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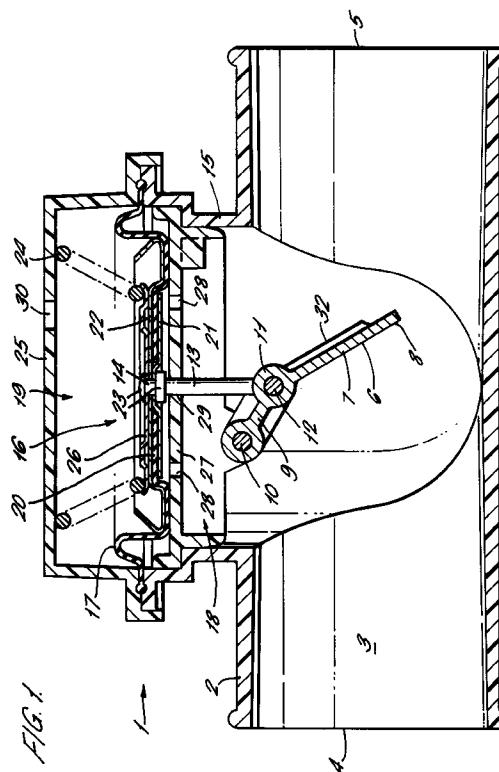
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(54) **Air regulating valve.**

(57) A valve for regulating air flow delivered to an internal combustion engine from a compressor has a body (2) defining a bore (3) through which an air flow is established. A vane (6) is pivotally connected to the body and moveable between a deployed position within the bore in which the vane presents a resistance to air flow and a retracted position in which the resistance is reduced. The vane is biased by a spring (24) into the deployed position. A pressure responsive diaphragm (17) is connected to the vane and urges the vane into the retracted position in response to excess pressure within the bore. The valve provides improved mixture of re-circulated exhaust gases with air delivered to the engine's intake manifold.



This invention relates to an air regulating valve for regulating the air flow delivered to an internal combustion engine from a compressor in situations where the air flow is mixed with re-circulated exhaust gases before being input to the engine's air intake manifold.

The need for such a valve arises because, when operating under idling or low load conditions, it is desirable to enhance the proportion of exhaust gas delivered to the intake manifold so as to minimise noxious exhaust emissions from the engine. It has hitherto been proposed that a valve be provided upstream of an exhaust gas re-circulation mixer to restrict the flow of air in response to command signals from an engine management system which actuates the valve to restrict flow under such idling or low load conditions.

According to the present invention there is disclosed a valve for regulating air flow delivered to an internal combustion engine from a compressor, the valve comprising a body defining a bore through which an air flow is established in use, a vane pivotally connected to the body and movable between a deployed position within the bore in which the vane presents a resistance to the air flow and a retracted position in which the vane presents a reduced resistance to air flow, biasing means urging the vane into the deployed position and a pressure responsive diaphragm connected to the vane and operable to urge the vane into the retracted position in response to excess pressure within the bore.

An advantage of such a valve is that it operates in a self-contained manner without the need for control from external sources such as an engine management system. The engine layout is thereby simplified by removing the need for connection between the valve and an external controlling device.

Preferably the biasing means exerts a biasing force which varies as a function of vane position so as to increase progressively from the deployed position to the retracted position.

A smooth transition between the deployed and retracted positions can thereby be effected and intermediate operating conditions of the engine can be accommodated by intermediate vane positions of the valve.

Preferably the biasing force in the deployed position has a value greater than zero and the biasing force increases substantially linearly with excess pressure between the deployed position and the retracted position.

Conveniently the body defines a chamber communicating with the bore, the diaphragm being disposed within the chamber so as to partition the chamber into an inner portion communicating with the bore and an outer portion isolated therefrom, the housing further comprising an aperture communicating between the outer portion and ambient air.

The diaphragm is thereby made responsive to the excess pressure within the bore (and communicated to the inner portion) relative to ambient air pressure as communicated to the outer portion.

Preferably the biasing means comprises a spring located in the outer portion of the chamber.

The required characteristics of the biasing means may thereby be achieved by selecting a suitably calibrated spring.

