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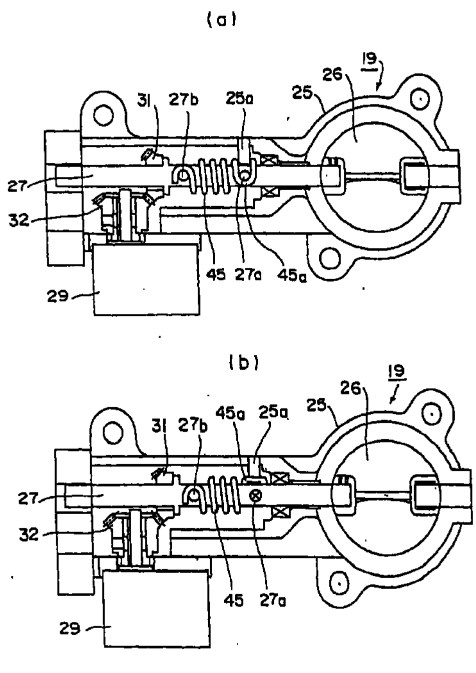
(54) COOLING CONTROL DEVICE OF INTERNAL COMBUSTION ENGINE

(57) The cooling controller can prevents the problem such as overheating of the internal combustion engine and, thus, can exhibit a secure fail safe function. A spring member (45) in a coil form is wound round the valve shaft (27) of the butterfly valve (26) Both ends thereof are communicated with a pair of pin members (27a and 27b) standing on the valve shaft (27) respectively. The pin member (27a) which is made of a material which fuses and breaks at a prescribed temperature is fused and broken, when the cooling water is heated up to a prescribed temperature. As a result, one end (45a) of the spring member (45) comes into contact with the communication pin (25a) projecting toward the valve shaft (25) due to the return force of the spring member (45), and due to the counteraction, the valve shaft (27) is caused to rotate in the direction of opening the valve. Consequently, it is possible to circulate the cooling water and, thus, the problem such as overheating of the engine can be prevented.

Fig.6



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Description

1.FIELD OF THE INVENTION

[0001] The present invention relates to a cooling controller for an internal combustion engine for cooling, e.g., an automobile engine, and particularly to a fail safe means in a flow controller to control the flow of the cooling water heated up by the internal combustion engine to the radiator side.

2.BACKGROUND OF ART

[0002] In an internal combustion engine (hereinafter abbreviated as "engine") to be used in an automobile or the like, a water cooling cooler utilizing a radiator as a heat exchanger has been used as a rule in order to cool the engine. Such a type of cooler is configured so that a cooling water which has been heated up through a water jacket within the engine is circulated to the radiator side, and the cooling water, which is cooled by a heat radiation by means of the radiator, is again fed within the water jacket.

[0003] Fig. 9 shows a basic configuration of the cooler. Within the engine E is placed the well-known water jacket 11. The water jacket 11 has an outlet 12 and an inlet 13 of the cooling water and is communicated with a radiator R by means of the cooling water channels 14a, 14b, and 15. Between the cooling water channel 14a and the cooling water channel 15, there is a bypass channel 16 which detours the radiator R. Between the cooling water channels 14a and 14b which are formed between the outlet 12 of the water jacket 11 and an inlet 17 of the radiator R, a flow controlling valve 19 is placed. Around the outlet 12 of the water jacket 11, a water temperature sensor 20 to detect the temperature of the water at the outlet of the engine E is placed. The information, from the water temperature sensor 20 is supplied to the controlling unit 21 (hereinafter referred to as "ECU").

[0004] In addition to the information of the temperature of the cooling water, information such as the rotation number of the engine and the opening of the engine is also supplied to the ECU 21 to form a control signal to control the flow of the cooling water by means of the flow controlling valve 19.

[0005] The opening and closing of the flow controlling valve 19 is controlled by such a configuration, making it possible to allow the cooling water to flow. This can control the flow of the cooling water to the side of the radiator R and, thus, can control the temperature of the cooling water within a constant range, whereby the engine E can be driven at an optimal temperature as a result.

