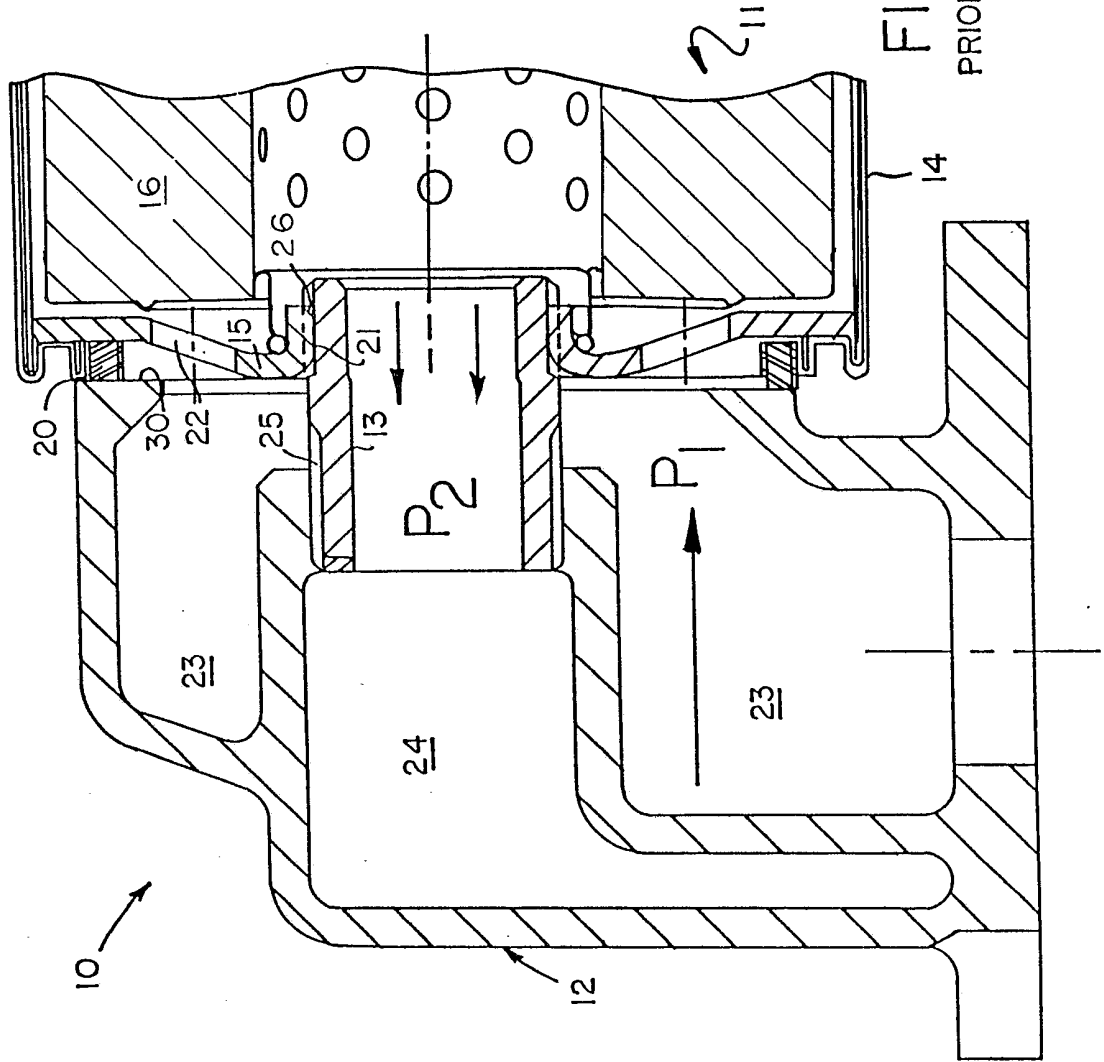


FIG. 1  
PRIOR ART

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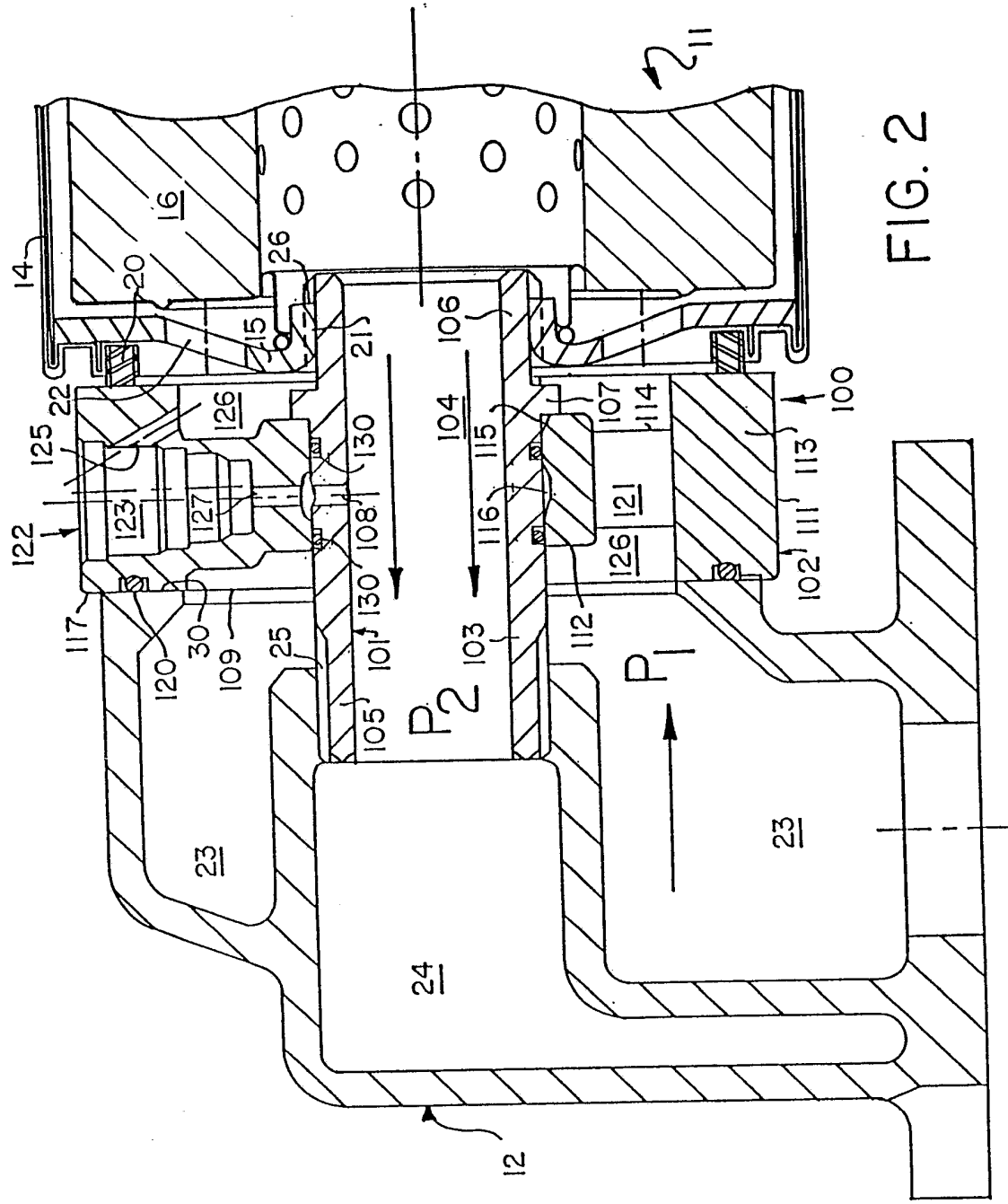