Preferably the diaphragm is connected to the vane by means of a push rod having a first end connected to the diaphragm for movement therewith and a second end connected to a crank portion of the vane such that linear movement of the push rod is transmitted as rotational movement to the vane.

Preferably the position of the vane in the retracted position is such that it is substantially retracted from the bore as viewed axially with respect to the bore.

The retracted bore thereby does not impede air flow.

Further in accordance with the present invention an internal combustion engine comprises a valve as disclosed above and wherein the bore communicates air flow between an air compressor and the air intake of an exhaust gas recirculation mixer.

The valve may thereby be used in a method of regulating the proportion of air and exhaust gas input to an internal combustion engine incorporating such a valve and in which the flow of air through the bore is attenuated by deployment of the vane in response to the air pressure in the bore being less than a predetermined lower value.

The air pressure will in general be less than the predetermined lower value only when the engine is idling or under low load conditions. Deployment of the vane to attenuate the air flow thereby results in the proportion of exhaust gas input to the engine being enhanced.

Preferably in such a method the vane is deployed to a varying extent so as to variable attenuate the air flow in a linear manner with respect to the air pressure in the bore between the lower value and a predetermined upper value of air pressure, the vane being held in its retracted position when the air pressure is greater than the upper value.

A smooth transmission is thereby effected in the operating conditions of the valve as the air pressure progressively increases under conditions of increasing load.

A preferred embodiment of the present invention will now be described by way of example only and with reference to the accompanying drawings of which:-

Figure 1 is a sectioned elevation of a valve in accordance with the present invention showing the vane in the deployed position;

Figure 2 is a sectioned elevation of the valve of

Figure 1 showing the vane in the fully retracted position; and

Figure 3 is a schematic diagram of an engine incorporating the valve of Figures 1 and 2.

In Figure 1 a valve 1 has a body 2 defining a cylindrical bore 3 through which an air flow is established from an upstream end 4 to a downstream end 5 in use.

A vane 6 is shown in Figure 1 in a deployed position in which it projects into the bore 3 so as to partially obturate the bore and present a restriction to the flow of air.

The vane 6 consists of a leaf portion 7 connected to a free end 8 of a crank portion 9 which is pivotally mounted on a shaft 10. The free end 8 of the crank portion 9 is formed with a cylindrical boss 11 within which a first end portion 12 of a rod 13 is journaled. The first end portion 12 is bent at right angles to the longitudinal extent of the rod such that the vane 6 is pivotally movable about the shaft 10 by crank action when the rod 13 is longitudinally reciprocated.

The body 2 includes a tubular projection 15 defining a generally cylindrical chamber 16 and extending at right angles to the bore 3.

A rubber diaphragm 17 is located in the chamber 16 so as to partition the chamber into an inner portion 18 and an outer portion 19 such that the diaphragm is movable in response to pressure differential between the inner and outer portions.

A central portion 20 of the diaphragm is clamped between inner and outer discs 21 and 22 respectively which are clamped together so as to grip the diaphragm by fastening formations 23 provided on the second end portion of the rod 13.

A coil spring 24 located within the outer portion 19 of the chamber 16 is held in compression between an outer end wall 25 of the tubular projection 15 and a spring locating disc 26 formed integrally with the outer disc 22.

The central portion of the diaphragm 20 is thereby spring biased in a direction towards the inner portion 18 of the chamber 16 and in its normal rest position as shown in Figure 1 the diaphragm 17 is biased into contact with a support plate 27 extending transversely within the cylindrical chamber 16 within the inner portion 18. The support plate 27 includes apertures 28 allowing air pressure to be equalised within the inner portion 18 on each side of the support plate 27. The apertures 28 are small relative to the cross-section of the inner portion 18 and are located both upstream and downstream with respect to the position of the vane 6 in the bore 3.

The support plate 27 is also provided with a central bore 29 within which the rod 13 is slidably received so as to be co-axially movable in unison with the central portion 20 of the diaphragm.

The outer end wall 25 of the tubular projection 15 is provided with an air vent 30 allowing air pressure

within the outer portion 19 of the chamber 16 to be equalised with ambient air pressure.