[0006] Fig. 10 shows an example of a butterfly valve 26 used in the flow controlling valve 19. To be specific, within a case 25 which is connected between the cooling water channels 14a and 14b, the butterfly valve 26 having a circular flat shape is supported on the case 25 in such a manner that the butterfly valve 26 can be rotated by a valve shaft 27. To one end of the valve shaft 27, for example, a worm wheel 28a is equipped. A worm 28b, inserted into a drive shaft of a step motor 29 is configured so as to be engaged with the worm wheel 28a to make up a gear reduction mechanism with the worm wheel 28a and the worm 28b. A control signal resulting from the calculation of the ECU is supplied to the step motor 29. The step motor 29 which has received the signal rotates to control the opening and closing of the butterfly valve 26 via the reduction gear mechanism. As a result the amount of the cooling water transferring from the side of the engine E to the side of the radiator R is controlled. In other words, the heat radiating efficiency is controlled. By such control, the cooling controller is configured so as to drive the engine E at an optimal temperature.

[0007] However, in the cooling controller as described above, since the step motor 29 which controls the opening of the butterfly valve 26 is driven by the control signal from the ECU 21, the opening of the butterfly valve 26 cannot be controlled, when, for example, the ECU is in a trouble by an unexpected accident,.

[0008] If a problem occurs at the time when the butterfly valve 26 is largely opened, the cooling water is sometime excessively cooled. In this case, although there are problems associated with the fuel efficiency of the engine E and the exhaust gas, the problem of the engine E being directly damaged does not occur.

[0009] However, if the ECU 21 has a problem particularly in the case of a small opening of the butterfly valve 26, the amount of the cooling water to be transferred to the side of the radiator R remains limited. In some cases, the engine E is overheated without being recognized by the driver, causing a mortal problem.

[0010] The present invention has been made in light of the problems described above, and is aimed to provide a cooling controller which can prevent the problems, e.g., of the engine E overheating due to the trouble of the ECU 21 or the like as described above, and which can exhibit a fail safe function.

SUMMARY OF THE INVENTION

[0011] A cooling controller for an internal combustion engine according to the present invention which has been made in order to attain the object described above includes a flow controlling valve, which is placed on a circulation channel for cooling water between the internal combustion engine and a heat exchanger and which controls the flow of the cooling water depending on the degree of the opening of the valve, and possesses:

a control unit which transfers a signal for driving a motor depending on the drive state of the internal combustion engine, a motor which is driven by the signal for driving the motor from the control unit,

a flow controlling valve whose degree of opening is controlled by the driving force of the motor, and

an electric control circuit which forcibly drives the flow controlling valve in the direction of opening the flow controlling valve based on an electric signal in the case where any abnormality of the internal combustion engine is detected.

[0012] In a preferred embodiment of the cooling controller, the electric circuit blocks the circuit for connecting the control unit and the motor and supplies a drive signal for opening the flow controlling valve to said motor, when any abnormality of the internal combustion engine is detected

[0013] In another preferred embodiment of the cooling controller, the cooling controller further possesses a second motor which drives the flow controlling valve, whereby the electric control circuit transfers a drive signal to the second motor to open the flow controlling valve in the case where any abnormality of the internal combustion engine is detected.

[0014] In another preferred embodiment of the cooling controller, the cooling controller further possesses a return spring which applies a resilient force to the flow controlling valve in the direction of opening the valve, a thermo switch which senses the temperature of the cooling water and switches according to the prescribed level is used in the electric control, whereby the flow controlling valve can be opened by the resilient force of the return spring by blocking the circuit for connecting the control unit and the motor. In another preferred embodiment of the cooling controller, the cooling controller further possesses a return spring which applies a resilient force to the flow controlling valve in the direction of opening the valve and a clutch mechanism which can control the connecting and disconnecting between the motor and the flow controlling valve by an electric signal, and a thermo switch which senses the temperature of the cooling water and switches according to the prescribed level is used in the electric control, whereby the flow controlling valve is opened by the resilient force of the return spring by releasing the clutch based on the actuation of the thermo switch.

[0015] In the cooling controller configured as described above having an electric control circuit which forcibly drives the flow controlling valve in the direction of opening the flow controlling valve based on an electric signal, in the case where any abnormality of the internal combustion engine is detected, for example, by the function of an electrically controlled means such as a relay, the flow controlling valve is forcibly opened.