FIG. 2

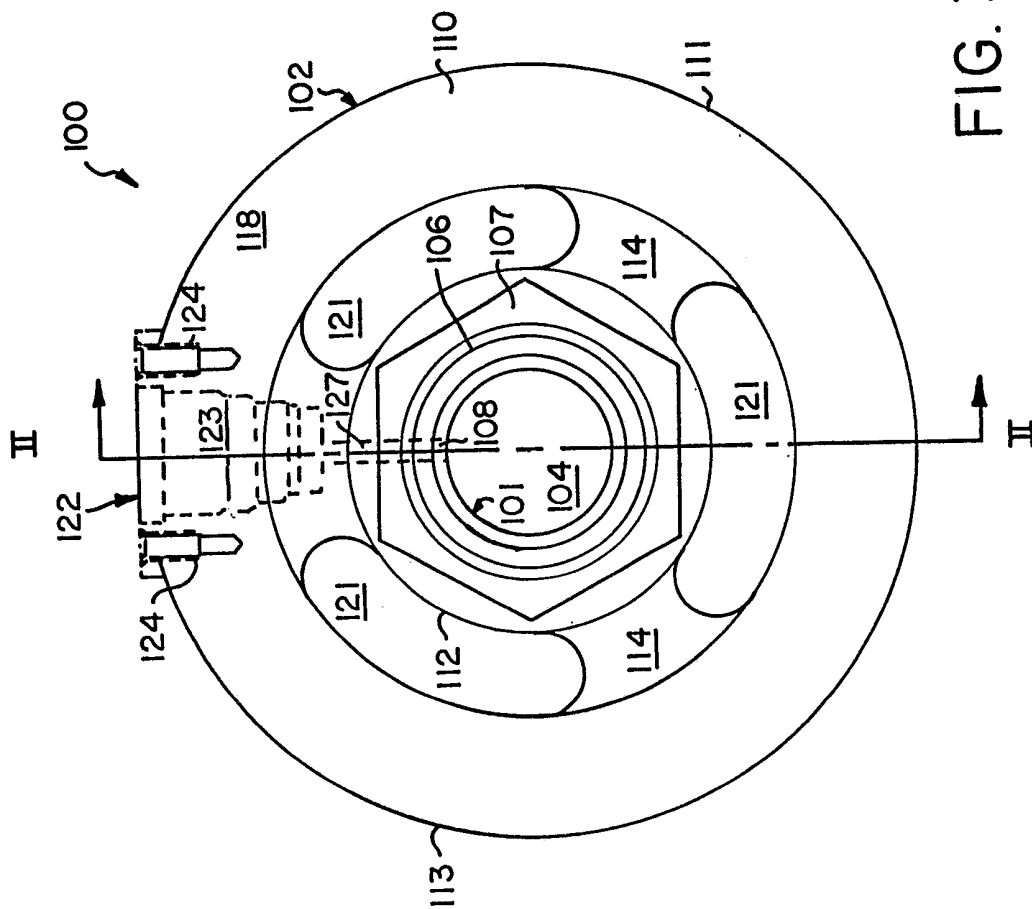


FIG. 3

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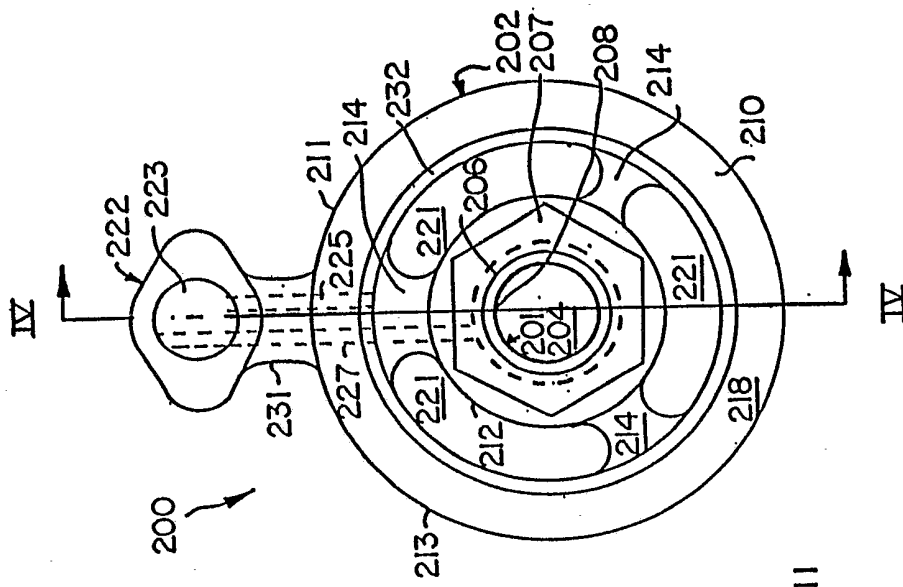


FIG. 5

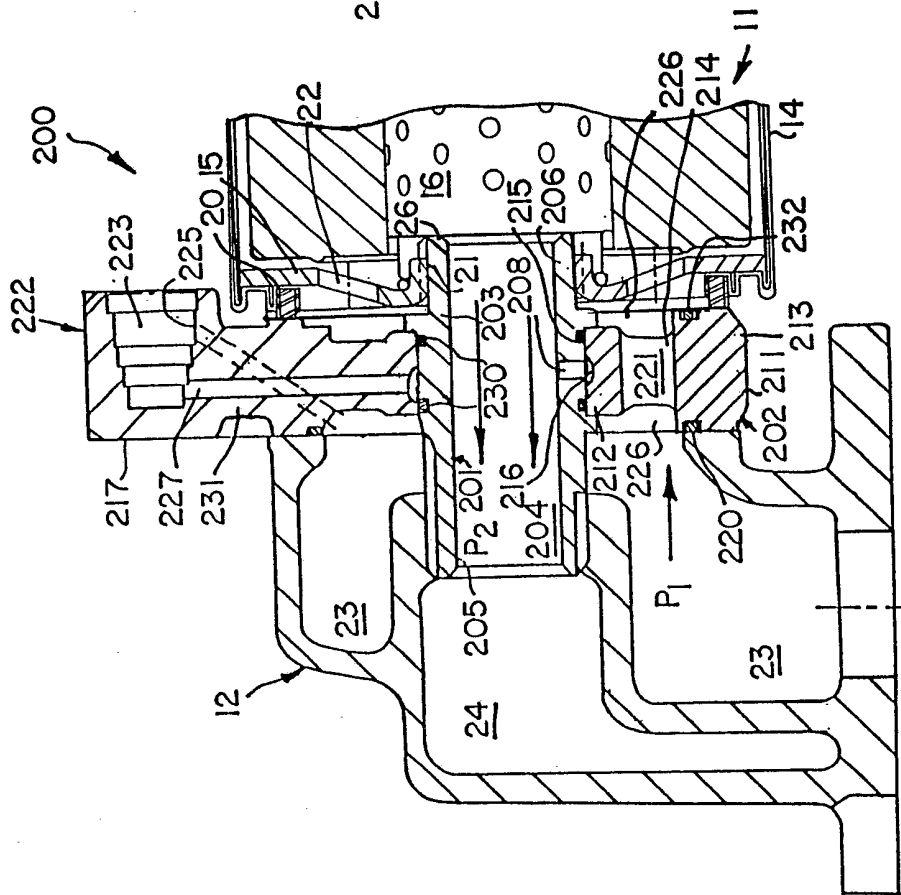


FIG. 4

## SPECIFICATION

### Adapter assembly for filter arrangement

5 The present invention relates to the measurement of pressure differential across filters in fluid systems and, in particular, to the measurement of the pressure differential across the filter element of a spin-on type filter  
 10 mounted on a filter pad, such as frequently utilized in fuel supply, hydraulic, and lubrication systems.

Engine oil lubrication systems, which are typical of many fluid systems, frequently utilize  
 15 a spin-on type filter unit which is mounted on a filter pad and which includes a filter element to remove potentially damaging particles from the oil. Mechanical wear within the engine, the outside environment, and contaminants introduced accidentally during normal servicing are  
 20 sources of particles which may plug lubricating nozzles, severely damage parts, and create excessive wear on any surfaces relying on a thin film of lubricating oil for protection.

25 These systems typically utilize a pump to force oil to circulate through the filter pad and spin-on filter unit assembly and then to the moving parts of the engine for lubrication. Oil is forced through the filter element due to a  
 30 difference in oil pressure, i.e., a pressure differential, between the upstream and downstream sides of the filter element, the pressure on the upstream side being greater than the pressure on the downstream side.

35 Over time, as the spin-on filter unit performs its filtering function, the filter element of the spin-on filter unit becomes plugged by particles removed from the lubricating oil. As the  
 40 amount of material filtered from the lubricating oil and retained by the filter element increases, a greater pressure differential across the filter element is required to pump sufficient fluid through the filter element. The amount of lubricating oil which will pass through the filter  
 45 element at the maximum pumping pressure will decrease until flow is insufficient to maintain proper lubrication of the engine. To prevent that occurrence, many lubrication systems include a pressure-sensitive bypass valve  
 50 which will open when the pressure differential across the filter element approaches that corresponding to the maximum pumping pressure, allowing oil to bypass the filter element. This ensures that lubricating oil will continue  
 55 to reach the moving parts of the engine but eliminates, at least in part, the filtering function.

