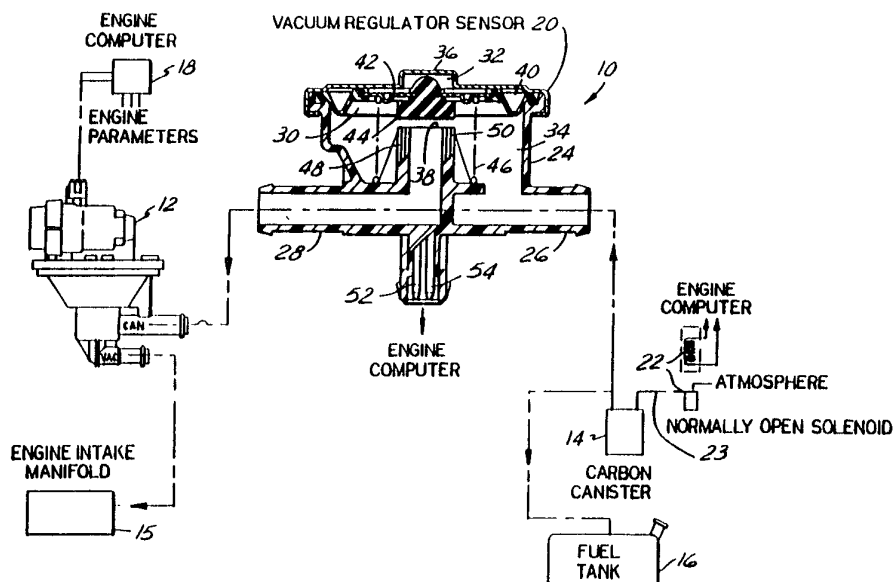


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(54) Title: DIAGNOSTIC SYSTEM FOR CANISTER PURGE SYSTEM**(57) Abstract**

A diagnostic system for detecting a leak in a portion of the canister purge system (10) which includes the canister (14) and fuel tank (16). A solenoid valve (22) is operated to close the canister vent (23). A vacuum regulator/sensor (VRS 20) closes the flow to the engine intake manifold (15) after a certain vacuum has been drawn and an electrically conductive portion of the VRS valve element (44) bridges a pair of contacts (48, 50) upon VRS closing. If a leak is present, vacuum will be lost, causing the bridge to be broken, thereby providing a signal to the engine computer.

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DIAGNOSTIC SYSTEM FOR CANISTER PURGE SYSTEM

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10 Field of the Invention

This invention relates generally to evaporative emission control systems that are used in automotive vehicles to control the emission of volatile fuel vapors. Specifically the invention relates to an on-board
15 diagnostic system for determining if a leak is present in a portion of the system which includes the fuel tank and the canister that collects volatile fuel vapors from the tank's headspace.

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Background and Summary of the Invention

25 U.S. governmental regulations require that certain future automobiles that are powered by volatile fuel such as gasoline have their evaporative emission control systems equipped with on-board diagnostic capability for determining if a leak is present in a portion of the
30 system which includes the fuel tank and the canister. One proposed response to that requirement is to connect a normally open solenoid valve in the canister vent, and to

energize the solenoid when a diagnostic test is to be conducted. A certain vacuum is drawn in a portion of the system which includes the tank headspace and the canister, and with the canister and the tank headspace not being vented due to the closing of the canister vent, a certain loss of vacuum over a certain time will be deemed due to a leak. Loss of vacuum is detected by a transducer mounted on the fuel tank. Because of the nature of the construction of typical fuel tanks, a limit is imposed on the magnitude of vacuum that can be drawn. Too large a vacuum will result in deformation and render the measurement meaningless. In order to avoid this problem, a relatively costly vacuum transducer is required.

15

The present invention provides a solution to the problem which is significantly less costly. The key to the solution is a new and unique vacuum regulator/sensor which is disposed in the conduit between the canister purge solenoid and the canister. This vacuum regulator/sensor is like a vacuum regulator but with the inclusion of a switch that is used to provide a signal indicating the presence or the absence of a leak.

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One aspect of the disclosed vacuum regulator/sensor that is especially unique is the manner in which the switch is embodied in it. Specifically, the movable valve element is a carbon-filled fluorosilicon that when seated on the associated valve seat, not only closes the valve seat, but also provides closure of the switch by bridging two electrical contacts that are embedded in the seat and that lead to corresponding terminals at the exterior of the vacuum regulator/sensor which provide the switch signal to external electronics.

25

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Another aspect relates to the ability of the disclosed vacuum regulator/sensor to sense and indicate both positive and negative pressures relative to a reference (atmosphere), and this feature is useful in the performance of a multiple-part diagnostic test that takes into account the possibility that the ambient temperature might be sufficiently high enough to be volatilizing the liquid fuel at a rate that might otherwise impair the validity of the diagnostic test.