The leaf portion 7 of the vane 6 is formed integrally with stiffening ribs 31 and 32 which can be seen from Figure 3.

The spring 24 is of the conical helical type and is selected to provide in its extended position corresponding to the rest position of Figure 1 a compression force of 13 Newtons and in a fully compressed state as shown in Figure 2 a compression force of 38 Newtons. The diaphragm will begin to move from the rest position when the force exerted by the diaphragm exceeds 13 Newtons and for the valve 1 this occurs when the pressure differential between the inner and outer portion 18 and 19 of the chamber exceeds 5kPa. The fully compressed state shown in Figure 2 is reached when the pressure differential is 15kPa and the degree of spring compression varies substantially linearly between these extremes.

As shown schematically in Figure 4 the valve 1 is fitted to an engine 33 such that air flow from a compressor 34 of a turbo charger 35 flows through the valve into an exhaust gas re-circulating mixer 36 before being input to the engine inlet manifold 37. The air passes through an inter cooler 38 before entering the valve 1.

Exhaust gas exiting a turbine 39 of the turbo charger 35 is conducted to the exhaust input 40 of the exhaust gas re-circulation mixer 36 via a pipe 41.

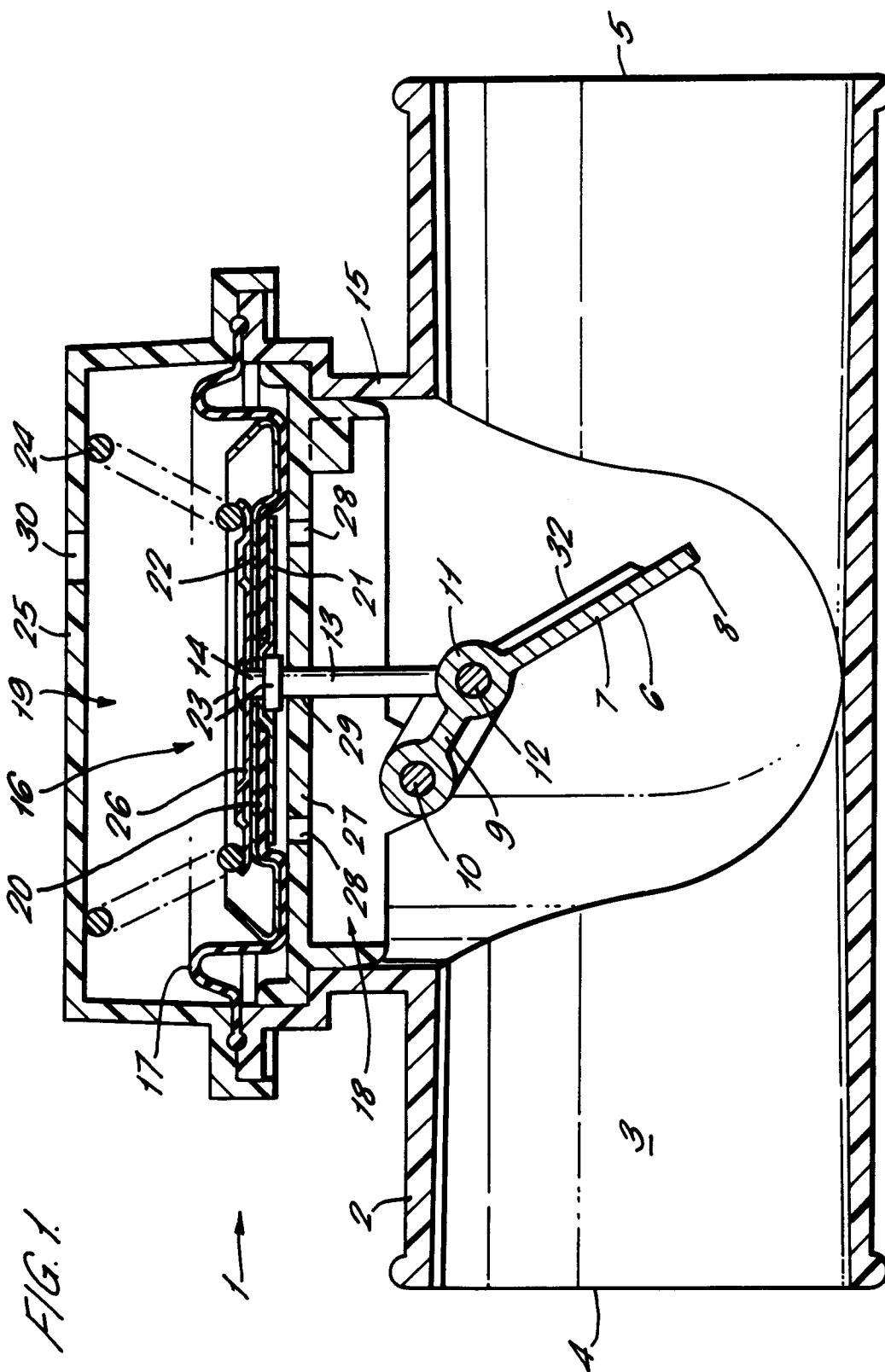
Prior to starting the engine the valve assumes its rest configuration as shown in Figure 1 in which the vane 6 is fully deployed. During engine operation the air pressure within bore 3 varies according to the operating conditions of the engine 33 and is influenced by the rate at which the compressor 34 is delivering air, the rate at which exhaust is output from the turbine 39 and the rate determined by engine speed at which air is sucked into the inlet manifold.