Thus, to ensure that sufficient filtered oil continues to reach the moving parts of the  
 60 engine, filter units must be replaced before they become so clogged as to cause the bypass valve to open. As few lubrication systems are equipped to monitor the pressure differential across the filter element to determine when the filter unit should be replaced,  
 65

70 the spin-on filter units are replaced at regular intervals of operation. Although the rates at which a filter element becomes blocked will vary greatly depending upon operating conditions for the engine, the filter unit replacement interval must be selected to be the shortest probable time in which excessive blockage may occur to ensure continuous proper lubrication system function. This results in the frequent disposal of filter units before their filtering capacity has been fully utilized, resulting in higher operational costs.

75 Some lubrication systems utilizing spin-on filter units include a pressure detector which senses the pressure only on the high pressure side, i.e., the upstream side, of the filter. The detector may be used to operate a filter blockage warning light when the upstream pressure becomes greater than a predetermined amount, e.g., approaches maximum  
 80 pumping pressure. However, the pressure on the upstream side of the filter element is dependent on the overall lubrication system pressure and cumulative pressure drop through the system and is not necessarily indicative of the filter condition. Thus, such a detector may result in a false indication of the need to replace a filter element if the system becomes blocked downstream of the filter unit.

85 Few new engines have lubrication systems equipped with a pressure differential monitor because of the expense of providing instrumentation to measure pressure on both the upstream and downstream sides of the filter  
 90 element and determine the difference between the two. The difficulty of accommodating such a monitoring system within the confines of the lubrication systems is also an important factor. Retrofit of existing engines to provide for  
 95 monitoring of the differential pressure across the filter element of the lubrication system is particularly difficult if pressure-sensing devices must be installed within the crankcase together with leads for appropriate instrumentation.  
 100

105 It is an object of the invention to provide for monitoring of the pressure differential across the filter element of a spin-on filter unit. Further, it is an object of the invention to provide for monitoring of the differential pressure across the filter element of existing systems, such as internal combustion engines, utilizing spin-on filter units mounted on filter pads which have been fabricated with no  
 110 contemplation of providing for such monitoring capability.

Accordingly, the invention provides an adapter assembly for a conventional fluid system having a filter unit mounted to a filter pad.

115 The filter unit typically includes a fluid inlet, a fluid outlet, and a filter element positioned in the fluid flow path between the inlet and the outlet. The filter pad typically includes an inlet fluid chamber which communicates with the  
 120 inlet of the filter unit and an outlet fluid cham-

ber which communicates with the outlet of the filter unit.

In accordance with the invention, the adapter assembly allows the pressure differential across the filter element to be conveniently measured by a differential pressure detector. The adapter assembly generally comprises an adapter plate, means for sealingly attaching the adapter plate to the filter pad, means for sealingly attaching the filter unit to the adapter plate, and means for connecting the differential pressure detector to the adapter plate. The adapter plate includes at least one aperture which allows fluid to communicate between the inlet chamber of the filter pad and the inlet of the filter unit and another aperture which allows fluid to communicate between the outlet of the filter unit and the outlet chamber of the filter pad. In addition, the adapter assembly comprises means for channeling fluid which flows between the inlet chamber of the filter pad and the inlet of the filter unit to the detector connecting means and means for channeling fluid which flows between the outlet of the filter unit and the outlet chamber of the filter pad to the detector connecting means.

The present invention is also directed to an adaptor assembly for a fluid system including a spin-on filter unit which has a base with a fluid inlet and a fluid outlet and a filter element disposed in the fluid flow path between the inlet and the outlet and which is attachable to a filter pad having an inlet chamber and an outlet chamber. The adapter assembly allows detection of differential pressure across the filter element by a differential pressure detector. The adaptor assembly comprises: an adapter plate having a first side formed to sealingly engage the filter pad, a second side formed to sealingly engage the base of the filter unit, and an aperture to allow fluid to flow from the inlet chamber of the filter pad to the inlet of the filter unit; a hub mounted to the adapter plate and including means for attaching the hub to the filter pad, means for retaining the first side of the adapter plate in sealed engagement with the filter pad, means for retaining the base of the filter unit in sealed engagement with the second side of the adapter plate, and a fluid channel to allow fluid to flow from the outlet of the filter unit to the outlet chamber of the filter pad; means for connecting a differential pressure detector to the adapter plate; a first fluid passage means for communicating fluid flowing through the aperture in the adapter plate to the detector connecting means; and a second fluid passage means for communicating fluid flowing through the channel in the hub to the detector connecting means.

Another aspect of the invention is directed to an adapter assembly for a fluid system including a spin-on filter unit which has a base with an inlet and an outlet and a filter element

disposed in the fluid flow path between the inlet and the outlet and which is attachable to a filter pad having an inlet chamber and an outlet chamber. The adapter assembly allows detection of the pressure differential across the filter element by a differential pressure detector. The adapter assembly comprises: an adapter plate including a first side formed to sealingly engage the filter pad, a second side formed to sealingly engage the base of the filter unit, a central orifice, an aperture spaced from the central orifice to allow fluid to flow from the inlet chamber of the filter pad into the inlet of the filter unit, a fitting including a detector orifice for receiving the differential pressure detector, a first fluid passage extending from the detector orifice to fluid flowing between the inlet chamber of the filter pad and the inlet of the filter unit, and a second fluid passage extending from the detector orifice to the central orifice; a hollow, tubular hub detachably mountable within the central orifice of the adapter plate and including a flange engageable with the second side of the adapter plate, a first end means for attaching the hub to the filter pad, and a second end means for attaching the hub to the base of the filter unit, the hub defining a central channel communicating between the outlet of the filter unit and the outlet chamber of the filter pad and further including a fluid channel extending radially through the tubular hub from the central channel of the hub to the central orifice of the adapter plate; and first and second means for sealing the adapter plate to the hub, said sealing means being disposed on either side of the fluid channel and within the first and second sides of the adapter plate, respectively, to form an annular space bounded by the adapter plate, the hub, and the first and second sealing means so that the second fluid passage, the annular space, and the fluid channel provide an isolated fluid communication between the central channel of the hub and the detector orifice.