10

Further specific details of the construction and arrangements of the vacuum regulator/sensor and the system, and of the method of operation thereof, will be presented in the ensuing description.

15

Drawings accompany this disclosure and portray a presently preferred embodiment of the invention according to the best mode presently contemplated at this time for carrying out the invention.

20

Brief Description of the Drawing

Fig. 1 is a schematic diagram, portions of which are in cross section, of a first embodiment of canister purge system, including the diagnostic system of the present invention.

Fig. 2 is a schematic diagram, portions of which are in cross section, of a second embodiment of canister purge system, including the diagnostic system of the present invention.

Fig. 3 is an electrical schematic diagram related to the embodiment of Fig. 2.

5 Description of the Preferred Embodiment

Fig. 1 shows a representative canister purge system 10 embodying principles of the invention. System 10 comprises a canister purge solenoid valve 12 (CPS valve 12), and a carbon canister 14, associated with the intake manifold 15 of an automotive vehicle internal combustion engine and with a fuel tank 16 of the automotive vehicle which holds a supply of volatile liquid fuel for powering the engine. CPS valve 12 is under the control of an engine management computer 18 for the engine.

In accordance with the invention, a vacuum regulator/sensor 20 (VRS 20), and a normally open solenoid valve 22 are associated with system in the following manner. VRS 20 is disposed in the flow conduit between CPS valve 12 and canister 14, and solenoid valve 22 is disposed in the atmospheric vent conduit 23 that vents the canister to atmosphere.

VRS 20 comprises a housing 24 that has an inlet nipple 26 and an outlet nipple 28 via which it is connected into the flow conduit between CPS valve 12 and canister 14, as shown. Internally, VRS 20 comprises a diaphragm 30 that divides VRS 20 into a first chamber space 32 and a second chamber space 34. Chamber space 32 is vented to atmosphere via a vent 36 through a portion of the wall of housing 24. Outlet nipple 28 is at one end of a conduit that is formed in housing 24, and the other end of this conduit forms a valve seat 38 that coaxially faces diaphragm 30.

Diaphragm 30 comprises an outer diaphragm part 40 that enables the diaphragm to be positioned axially within housing 24, and an inner, and relatively rigid, inner part 42 that centrally carries a valve element 44 adapted for coaction with valve seat 38. A helical spring 46 is disposed within chamber space 34 and acts between a wall portion of housing 24 and inner diaphragm part 42 to urge the diaphragm, and hence the valve element, away from valve seat 38.

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Embedded within housing 24 are two electrical contacts 48 and 50. They are arranged in valve seat 38 to be bridged by valve element 44 when the latter seats on valve seat 38 in a manner to be subsequently described. Internally of housing 24, each contact 48, 50 leads to a corresponding terminal 52, 54 which, in cooperation with a surrounding portion of the housing wall form an external electrical connector plug that can be mated with a mating connector plug (not shown) that leads to computer 18. By making the housing from a suitable plastic material which is not electrically conductive, the terminals and contacts can be formed electrical conductors that are insert-molded into the housing when the latter is fabricated.

25

Valve element 44 cooperates with contacts 48, 50 to form a normally open switch, which is illustrated in the normally open condition in Fig. 1. To accomplish this, valve element 44 is constructed to provide an electrically conductive path between the two contacts when the valve element is seated on seat 38. One way of providing this path is by making the valve element itself electrically conductive. A material which can provide a suitable character for performing the valving function as well as a suitable character for performing the

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electrical conductor function is carbon-filled fluorosilicon. While this particular construction for the switch is particularly novel, generic aspects of the invention contemplate that other specific switch constructions could be associated with a vacuum regulator/sensor.

The system functions in the following manner. With the canister vent open and the CPS valve being operated by the engine management computer, purging flow of vapors from the canister to the intake manifold is conducted under conditions conducive for purging. VRS 20 remains open and imposes no significant restriction in the purge flow. When it is desired to perform a test of the system to determine if a leak is present in that portion of the system which is upstream of VRS 20 and includes the canister and fuel tank, solenoid valve 22 is operated closed by computer 18.

At the same time, CPS valve 12 is operated by the computer to communicate the intake manifold through VRS 20 to the canister and tank headspace. With the engine operating to provide a suitable level of engine manifold vacuum, vacuum begins to be drawn in the canister and the tank headspace because they are no longer vented to atmosphere due to the closure of solenoid valve 22. Since this increasing vacuum is present in chamber space 34, there is an increasing pressure differential across diaphragm 30 which acts against spring 46. Accordingly, the diaphragm increasingly moves valve element 44 toward valve seat 38.