When the pressure within bore 3 is less than a predetermined lower value of 5kPa the valve remains in its rest position as shown in Figure 1 in which the vane 6 presents a restriction to the flow of air thereby tending to reduce the air pressure downstream of the valve and enhancing the rate at which exhaust gas is drawn into the exhaust gas re-circulating mixer 36 to be re-circulated into the inlet manifold 37. When the air pressure lies within the range 5 to 15kPa the diaphragm position varies linearly as a function of air pressure between the rest position of Figure 1 and the retracted position of Figure 2 so that the vane position varies accordingly, the restriction to the flow being progressively reduced with increasing pressure within this range.

For air pressure greater than a predetermined upper value of 15kPa the vane remains in its retracted position as shown in Figure 2 in which resistance to the flow is a minimum.

**Claims**

1. A valve (1) for regulating air flow delivered to an internal combustion engine (33) from a compressor (34), the valve comprising a body (2) defining a bore (3) through which an air flow is established in use, a vane (6) pivotally connected to the body and movable between a deployed position within the bore in which the vane presents a resistance to the air flow and a retracted position in which the vane presents a reduced resistance to air flow, biasing means (24) urging the vane into the deployed position and a pressure responsive diaphragm (17) connected to the vane and operable to urge the vane into the retracted position in response to excess pressure within the bore. 5 10 15
2. A valve as claimed in claim 1 wherein the biasing means exerts a biasing force which varies as a function of vane position so as to increase progressively from the deployed position to the retracted position. 20
3. A valve as claimed in claim 2 wherein the biasing force in the deployed position has a value greater than zero and wherein the biasing force increases substantially linearly with excess pressure between the deployed position and the retracted position. 25 30
4. A valve as claimed in any preceding claim wherein the body defines a chamber (16) communicating with the bore, the diaphragm being disposed within the chamber so as to partition the chamber into an inner portion (18) communicating with the bore and an outer portion (19) isolated therefrom, the housing further comprising an aperture (28) communicating between the outer portion and ambient air. 35 40
5. A valve as claimed in claim 4 wherein the biasing means comprises a spring (24) located within the outer portion of the chamber.
6. A valve as claimed in any preceding claim wherein the diaphragm is connected to the vane by means of a push rod (13) having a first end (12) connected to the diaphragm for movement therewith and a second end (14) connected to a crank portion (9) of the vane such that linear movement of the push rod is transmitted as rotational movement to the vane. 45 50
7. A valve as claimed in any preceding claim wherein the position of the vane in the retracted position is such that it is substantially retracted from the bore as viewed axially with respect to the bore. 55
8. An internal combustion engine having a valve as claimed in any preceding claim wherein the bore communicates air flow between an air compressor (34) and the air intake of an exhaust gas recirculation mixer (36).
9. A method of regulating the proportion of air and exhaust gas input to an internal combustion engine as claimed in claim 8 in which the flow of air through the bore is attenuated by deployment of the vane in response to the air pressure in the bore being less than a predetermined lower value.
10. A method as claimed in claim 9 wherein the vane is deployed to a varying extent so as to variably attenuate the air flow in a linear manner with respect to air pressure in the bore between the lower value and a predetermined upper value of air pressure, the vane being held in its retracted position when the air pressure is greater than the upper value.