The invention is also directed to a process for detecting the differential pressure across a filter element in a fluid system including a spin-on filter unit having an inlet, an outlet, and a filter element disposed in the fluid flow path between the inlet and the outlet, and a filter pad having an inlet chamber and an outlet chamber wherein the filter unit is attached to the filter pad with the inlet chamber communicating with the inlet and the outlet chamber communicating with the outlet. The process comprises: detaching the filter unit from the filter pad; attaching one side of an adapter to the filter pad with an aperture in the adapter communicating with the inlet chamber of the filter pad and a channel in the adapter communicating with the outlet chamber of the filter pad, the adapter including a fitting for receiving a differential pressure detector and first and second fluid passages intercepting

the fitting and respectively communicating with fluid flowing through the aperture and fluid flowing through the channel; attaching the filter unit to the other side of the adapter assembly with the aperture communicating with the inlet of the filter unit and the channel communicating with the outlet of the filter unit; connecting a differential pressure detector to said fitting; and detecting the differential pressure across the filter element with the differential pressure detector.

The invention thus provides a convenient, effective and economical way to allow monitoring of the pressure differential across the filter element of either a new or existing system utilizing a spin-on filter mounted on a filter pad. For example, the invention may provide input for an indicator to be used to warn of clogged filter elements so operation of an engine with the bypass valve open may be avoided yet filters may be used to their full capacity for greatest economy.

Other objects, advantages, and aspects of the invention will become apparent upon reading the following detailed description and appended claims and upon reference to the accompanying drawings.

Figure 1 is a sectional view of a conventional filter arrangement including a spin-on filter unit mounted on a filter pad.

Figure 2 is a sectional view of a first exemplary adapter assembly embodying the invention as shown mounted between a spin-on filter unit and a filter pad and is taken along line II-II of Figure 3.

Figure 3 is a plan view of the first exemplary adapter assembly of Figure 2.

Figure 4 is a sectional view of a second exemplary adapter assembly embodying the present invention as shown mounted between a spin-on filter unit and a filter pad and is taken along line IV-IV of Figure 5.

Figure 5 is a plan view of the second exemplary adapter assembly of Figure 4.

As shown in Figure 1, a conventional filter arrangement 10 may comprise a spin-on filter unit 11 mounted to a filter pad 12 by means of a hollow, threaded stud 13. The filter unit 11 typically includes a housing 14 which is sealed to the periphery of an attachment plate or base 15 and which contains a hollow, cylindrical filter element 16. The filter element 16 is mounted concentrically to one side of the base 15 while a seal 20 is mounted concentrically to the opposite side of the base 15. The base 15 includes a central outlet hole 21 and several inlet holes 22 positioned between the outlet hole 21 and the seal 20.

The filter pad 12 defines separate inlet and outlet chambers 23, 24 which are respectively coupled to inlet and outlet lines or ports (not shown) of a fluid system such as a hydraulic or lubrication oil system. The filter pad 12 includes threads 25 to receive one end of the hollow stud 13, while the base 15 includes

threads 26 at the outlet hole 21 to receive the opposite end of stud 13. With the stud 13 tightened to the filter pad 12, the base 15 of the filter unit 11 may be threaded onto the stud 13 until the seal 20 seats tightly against a seating surface 30 of the filter pad 12.

Fluid at a pressure  $P_1$  may then be forced into the inlet chamber 23 of the filter pad 12. From the inlet chamber 23, the fluid flows through the inlet holes 22 in the base 15, into a space between the housing 14 and the filter element 16, and radially inwardly through the filter element 16. As the fluid flows through the filter element 16, particles are filtered from the fluid and the pressure of the fluid drops from  $P_1$  to  $P_2$ . Filtrate at pressure  $P_2$  then flows from the interior of the filter element 16 through the hollow stud 13 into the outlet chamber 24 of the filter pad 12.

In accordance with the invention, an adapter assembly may be disposed between the spin-on filter unit 11 and the filter pad 12. Without interfering with the flow of fluid through the filter unit 11 and filter pad 12, the adapter assembly allows the pressure differential across the filter element 16 to be detected.

As shown in Figures 2 and 3, a first exemplary adapter assembly 100 generally comprises a hollow, threaded hub 101 and an adapter plate 102. The hub 101, which may be fashioned from any suitable rigid impervious material compatible with the fluid being filtered, has a generally tubular body 103 defining a central channel 104. A first end 105 of the hub 101 is threaded to engage the threads 25 of the filter pad 12, while a second end 106 of the hub 101 is threaded to engage the threads 26 of the base 15 of the spin-on filter unit 11. A flange 107 extends radially outwardly from the tubular body 103 at a position near the second end 106 of the hub 101. Flats are preferably formed along the periphery of the flange 107, allowing engagement by a wrench to tighten the hub 101 onto the filter pad 12 to an appropriate degree of torque. A fluid passage 108 extends through the tubular body 103 at a position between the first end 105 of the hub 101 and the flange 107.

The adapter plate 102, which also may be fashioned from any suitable rigid impervious material compatible with the fluid being filtered, preferably has a circular form, as shown in Figure 3, generally comprising first and second sides 109, 110 and a peripheral edge 111. The adapter plate 102 includes a ring-shaped inner portion 112 held in fixed coaxial relation to a ring-shaped outer portion 113 by several spokes 114. The inner portion 112 defines a central aperture 115 which has a diameter that is greater along an inner section of the axis of the inner portion 112, providing an expanded portion 116 of the central aperture 115. The outer portion 113 includes first and second end faces 117, 118. The first end



face 117, which has mounted to it a circular seal 120, such as the groove and O-ring arrangement illustrated in Figure 2, has a diameter similar to that of the seating surface 30 of the filter pad 11. The spokes 114 define several apertures 121 between the inner and outer portions 112, 113 of the adapter plate 102.