When a certain magnitude of vacuum is reached, valve element 44 seats on seat 38 to close the flow path through the VRS. At the same instant, the valve element

bridges contacts 48 and 50 to provide a switch closure signal to the computer via terminals 52, 54. The closure of VRS 20 results in the vacuum being sealed in that portion of the system which is upstream of the VRS. The magnitude of the ensealed vacuum is equal to the vacuum that existed just as the VRS closed. However, since the intake manifold vacuum is of a larger magnitude, that larger magnitude will be applied to the seated valve element 44, in effect creating an extra sucking force at the center of the diaphragm to hold the diaphragm against the valve seat.

If a leak is present in the ensealed portion of the system, the ensealed vacuum will begin to diminish. A predetermined loss of vacuum within a predetermined time is deemed to indicate the presence of a leak. Therefore, VRS 20 is designed such that during the testing time period, the existence of a leak is indicated by valve element 44 unseating from seat 38 such that the bridging contact of the valve element with the electric contacts 48 and 50 is lost whereby the switch signal from the VRS to the computer changes from closed to open. In other words, if the computer detects a change from closed to open of the VRS during the test period, the existence of a leak is indicated.

The invention is advantageous because the VRS can be mass-produced in a more economical fashion in comparison to the tank-mounted vacuum transducer solution described earlier. Moreover, the invention can enable a test to be performed at relatively small vacuum levels in the canister and fuel tank so that the drawing of vacuum therein will not cause deformation of properly designed canisters and tanks.

The increased sucking force exerted on the center of the diaphragm when VRS 20 closes provides a very useful hysteresis effect. For example if a vacuum of ten inches of water is effective to close the VRS, the trapped
5 vacuum must drop a certain amount below ten inches of water before the VRS will re-open, say a drop of two inches of water from ten to eight inches. In order to adapt the invention to any particular system for a particular test procedure, calculations must be made in
10 accordance with conventional engineering design practices so that the VRS design is properly sized for operation in the intended manner. It should also be mentioned that at the completion of a test the canister vent is re-opened by de-energizing solenoid valve 22.

15

If a test is conducted above a certain temperature, it is possible that vapor may be generated at a rate that is sufficiently fast that the increase in vapor pressure will re-open the VRS, in which case the test result could
20 indicate a leak when none actually exists. To avoid a faulty test, a temperature sensor may be mounted on the fuel tank to provide a fuel temperature measurement to the computer. If the temperature is not below a predetermined temperature above which the generation of
25 vapor could affect the validity of the test, the test would be deemed invalid. Valid testing would therefore occur only below the predetermined temperature.

Figs. 2 and 3 disclose a second embodiment of
30 canister purge system 110. The system contains a number of parts that are like corresponding parts in Fig. 1, and so like reference numerals are used to designate like parts in both embodiments. The primary constructional difference between the two embodiments resides in the VRS
35 of each, the VRS of Fig. 2 being identified by the

numeral 120. System 110 differs also in that its CPS valve 112 is specifically depicted as a regulated canister purge solenoid of the type manufactured and sold by the Assignee.

5

VRS 120 comprises a housing 124 that has an inlet nipple 126 and an outlet nipple 128 via which the VRS is connected in the flow path between canister 14 and engine intake manifold 15. As in the first embodiment, CPS valve 112 is connected in the flow path downstream of VRS 120. Internally, VRS 120 comprises a diaphragm 130 which divides housing 124 into a first, or reference, chamber space 132 and a second, or sensing, chamber space 134. The latter chamber space is included in the flow path through housing 124 between nipple 126 and nipple 128. Chamber space 132 is vented to atmosphere through a vent hole 136 in the housing wall. Nipple 128 is at one end of a conduit that is formed in housing 124, and the other end of this conduit forms a valve seat 138.

20

Diaphragm 130 comprises an outer part 140 that enables the diaphragm to be positioned axially within the housing, and a relatively rigid inner part 142. A helical coil spring 143 is disposed in chamber space 132 and acts to urge diaphragm 130 in a sense that is toward seat 138. One end of spring 143 is seated on inner part 142 while the other end of the spring seats on the outer margin of a spring seat element 145. Element 145 has a central conical depression that is concave toward a set screw 147 that is threaded into the wall of housing 124. The set screw is externally adjustable by means of a suitable adjustment tool (not shown) for setting the depth to which the set screw penetrates the housing. The interior tip end of the set screw bears against the bottom of the concave conical depression in element 145.

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A somewhat disc-shaped valve element 144 is associated with seat 138. A second helical coil spring 146 is disposed between an internal housing wall 149 and the outer margin of element 144 and acts to urge element 144 in a sense that is away from seat 138. The central region of element 144 contains a projecting tip 151 that bears against the central region of inner part 142 of diaphragm 130. Valve element 144 is joined to a stem 152 which passes from the element through the opening circumscribed by seat 138 and also through a guide sleeve 153 that is formed in housing 124. The end of stem 152 which is opposite valve element 144 is joined to a disc 155 which carries a switch contact 157. Valve element 144 also carries a switch contact 159. The condition assumed in Fig. 2 by the parts that constitute the inner workings of VRS 120 represents one of equal pressures acting on opposite sides of the diaphragm, e.g. both chamber spaces at atmospheric pressure.