[0016] Consequently, because of increasing the radiating efficiency by increasing the amount of the cooling water entering into the heat exchanger, the cooling controller can exhibit a fail safe mechanism without overheating the internal combustion engine.

[0017] Furthermore, a cooling controller for an internal combustion engine according to the present invention includes a flow controlling valve, which is placed on a circulation channel of a cooling water between the internal combustion engine and a heat exchanger and which controls the flow of the cooling water depending on the degree of the opening of the valve, and possesses:

a control unit which transfers a signal for driving a motor depending on the drive state of the internal combustion engine,

a motor which is driven by the signal for driving the motor from the control unit,

a flow controlling valve whose degree of opening is controlled by the driving force of the motor, and

a forcible driving mechanism which is placed within the flow controlling valve and which applies the resilient force to the flow controlling valve in the direction of opening the valve, when an abnormal temperature of the cooling water is sensed.

[0018] In a preferred embodiment of this aspect, the forcible driving mechanism is configured by a spring member, which control opening and closing of the flow controlling valve, provided by winding it on the valve shaft, and a pair of pin members communicated with both ends of the spring member respectively to hold the spring member, and the cooling controller is configured so that any one of the pins is formed from a heat-sensitive material which senses an abnormal temperature of the cooling water in which case the pin is released from the communication to the spring member, and the flow controlling valve is opened by the return force accompanying the release of the communication of the pin member.

[0019] In another preferred embodiment of this aspect, the forcible driving mechanism possesses a thermo element having a piston rod which moves when an abnormal temperature of the cooling water is sensed, and a cam member which converts the movement of the piston rod to a rotation, whereby the flow controlling valve is opened based on the rotation.

[0020] It is further desirable to possess a power blockage mechanism to prevent the transmission of the driving force of the motor to the flow controlling valve according to the movement of the piston rod of the thermo element.

[0021] In a still another preferred embodiment of this aspect, the cooling controller further possesses a return spring which applies a resilient force to the flow controlling valve in the direction of opening the valve, and the forcible driving mechanism possesses a thermo element having a piston rod which moves when an abnormal temperature of the cooling water is sensed, and a connecting member for blocking the driving force of the motor on a valve shaft which controls opening and closing the flow controlling valve according to the movement of the piston rod of the thermo element, whereby the flow controlling valve is opened by the resilient force of the return spring through the blockage of the connecting member.

[0022] In a still further preferred embodiment of this aspect, the cooling controller further possesses a return spring which applies a resilient force to the flow controlling valve in the direction of opening the valve, and the forcible driving mechanism possesses a heat actuating member formed from a shape memory alloy which changes its shape when an abnormal temperature of the cooling water is sensed, and a connecting member for blocking the driving force of the motor on a valve shaft which controls opening and closing the flow controlling valve by the actuation of the heat actuating member, whereby the flow controlling valve is opened by the resilient force of the return spring through the blockage of the connecting member.

[0023] In the cooling controller configured as described above, when any abnormality of the internal combustion engine is detected, the flow controlling valve is opened, what is called mechanically, by means of the forcible driving mechanism, when an abnormal temperature of the cooling water in the flow controlling valve is sensed.

[0024] Consequently, because of increasing the radiating efficiency by increasing the amount of the cooling water entering into the heat exchanger, the cooling controller can exhibit a fail safe mechanism without overheating the internal combustion engine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Fig. 1 is a configuration figure showing a first embodiment of the cooling controller according to the present invention; Fig. 2 is a configuration figure similarly showing a second embodiment of the cooling controller according to the present invention; Fig. 3 is a configuration figure similarly showing a third embodiment of the cooling controller according to the present invention; Fig. 4 is a configuration figure similarly showing a forth embodiment of the cooling controller according to the present invention; Fig. 5 is a configuration figure similarly showing a fifth embodiment of the cooling controller according to the present invention; Fig. 6 is a configuration figure similarly showing a sixth embodiment of the cooling controller according to the present invention; Fig. 7 is a configuration figure similarly showing a seventh embodiment of the cooling controller according to the present invention; Fig. 8 is a configuration figure similarly showing an eighth embodiment of the cooling controller according to the present invention; Fig. 9 is a configuration figure showing one example of the arrangement of circulation channels for a cooling water of the internal combustion engine and the flow controlling valve; and Fig. 10 is a configuration figure showing one example of the prior butterfly valve and the driving mechanism thereof