To allow detection of the differential pressure across the filter element 16, the adapter plate 102 further includes a fitting 122 to which a differential pressure detector (not shown) may be mounted. In the first exemplary adapter assembly 100, the fitting 122 generally comprises an orifice 123 which is disposed in the peripheral edge 111 of the adapter plate 102 and extends radially inwardly through the ring-shaped outer portion 113 into a spoke 114. The detector, which may comprise any suitable conventional device, such as those available from Pall Corporation under the trademarks DELTAMYND or DELTADYNE, may be mounted within the orifice 123, for example, by bolts (not shown) cooperating with tapped holes 124 in the outer portion 113. Alternatively, the detector may be mounted by means of a retaining ring or threaded fitting. A first fluid passage 125 communicates between an outer section of the detector orifice 123 and the space 126 between the inner and outer portions 112, 113 of the adapter plate 102, which space 126 includes the apertures 121. A second fluid passage 127 communicates between the expanded portion 116 of the central aperture 115 and an inner section of the detector orifice 123. However, the locations at which the first and second passages 125, 127 intersect the detector orifice 123 as well as the shape of the detector orifice 123 may vary depending on the particular differential pressure detector being used.

The first exemplary adapter assembly 100 may be easily installed in the conventional filter arrangement 10 shown in Figure 1. The spin-on filter unit 11 is first removed from the filter pad 12 by unscrewing it from the threaded stud 13. The threaded stud 13 is then removed by unscrewing it from the threads 25 of the filter pad 12.

Next, the adapter assembly 100 with the differential pressure detector installed in the fitting 122 is mounted to the filter pad 12. For example, the first end 105 of the hub 101 may be passed through the central aperture 115 of the adapter plate 102 until the flange 107 engages the ring-shaped inner portion 112 of the adapter plate 102. In this position, the fluid passage 108 of the hub 101 communicates between the central channel 104 and the expanded portion 116 of the central aperture 115 of the adapter plate 102, the expanded portion 116 providing positive relief from the hub 101 along its axial span. The first end 105 of the hub 101 may then be

loosely engaged in the threads 25 of the filter pad 12, and the adapter plate 102 may be rotated about the hub 101 to locate the fitting 122 in any desired position. With the adapter plate 102 held in position, the hub 101 may then be tightened to the filter pad 12 by means of the flats on the flange 107. By the action of the flange 107 against the inner ring-shaped portion 112 of the adapter plate 102, the first side 109 of the adapter plate 102 may be drawn to and retained against the filter pad 12 with the seal 120 on the adapter plate 102 sufficiently sealed against the seating surface 30 of the filter pad 12.

Although an adapter assembly embodying the invention may be a one-piece construction, the two-piece construction comprising the hub 101 and adapter plate 102 of the first exemplary assembly 100 is particularly advantageous. Because the enlarged portion 116 of the central aperture 115 enables the fluid passage 108 in the hub 101 to communicate with the second fluid passage 127 in the adapter plate 102 regardless of their relative angular orientation, the adapter plate 102 may be positioned in any desired angular (i.e., universal) orientation about the hub 101 independent of the angular orientation of the hub 101 required to sufficiently tighten the hub 101 to the filter pad 12. This is important when the available space is limited or when the differential pressure detector is visible only at a particular orientation.

Once the first exemplary adapter assembly 100 is mounted to the filter pad 12, the spin-on filter unit 11 may be mounted to the second side 110 of the adapter plate 102 by engaging the threads 26 on the base 15 of the filter unit 11 with the threaded second end 106 of the hub 101. The filter unit 11 is then tightened onto the hub 101 until the seal 20 on the base 15 of the filter unit is sufficiently sealed against the second end face 118 of the ring-shaped outer portion 113 of the adapter plate 102. Replacement of the filter unit 11 simply requires unscrewing the old filter unit 11 from the hub 101 of the adapter assembly 100 and then screwing a new filter unit 11 onto the hub 101.

In the preferred mode of operation, fluid at a pressure  $P_1$  may be forced into the inlet chamber 23 of the filter pad 12. From the inlet chamber 23, fluid flows through the space 126 between the inner and outer ring-shaped portions 112, 113. Seals 130, such as the groove and O-ring arrangements, between the hub 101 and the adapter plate 102 on both sides of the expanded portion 116 of the central aperture 115 prevent the fluid from flowing directly into the hub 101 and bypassing the filter element 16. From the space 126, the fluid flows through the inlet holes 22 in the base 15 of the filter unit 11, into the space between the housing 14 and the filter element 16, and radially inwardly through the

filter element 16 where any harmful particles are filtered from the fluid and the pressure of the fluid drops from  $P_1$  to  $P_2$ . Filtrate at pressure  $P_2$  then flows from the interior of the filter element 11 through the central channel 104 of the hub 101 into the outlet chamber 24 of the filter pad 12.

In accordance with the invention, the differential pressure across the filter element 16 may be detected by the differential pressure detector (not shown) by means of the adapter assembly 100. The upstream high pressure fluid is channeled to the differential pressure detector via the first fluid passage 125, communicating the pressure  $P_1$  to the differential pressure detector. The downstream low pressure fluid is channeled to the differential pressure detector via the fluid passage 108 in the hub 101, the expanded portion 116 of the central aperture 115, and the second fluid passage 126 in the adapter plate 102, communicating the pressure  $P_2$  to the differential pressure detector. Thus, the seals 130 further isolate the fluid communication between the central channel 104 of the hub 101 and the detector orifice 123.