Embedded within the housing are several electric conductors. Two conductors 161, 163 terminate as contacts at seat 138; two conductors 163, 167 terminate as contacts which confront disc 155. Switch contact 159 cooperates with the contact terminations of conductors 161, 163 to form a first, normally open switch 164 while switch contact 157 cooperates with the contact terminations of conductors 163, 167 to form a second, normally open switch 166. Conductor 163 is common to both switches. These switches are schematically portrayed in Fig. 3. Contacts 157, 159 are made from conductive elastomer, like the element 44 in Fig. 1.

With canister vent solenoid 22 open to atmosphere, canister purge system 110 performs canister purging in conventional fashion by the operation of CPS valve 112

from engine computer 18. During canister purging, VRS 120 remains open to allow the purge flow.

5 The inclusion of VRS 120 and vent solenoid 22 enable a two-part diagnostic test to be performed to test for possible leaks to atmosphere in the portion of the system that is upstream of VRS 120, i.e. in the canister and the tank headspace and associated conduits.

10 The first part of the diagnostic test comprises determining the rate at which fuel is being volatilized in the fuel tank. This part is commenced by closing (de-energizing) CPS valve 112 and by closing (energizing) vent solenoid 22. It can be assumed that the pressures
15 across the diaphragm are essentially equal at the beginning of this part of the test. If vapor is being generated at a sufficiently high rate, the pressure in the sensing chamber will increase at a sufficiently rapid rate that diaphragm 130 will move upwardly against the
20 force of spring 143. Although it is not fixedly attached to the diaphragm, valve element 144 will follow the diaphragm's motion because of spring 146. A sufficiently high rate of vapor generation will create a sufficient amount of travel within a certain measure of time that
25 switch 166 will close and thereby provide a signal to the computer. Should the pressure continue to build after the switch has closed, the diaphragm will separate from the projecting tip of the valve element since the two are not fixedly connected.

30

The computer contains a timer that is started at the beginning of the test and that is stopped when switch 166 closes, assuming that such closure occurs before an allotted time. Of course if closure does not occur
35 within the allotted time, then the rate at which vapor is

12

being generated is deemed sufficiently slow that it will not affect the validity of the second part of the test. By measuring how long it takes for the switch to close, one can obtain the rate at which vapor is being
5 generated. This information is used to validate or invalidate the results of the second part of the test which will now be described.

The second part is the actual leakage test. This is
10 commenced by closing vent solenoid 22 and energizing CPS solenoid 112 until valve element 144 is forced by the downward motion of diaphragm 130 to seat switch contact 159 on seat 138 and thereby close the flow path through the VRS and concurrently close switch 164. Should the
15 switch fail to close, it is assumed that a gross leak is present in the system since the intake manifold vacuum in that case is unable to draw sufficient vacuum in sensing chamber space 134 to cause the diaphragm to be moved downward and force valve element 144 to close against the
20 valve seat. When closure of switch 164 is detected by the computer, CPS valve 112 is operated to reduce the magnitude of manifold vacuum delivered to nipple 128, and a timer in the computer is started. This timer measures the time required for valve element 144 and switch
25 contact 159 to unseat from the seat and hence re-open switch 164 concurrent with the re-opening of the flow path through the VRS. Consequently, if a leak which is less than a gross leak, but nonetheless still an unacceptable one, is present, switch 164 will open within
30 a predetermined time established by the timer. If no such leak is present, the timer will time out without the switch having opened.

However, failure of switch 164 to open within the
35 period established for the timer does not inherently

confirm that there is no unacceptable leakage because the¹³
presence of a leak may be masked if the liquid fuel is
being volatilized at a sufficiently fast rate.

Therefore, if the leak test indicates that no leakage is
5 present, the test validity is either confirmed or denied
by the result of first part of the test. If a leak test
is deemed invalid, it must be repeated at another time
when the vapor generation rate is sufficiently slow to
confirm its validity.

10

Having disclosed generic principles of the
invention, this application is intended to provide legal
protection for all embodiments falling within the scope
of the following claims.