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0026] An embodiment of the cooling controller for the internal combustion engine according to the present invention will now be described by referring to the drawings. An arrangement of a control unit (ECU) 21 making up the cooling controller is the same as that of the prior art described in the section of the background of the art. Also the parts corresponding to those described in Fig. 9 and Fig. 10 above utilize the same symbols and the description thereof is omitted.

[0027] Fig. 1 shows a first embodiment of the present invention. On a valve shaft 27 of a flow controlling valve 19, a first bevel gear 31 is placed. A motor 29 embedding a reduction gear mechanism (not shown) is arranged on the side wall of a case 25, and a driving force reduced by means of the reduction gear mechanism is transmitted to a second bevel gear 32.

[0028] As shown in the figure, the second bevel gear 32 is configured to be engaged with the first bevel gear 31 so that a butterfly valve 26 can control the degree of opening by the motor 29.

[0029] On the other hand, an electric circuit, which forcibly drives the butterfly valve 26 in the direction of opening the valve based on an electric signal when any abnormality of the engine E is detected is provided. To be specific, a coolant temperature gauge of a meter panel 33 placed on the driver's seat possesses a bridge circuit (not shown), having a drive coil for the coolant temperature gauge, a thermistor which detects the temperature of the cooling water, and the like included therein on one side, and the bridge circuit is configured so as to drive the indicator of the coolant temperature gauge to the high temperature side due to the unbalanced state of the bridge circuit accompanying the increase in the temperature of the cooling water.

[0030] To be specific, it is possible to electrically extract information concerning the temperature of the cooling water from one side of the bridge circuit. In the case where the indicator reaches a red zone, it can be tentatively considered to generate a trouble in the ECU 21.

[0031] At this time, a level detector to detect electric information obtainable from one side of the bridge circuit (e.g., a well-known threshold circuit) 34 is connected to the meter panel 33. The level detector 34 switches the output terminal 34a to the reference potential (ground = body of the automobile) at a value more than threshold value (or less than threshold value).

[0032] The output terminal 34a of the level detector 34 is connected to a battery (+12V) via a relay 35 and, thus, has such a function that a current runs through a coil 35a positioned on the relay 35, a dipolar switching connect 35b is switched from the side of the ECU 21 to the side of the battery (+12V). Consequently, the motor 29 rotates by means of the voltage obtained from the battery and actuates so as to forcibly open the butterfly valve 26.

[0033] This suppresses an abnormal increase in the temperature of the cooling water to conduct a fail safe function which prevents the overheating of the engine E.

[0034] In the configuration described above, when the temperature of the cooling water is again decreased, the connect 35b of the relay 35 is again switched to the side of ECU 21. It is desirable to embed a bistable multi-vibrator in the level detector 34 so that when the level detector 34 once actuates, the actuation is continued by the self-hold function. At this time, while a current is kept on running through the motor 29 from the battery, it is desirable to place a timer connect, which actuates by means of a relay movement between the relay 35 and the motor 29 so as to block the current running through the motor 29 after a prescribed time elapses.

[0035] Fig. 2 shows a second embodiment of the present invention. In this embodiment, a second motor 38 having a reduction gear mechanism embedded on the side wall of a case 25 is provided. A third bevel gear 39 which rotates by mean of the motor 38 is configured to be engaged with the first bevel gear 31.

[0036] When any abnormality of the engine, such as an excessive increase in the temperature of the cooling water, is detected, the level detector 34 sets the output terminal 35a thereof at a reference potential so as to actuate the relay 35.

[0037] The relay 35 used herein is a double connect relay having a normally open connect which closes the connect when it actuates and a normally close connect which opens the connect when it actuates. To be specific, as shown in Fig. 2, the normally open connect 35b is connected between the battery and the second motor 38, and the normally close connect 35c is connected between the ECU 21 and the first motor 29. Due to the actuation of the relay 35, for example, due to an excessive increase in the temperature of the cooling water, the normally open connect 35b is closed, to thereby supply a current for opening the butterfly valve 26 to the second motor 38 from the battery via the normally open connect 35b.