As shown in Figures 4 and 5, a second exemplary adapter assembly 200, which may be installed in the conventional filter arrangement 10 and operated similarly to the first exemplary adapter assembly 100, generally comprises a hub 201 and an adapter plate 202 similar to those of the first exemplary adapter assembly 100. (Components of the second exemplary adapter assembly 200 analogous to those of the first exemplary adapter assembly 100 are identified by reference numerals having the same last two digits as those of the first exemplary adapter assembly 100.) However, the fitting 222 of the second exemplary adapter assembly 200 comprises a boss 231 formed on the perimeter of the adapter plate 202. The boss 231 includes a detector orifice 223 similar to that of the first exemplary adapter assembly 100. The first and second fluid passages 225, 226 of the adapter plate 202 again communicate, respectively, between the expanded portion 216 of the central orifice 215 and an inner section of the detector orifice 223 and between an outer section of the detector orifice 223 and the space 226 between the inner and outer ring-shaped portions 212, 213.

Although the axis of the detector orifice 223 may be oriented within the boss 231 in any direction relative to the axis of the adapter plate 202, the axis of the detector orifice 223 is shown parallel to that of the adapter plate 202 and hub 201. This allows the differential pressure detector (not shown) to be mounted to the adapter plate 202 at an angle perpendicular to the plane of the adapter plate 202. Thus, the differential pressure detector may extend closely along the side of the spin-on filter unit 11 to facilitate installation in a

confined environment.

In the second exemplary adapter assembly 200, the circular seal 220 mounted to the first end face 217 of the ring-shaped outer portion 213 of the adapter plate 202 has a different diameter than the seal 20 on the base 15 of the spin-on filter unit 11. Further, the second end face 218 of the outer portion 213 also includes a groove 232 into which an O-ring may be installed. Since the first and second end faces 217, 218 are similarly shaped, the adapter plate 202 may be reversed so the first end face 217 contacts the seal 20 of the spin-on filter unit 11 while an O-ring seal in the second end face 218 contacts the seating surface 30 of the filter pad 12. This allows the differential pressure detector to be mounted to the adapter plate 202 so that it extends along the side of either the spin-on filter unit 11 or the filter pad 12.

While two exemplary adapter assemblies embodying the invention have been shown, it will be understood, of course, that the invention is not limited to those embodiments. Modification may be made by those skilled in the art, particularly in light of the foregoing teaching. For example, the adapter assembly may comprise an adapter plate that may be positioned between the filter pad and the spin-on filter unit of a conventional filter arrangement by simply threading it onto the stud.

#### CLAIMS

1. In a fluid system having a filter unit mounted to a filter pad wherein the filter unit includes a fluid inlet, a fluid outlet, and a filter element disposed in the fluid flow path between the inlet and the outlet and wherein the filter pad includes inlet and outlet chambers respectively communicating with the inlet and outlet of the filter unit; an adapter assembly to allow detection of the pressure differential across the filter element of the filter unit by a differential pressure detector, the adapter assembly comprising:
  - an adapter plate;
  - means for sealingly attaching the adapter plate to the filter pad;
  - means for sealingly attaching the filter unit to the adapter plate;
  - means for connecting the differential pressure detector to the adapter plate;
  - said adapter plate including a first aperture allowing fluid to communicate between the inlet chamber of the filter pad and the inlet of the filter unit and a second aperture allowing fluid to communicate between the outlet of the filter unit and the outlet chamber of the filter pad;
  - first means for channeling to the detector connecting means fluid which flows between the inlet chamber of the filter pad and the inlet of the filter unit; and
  - second means for channeling to the detector connecting means fluid which flows between

the outlet of the filter unit and the outlet chamber of the filter pad.

2. The adapter assembly of claim 1 wherein the means for sealingly attaching the adapter plate to the filter pad and the means for sealingly attaching the filter unit to the adapter plate comprise a hub detachably mounted to the adapter plate to provide for universal orientation.

3. The adapter assembly of claim 1 wherein the means for sealingly attaching the adapter plate to the filter pad includes a hub detachably mounted to the adapter plate.

4. The adapter assembly of claim 3 wherein the hub and filter pad include cooperating threaded portions and wherein the means for sealingly attaching the adapter plate to the filter pad further includes a seal on the adapter plate which is compressed between the adapter plate and filter pad when the hub is threaded onto the filter pad.

5. The adapter assembly of either of claims 1 or 4 wherein the means for sealingly attaching the filter unit to the adapter plate includes a hub detachably mounted to the adapter plate.

6. The adapter assembly of claim 5 wherein the hub and the filter unit include cooperating threaded portions and wherein the means for sealingly attaching the filter unit to the adapter plate further includes a surface on the adapter plate to which the filter unit is sealable when the filter unit is threaded onto the hub.

7. The adapter assembly of any one of claims 1, 2, or 4 wherein the detector connecting means comprises a detector orifice extending into the adapter plate from a peripheral edge.

8. The adapter assembly of any one of claims 1, 2, or 4 wherein the detector connecting means comprises a boss extending outwardly from a peripheral edge of the adapter plate and wherein the boss includes a detector orifice.

9. The adapter assembly of any one of claims 1, 2, or 4 wherein the adapter plate comprises an outer ring-shaped portion, an inner ring-shaped portion, and at least one spoke which maintains the inner and outer ring-shaped portions in fixed coaxial relation, wherein the inner and outer ring-shaped portions define therebetween a space including the first aperture, and wherein the first channeling means comprises a fluid passage communicating between the space and the detector connecting means.

10. The adapter assembly of claim 1 wherein the means for sealingly attaching the adapter plate to the filter pad and the means for sealingly attaching the filter unit to the adapter plate comprise a hollow hub wherein the hollow hub is mounted to the adapter plate within the second aperture and defines a central channel which communicates between the outlet of the filter unit and the outlet

chamber of the filter pad, and wherein the second channeling means includes a fluid passage in the hub communicating between the central channel and the periphery of the hub, means for channeling fluid around the periphery of the hub, and a fluid passage in the adapter plate which communicates between the peripheral channeling means and the detector-connecting means.