WHAT IS CLAIMED IS:

1 1. A canister purge system comprising a collection
2 canister for collecting volatile fuel vapors from a fuel
3 tank, and means for selectively purging collected fuel
4 vapors from said canister to an internal combustion
5 engine's intake manifold for entrainment with a
6 combustible mixture that passes from the manifold into
7 combustion chamber space of the engine for combustion
8 therein, said means including a purge flow path between
9 said canister and manifold, characterized by a diagnostic
10 system that detects unacceptable leakage in a portion of
11 the canister purge system which portion includes said
12 canister and tank and that comprises atmospheric vent
13 means for selectively venting and unventing the canister
14 and headspace of the tank to atmosphere and vacuum
15 regulator/sensor means that is disposed in said flow path
16 and that is selectively operable to open and close said
17 flow path, characterized further by means for causing
18 said diagnostic system to perform a multiple-part
19 diagnostic test to determine whether any such leakage is
20 present comprising means for performing one part of the
21 test comprising pressure increase detection means
22 comprising means for operating said atmospheric vent
23 means to unvent said portion of the canister purge system
24 to atmosphere, flow control means disposed in said flow
25 path between said vacuum regulator/sensor means and
26 intake manifold for selectively opening and closing said
27 flow path, and means for obtaining a measurement of
28 increase in the vapor pressure in said portion in
29 consequence of unventing of said portion to atmosphere
30 and of closing of said flow path by said flow control
31 means, and means for performing another part of the test
32 comprising means for performing a leakage test on said
33 portion comprising means for operating said atmospheric

34 vent means to unvent said portion to atmosphere and means
35 for operating said flow control means to open said flow
36 path so as to allow engine intake manifold vacuum to
37 commence drawing vacuum in said portion, said vacuum
38 regulator/sensor means comprises means for closing said
39 flow path upon the drawing of a certain magnitude of
40 vacuum in said portion within a certain measure of time
41 indicative of the absence of a gross unacceptable leak in
42 said portion, means for distinguishing a gross
43 unacceptable leak in said portion from less gross
44 unacceptable leaks by distinguishing the non-attainment
45 of closure of said flow path by said vacuum
46 regulator/sensor means within said measure of time from
47 the attainment of closure of said flow path by said
48 vacuum regulator/sensor means within said measure of
49 time, means effective after the attainment of closure of
50 said flow path by said vacuum regulator/sensor means
51 within said measure of time for operating said flow
52 control means to cause the magnitude of manifold vacuum
53 delivered through said flow path to said vacuum
54 regulator/sensor means to be attenuated from the
55 magnitude that was delivered prior to closure of said
56 flow path by said vacuum regulator/sensor means, and
57 indicator means for indicating the absence of such a less
58 gross unacceptable leak comprising means for indicating
59 whether or not said vacuum regulator/sensor means has,
60 after having closed said flow path, maintained said flow
61 path closed for a certain period of time, and if
62 maintenance of closure of said flow path for said certain
63 period of time is not indicated, for distinguishing
64 between the presence and absence of such a less gross
65 unacceptable leak comprising means for utilizing the
66 measurement obtained from said one test in distinguishing
67 between the presence and absence of such a less gross
68 unacceptable leak.

1 2. A system as set forth in claim 1 in which said
2 means for obtaining a measurement of increase in the
3 vapor pressure in consequence of unventing of said
4 portion to atmosphere and of closing of said flow path by
5 said flow control means comprises measuring means for
6 measuring the time required for the vapor pressure in
7 said portion to undergo a predetermined increase relative
8 to a reference pressure.

1 3. A system as set forth in claim 2 in which said
2 vacuum regulator/sensor means comprises a reference
3 chamber space that is referenced to atmospheric pressure
4 and a sensing chamber space that is included by said
5 portion, and said measuring means comprises means for
6 measuring the time required for the vapor pressure in
7 said sensing chamber space to undergo a predetermined
8 increase in relation to atmospheric pressure in said
9 reference chamber space and comprises a switch that is
10 disposed on said vacuum regulator/sensor means to assume
11 a non-actuated condition at the commencement of measuring
12 and is operated to actuated condition when said
13 predetermined increase in vapor pressure in said sensing
14 chamber space is attained.

1 4. A system as set forth in claim 3 in which said
2 switch is open circuit when in non-actuated condition and
3 closed circuit when in actuated condition.

1 5. A system as set forth in claim 1 in which said
2 indicator means comprises switch means which is disposed
3 on said vacuum regulator/sensor means and is operated
4 from non-actuated condition to actuated condition upon
5 said vacuum regulator/sensor means operating to close
6 said flow path, and the length of time that said switch
7 means is in its actuated condition distinguishes between

8 the presence and absence of such a less gross
9 unacceptable leak.

1 6. A system as set forth in claim 5 in which said
2 switch means is open circuit when in non-actuated
3 condition and closed circuit when in actuated condition.

1 7. A system as set forth in claim 1 in which said
2 means for obtaining a measurement of increase in the
3 vapor pressure in consequence of unventing of said
4 portion to atmosphere and of closing of said flow path by
5 said flow control means comprises measuring means for
6 measuring the time required for the vapor pressure in
7 said portion to undergo a predetermined increase relative
8 to a reference pressure, and said indicator means
9 comprises switch means which is disposed on said vacuum
10 regulator/sensor means and is operated from non-actuated
11 condition to actuated condition upon said vacuum
12 regulator/sensor means operating to close said flow path,
13 and the length of time that said switch means is in its
14 actuated condition distinguishes between the presence and
15 absence of such a less gross unacceptable leak.