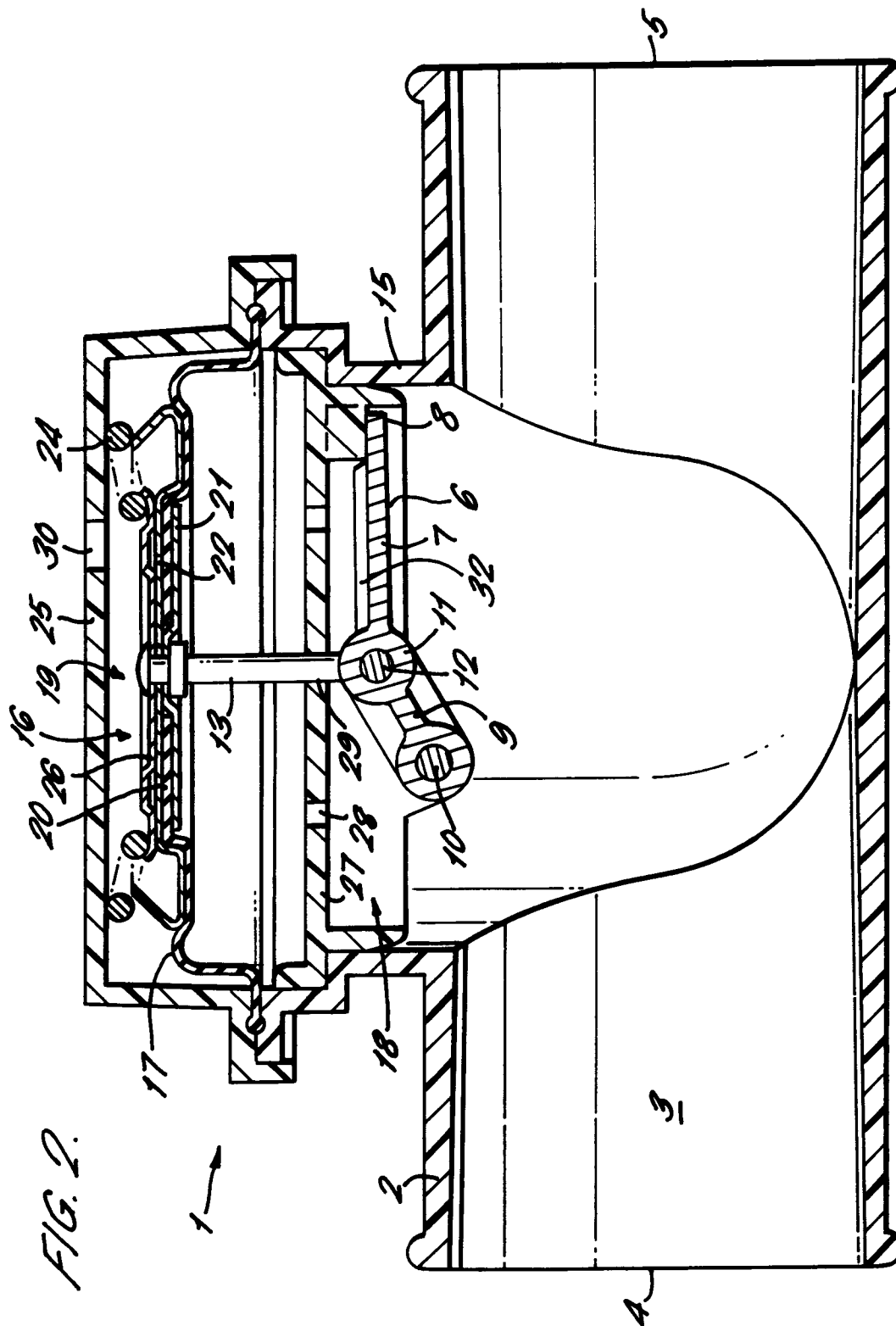
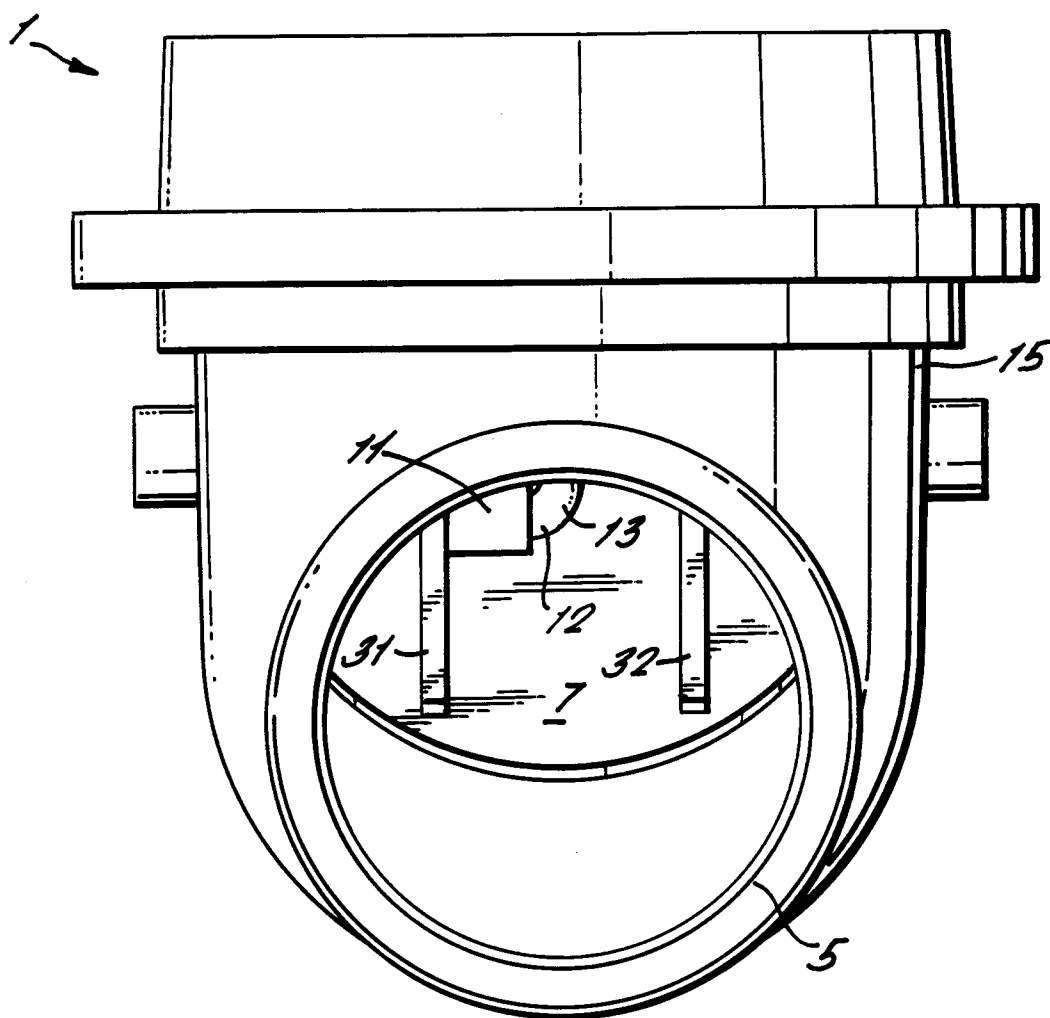
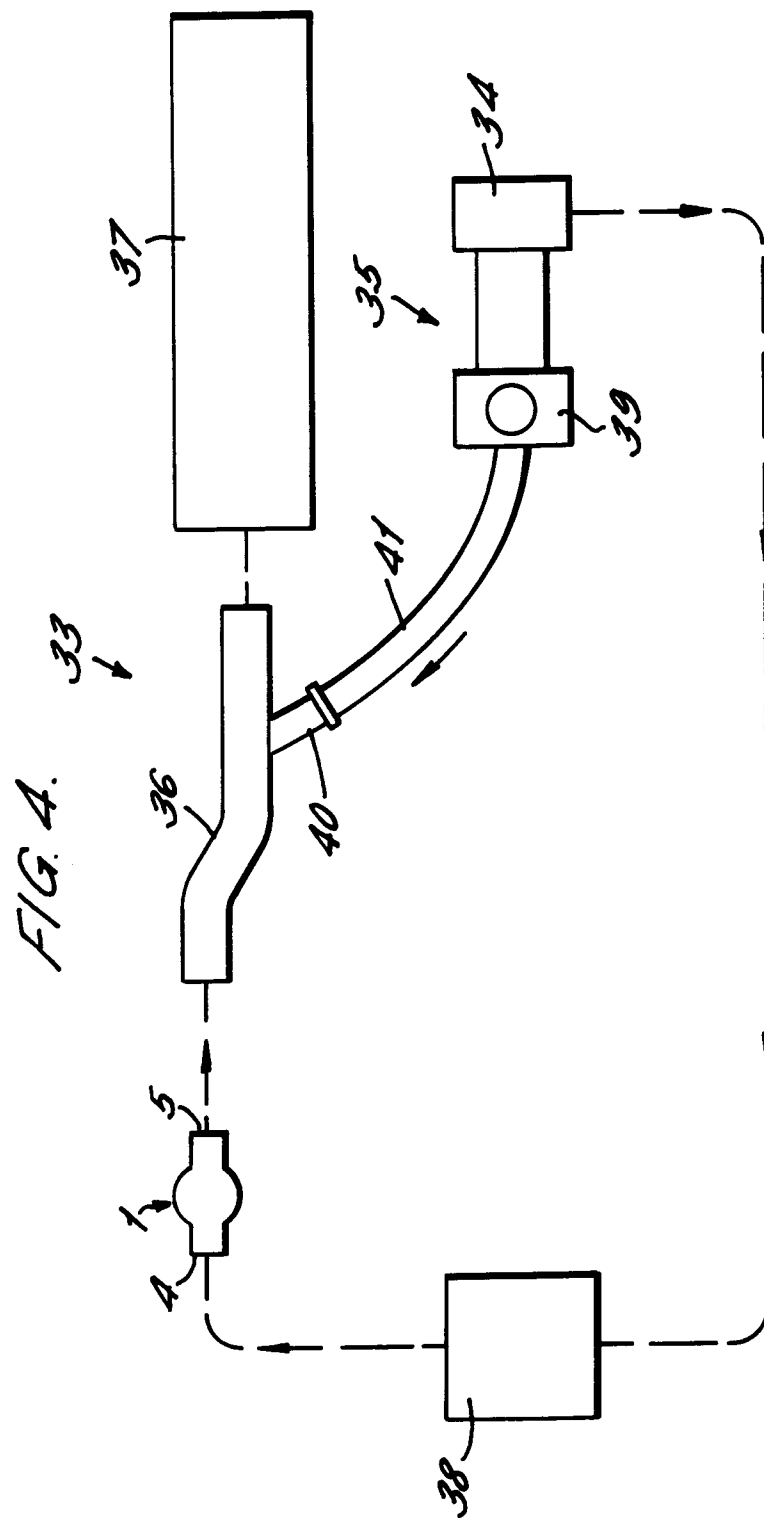


FIG. 3.









European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 94 30 0797

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X A	DE-B-12 61 701 (ACF INDUSTRIES) * column 3, line 10 - line 64; figure 1 * ---	1,2,6 3-5	F02D9/10 G05D7/01
A	EP-A-0 412 076 (AVL GESELLSCHAFT FÜR VERBRENNUNGSKRAFTMASCHINEN UND MESSTECHNIK) * column 3, line 16 - line 33; figure 1 * ---	8-10	
A	US-A-1 547 269 (SPENCER) -----		
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			F02D G05D F02B F02M
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 18 April 1994	Examiner Van Zoest, A
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  .....  &amp; : member of the same patent family, corresponding document</p>			

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