11. The adapter assembly of claim 10 wherein the peripheral channeling means comprises an expanded portion of the second aperture.

12. In a fluid system including a spin-on filter unit which has a base with a fluid inlet and a fluid outlet and a filter element disposed in the fluid flow path between the inlet and the outlet and which is attachable to a filter pad having an inlet chamber and an outlet chamber, an adapter assembly to allow detection of differential pressure across the filter element by a differential pressure detector, the adapter assembly comprising:

an adapter plate having a first side formed to sealingly engage the filter pad, a second side formed to sealingly engage the base of the filter unit, and an aperture to allow fluid to flow from the inlet chamber of the filter pad to the inlet of the filter unit;

a hub mounted to the adapter plate and including means for attaching the hub to the filter pad, means for retaining the first side of the adapter plate in sealed engagement with the filter pad, means for retaining the base of the filter unit in sealed engagement with the second side of the adapter plate, and a fluid channel to allow fluid to flow from the outlet of the filter unit to the outlet chamber of the filter pad;

means for connecting a differential pressure detector to the adapter plate;

a first fluid passage means for communicating fluid flowing through the aperture in the adapter plate to the detector connecting means; and

a second fluid passage means for communicating fluid flowing through the channel in the hub to the detector connecting means.

13. The adapter assembly of claim 12 wherein the detector connecting means includes a boss protruding from the perimeter of the adapter plate and having a detector orifice intercepting the first and second fluid passage means.

14. The adapter assembly of claim 13 wherein the adapter plate is generally circular and wherein the axis of the detector orifice is parallel to the axis of the adapter plate.

15. The adapter assembly of either of claims 12 or 13 wherein the adapter plate includes a ring-shaped outer portion, a ring-shaped inner portion, and at least one spoke fixing the inner and outer portions in coaxial relation, said aperture being disposed between the inner and outer portions.

16. The adapter assembly of claim 15 wherein the outer portion includes similarly-shaped end faces.

17. The adapter assembly of either of claims 12 or 13 wherein the adapter plate is generally circular and wherein the detector connecting means includes a detector orifice extending into the adapter plate from a peripheral edge and having an axis extending radially inward toward the center of the adapter plate, the detector orifice intercepting the first and second fluid passage means.

18. The adapter assembly of any one of claims 12 through 14 wherein the hub is detachably mounted to the adapter plate.

19. In a fluid system including a spin-on filter unit which has a base with an inlet and an outlet and a filter element disposed in the fluid flow path between the inlet and the outlet and which is attachable to a filter pad having an inlet chamber and an outlet chamber, an adapter assembly to allow detection of the pressure differential across the filter element by a differential pressure detector, the adapter assembly comprising:

an adapter plate including a first side formed to sealingly engage the filter pad, a second side formed to sealingly engage the base of the filter unit, a central orifice, an aperture spaced from the central orifice to allow fluid to flow from the inlet chamber of the filter pad into the inlet of the filter unit, a fitting including a detector orifice for receiving the differential pressure detector, a first fluid passage extending from the detector orifice to fluid flowing between the inlet chamber of the filter pad and the inlet of the filter unit, and a second fluid passage extending from the detector orifice to the central orifice;

a hollow, tubular hub detachably mountable within the central orifice of the adapter plate and including a flange engageable with the second side of the adapter plate, a first end means for attaching the hub to the filter pad, and a second end means for attaching the hub to the base of the filter unit, the hub defining a central channel communicating between the outlet of the filter unit and the outlet chamber of the filter pad and further including a fluid channel extending radially through the tubular hub from the central channel of the hub to the central orifice of the adapter plate; and

first and second means for sealing the adapter plate to the hub, said sealing means being disposed on either side of the fluid channel and within the first and second sides of the adapter plate, respectively, to form an annular space bounded by the adapter plate, the hub, and the first and second sealing means so that the second fluid passage, the annular space, and the fluid channel provide an isolated fluid communication between the central channel of the hub and the detector orifice.

20. For a fluid system including a spin-on filter unit having an inlet, an outlet, and a filter

element disposed in the fluid flow path between the inlet and the outlet, and a filter pad having an inlet chamber and an outlet chamber wherein the filter unit is attached to the filter pad with the inlet chamber communicating with the inlet and the outlet chamber communicating with the outlet, a process for detecting the differential pressure across the filter element comprising:

detaching the filter unit from the filter pad; attaching one side of an adapter to the filter pad with an aperture in the adapter communicating with the inlet chamber of the filter pad and a channel in the adapter communicating with the outlet chamber of the filter pad, the adapter including a fitting for receiving a differential pressure detector and first and second fluid passages intercepting the fitting and respectively communicating with fluid flowing through the aperture and fluid flowing through the channel; attaching the filter unit to the other side of the adapter assembly with the aperture communicating with the inlet of the filter unit and the channel communicating with the outlet of the filter unit; connecting a differential pressure detector to said fitting, and detecting the differential pressure across the filter element with the differential pressure detector.

21. The process of claim 20 wherein the filter system further includes a threaded stud threaded at one end to the filter unit and threaded at the other end to the filter pad, wherein detaching the filter unit from the filter pad includes unscrewing the filter unit from the stud, wherein attaching the adapter to the filter pad includes unscrewing the stud from the filter pad and threading a threaded portion of the adapter to the filter pad; and wherein attaching the filter unit to the adapter includes threading the filter unit onto another threaded portion of the adapter.

22. The process of claim 21 wherein the adapter includes an adapter plate with a central aperture and a hub having first and second threaded end portions and wherein attaching the adapter to the filter pad further includes removably mounting the hub in the central aperture of the adapter plate.