1 8. A system as set forth in claim 1 in which said
2 vacuum regulator/sensor means comprises a reference
3 chamber space that is referenced to atmospheric pressure
4 and a sensing chamber space that is included by said
5 portion, said chamber spaces being divided by a movable
6 wall, a first spring means that is disposed in said
7 reference chamber space and is effective to urge said
8 movable wall in a sense that is toward causing said
9 vacuum regulator/sensor means to close said flow passage,
10 and a second spring means that is disposed in said
11 sensing chamber and is effective to urge said movable

12 wall in a sense that is away from causing said vacuum
13 regulator/sensor means to close said flow passage.

1 9. In a canister purge system comprising a
2 collection canister for collecting volatile fuel vapors
3 from a fuel tank, and means for selectively purging
4 collected fuel vapors from said canister to an internal
5 combustion engine's intake manifold for entrainment with
6 a combustible mixture that passes from the manifold into
7 combustion chamber space of the engine for combustion
8 therein, said means including a purge flow path between
9 said canister and manifold, a method for diagnosis of
10 unacceptable leakage in a portion of the canister purge
11 system which portion includes said canister and tank,
12 said method comprising performing a multiple-part
13 diagnostic test to determine whether any such leakage is
14 present comprising performing one part of the test by
15 measuring increase in the vapor pressure in said portion
16 in consequence of unventing said portion to atmosphere
17 and of closing said flow path between said canister and
18 intake manifold, and performing another part of the test
19 comprising performing a leakage test on said portion by
20 unventing said portion to atmosphere and opening said
21 flow path so as to allow engine intake manifold vacuum to
22 commence drawing vacuum in said portion, thereafter
23 closing said flow path between said canister and intake
24 manifold upon the drawing of a certain magnitude of
25 vacuum in said portion within a certain measure of time
26 indicative of the absence of a gross unacceptable leak in
27 said portion, distinguishing a gross unacceptable leak in
28 said portion from less gross unacceptable leaks by
29 distinguishing the non-attainment of closure of said flow
30 path within said measure of time from the attainment of
31 closure of said flow path within said measure of time,
32 and after the attainment of closure of said flow path

33 within said measure of time, indicating the absence of
34 such a less gross unacceptable leak by maintaining said
35 flow path closed for a certain period of time, and if
36 maintenance of closure of said flow path for said certain
37 period of time is not indicated, for distinguishing
38 between the presence and absence of such a less gross
39 unacceptable leak by utilizing the measurement obtained
40 from said one test in distinguishing between the presence
41 and absence of such a less gross unacceptable leak.

1 10. A canister purge system for purging of fuel
2 vapors from a canister to an internal combustion engine's
3 intake manifold for entrainment with a combustible
4 mixture to be introduced into and combusted in combustion
5 chamber space of the internal combustion engine
6 comprising a diagnostic system for detecting a leak in a
7 portion of the canister purge system which includes the
8 canister and a tank from which the canister collects fuel
9 vapors characterized in that in an atmospheric vent for
10 the canister and the tank headspace there is a normally
11 open solenoid valve that is energized to close the vent
12 during a diagnostic leak test, and in the flow path from
13 the canister to the intake manifold there is a vacuum
14 regulator/sensor that is effective to close the flow path
15 after a certain vacuum has been drawn in the canister and
16 tank headspace by vacuum from the intake manifold so that
17 said certain vacuum is trapped therein and that comprises
18 a switch which closes upon the closing of said flow path
19 by said vacuum regulator/sensor and opens upon the
20 re-opening of said flow path by said vacuum
21 regulator/sensor in the event of a predetermined loss of
22 trapped vacuum within a predetermined time after the
23 closing of said vacuum regulator/sensor.

1 11. A system as set forth in claim 10 in which said
2 switch comprises a pair of contacts embedded in a valve
3 seat of said vacuum regulator/sensor and a conductive
4 path that is carried by a valve element that coacts with
5 said valve seat and that bridges said contacts when said
6 valve element is seated on said valve seat.

1 12. A system as set forth in claim 11 in which said
2 valve element comprises a carbon-filled fluorosilicone.

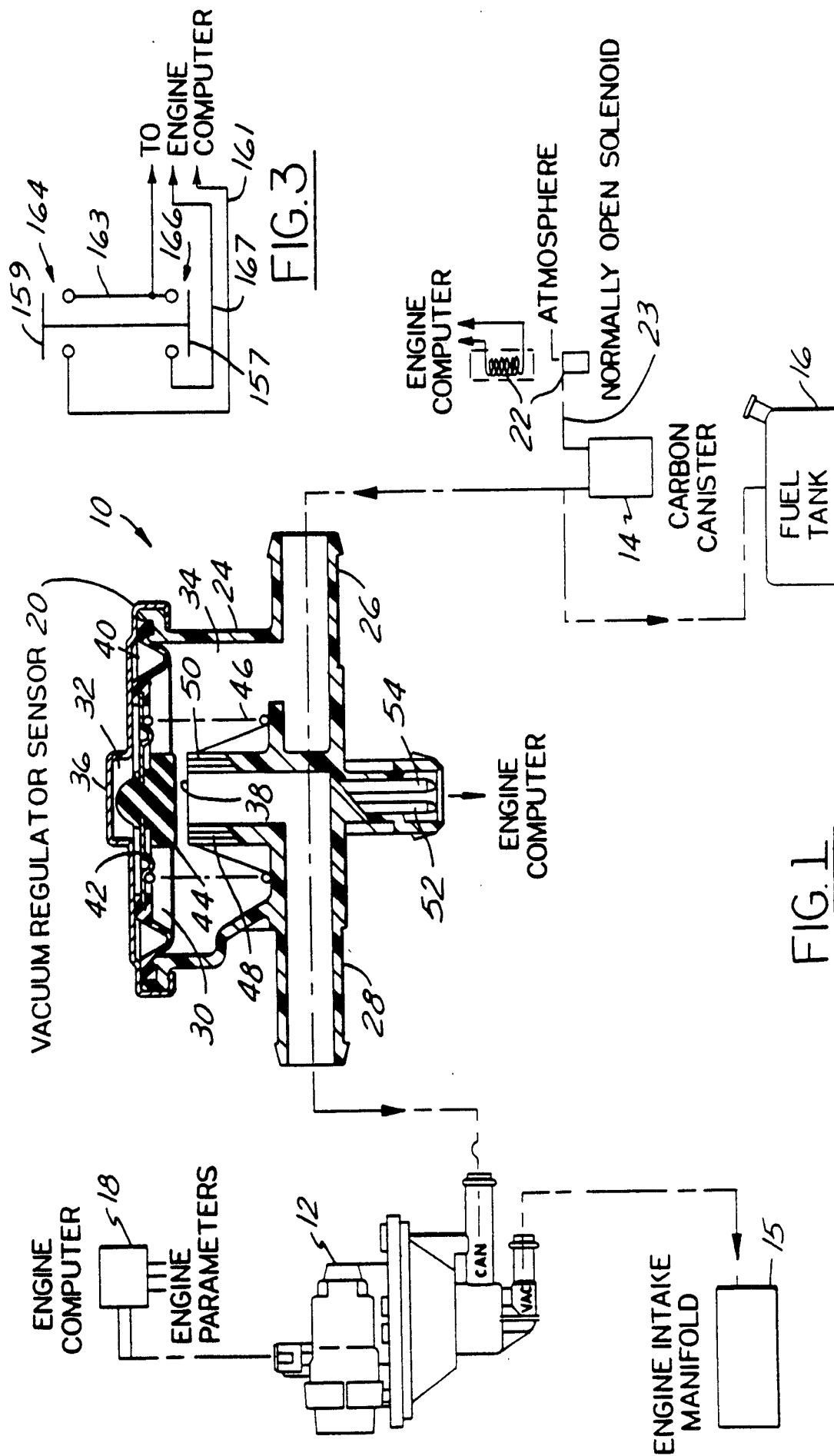
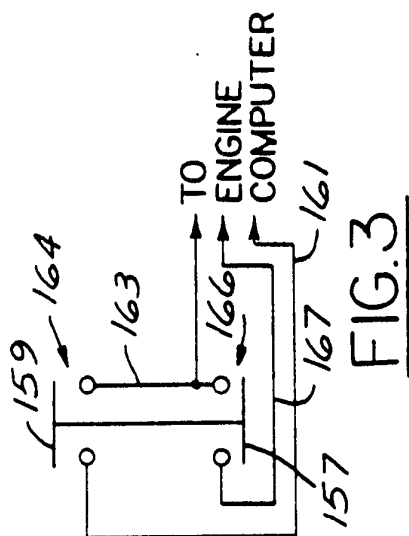
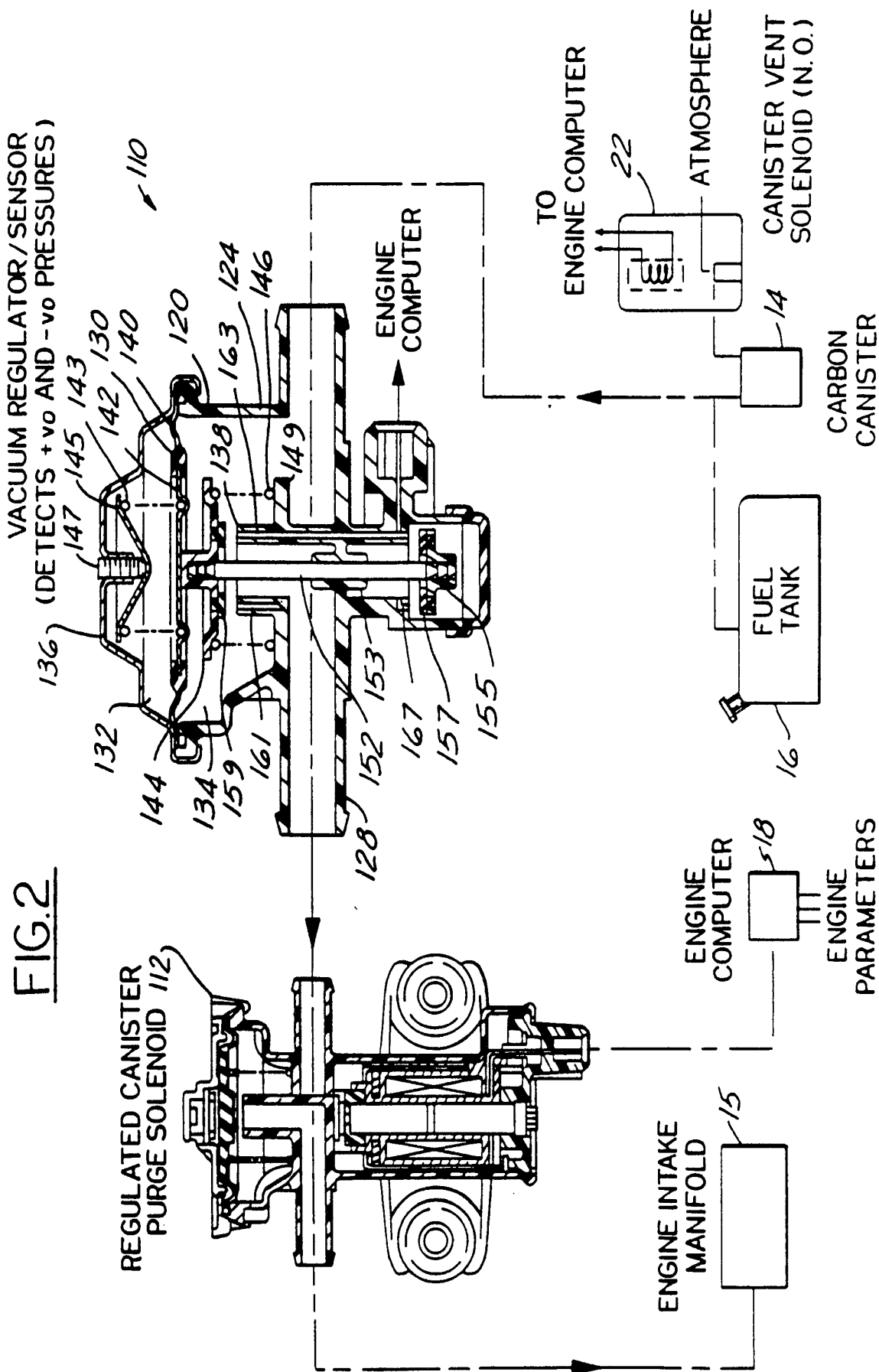


FIG. 1

FIG. 3



2/2



INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 92/00529

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.C1.5 F 02 M 25/08		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.C1.5	F 02 M B 60 K G 01 M	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ^o	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	FR,A,2635823 (BENDIX) 2 March 1990, see abstract; page 2, lines 5-25; page 4, line 33 - page 5, line 30; page 6, line 27 - page 7, line 15; page 7, lines 26-33 ---	1
A	DE,C,4012111 (AUDI) 7 March 1991, see abstract; column 1, lines 32-51; column 1, line 68 - column 2, line 11; column 2, line 55 - column 3, line 39 ---	1
A	EP,A,0357882 (CARL FREUDENBERG) 14 March 1990, see page 3, line 51 - page 4, line 3; figure 1 ---	3,8
A	US,A,3859845 (SAWYER) 14 January 1975, see abstract; column 4, lines 5-16 --- -/-	3,8
^o Special categories of cited documents : ¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
12-05-1992		09 JUN 1992
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer  MISS T. TAZELAAR

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
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A	US,A,3793876 (OSWALD) 26 February 1974, see column 2, line 59 - column 3, line 7 ---	3,5
P,A	WO,A,9112426 (BOSCH) 22 August 1991, see page 3, paragraph 4; page 6, paragraph 1; page 7, paragraph 2 - page 8, paragraph 2; page 10, lines 16-22 -----	1

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 27/05/92
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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