[0038] At the same time, the motor drive signal from the ECU 21 to the first motor 29 is blocked.

[0039] Consequently, due to the driving force of the second motor 38 which competes with the driving force of the first motor 29, the butterfly valve 26 is forcibly opened to thereby suppress an abnormal increase in the temperature of the cooling water, conducting a fail safe function which prevents the overheating of the engine E.

[0040] In this case, since the first motor 29 forcibly rotates via the reduction gear mechanism embedded in the first motor 29, it is desirable for the reduction gear mechanism not to use a combination of worm gears, but to use a combination, for example, of flat gears.

[0041] Also, in the case of the embodiment shown in Fig. 2, while a current is kept running through the second motor 38 from the battery by means of the actuation of the relay 35 in the direction of opening the valve, it is desirable to place a timer connect, which actuates by means of the actuation of the relay 35, between the normally open connect 35b and the motor 38, so as to block the current running through the motor 38 after a prescribed time elapses.

[0042] Fig. 3 shows a third embodiment of the present invention. In this embodiment, a return spring 41 which applies a resilient force to the butterfly valve 26 is further provided. A thermo switch 42 which makes a switching movement when it senses the temperature of the cooling water higher than a prescribed level is placed on the cooling water channel 14a. The thermo switch 42 includes, for example, a bimetal (not shown), and is configured so that the switch is off when the temperature of the cooling water exceeds a prescribed level.

[0043] The thermo switch 42 is configured so as to be intervened between the ECU 21 and the motor 29. Consequently, when the cooling water is heated up to a temperature over the prescribed level, the thermo switch 42 is actuated to block the circuit for connecting the ECU 21 and the motor 29. For this reason, by means of the resilient force of the return spring 41, the butterfly valve 26 is forcibly opened.

[0044] This suppresses an abnormal increase in the temperature of the cooling water to conduct a fail safe function which prevents the overheating of the engine E.

[0045] By placing the thermo switch 42 not only on the cooling water channel 14a near the butterfly valve 26 as shown in the figure, but also by directly placing the thermo switch(es) 42 on the elements to be detected such as around the outlet of the cooling water of the engine E, the cylinder block, and cylinder head, more secure (direct) actuation can be carried out.

[0046] Fig. 4 shows a fourth embodiment of the present invention. This embodiment is characterized in the fact that a clutch mechanism, which can control the connection and disconnection thereof by means of an electric signal, is further placed on the portion of a transmission mechanism from the motor 29 which is utilized for driving the butterfly valve 26 to the butterfly valve 26.

[0047] To be specific, Fig. 4(b) outlines an internal configuration of the portion represented by the symbol 29 in Fig. 4(a). As shown in Fig. 4(b), on a drive shaft 29A1 of the motor 29A, a first clutch plate 29B1 making up the clutch mechanism 29B is provided. The drive shaft 29A1 is formed into a polygonal shape. On the other hand, polygonal pore is formed on the first clutch plate 29BI so that the pore encircles the drive shaft 29A1. In such a manner, the first clutch plate 29B1 is connected to the drive shaft 29A1 in the direction of the rotation of the drive shaft 29A1 and is slidable in the direction of the axis of the drive shaft 29A1.

[0048] On the side of the circumference of the first clutch plate 29B1, a circular groove 29B2 is formed. The edge of an actuating element 29B4 of an electronic plunger 29B3 is inserted into the groove 29B2 in a detachable manner. A coil spring 29B5 is placed onto the plunger 29B3, and when the coil spring 29B5 is unfolded, in the case where no electricity to the plunger 29B3 is turned on, the first clutch plate 29B1 is taken into the side of the motor 29A as shown in the figure.

[0049] Opposite to the first clutch plate 29B1, a second clutch plate 29B6 is placed. The second clutch plate 29B6 is fixed onto a rotating shaft 29C1 at the input side making up the reduction gear mechanism 29C.

[0050] The reduction gear mechanism 29C is configured with pinions and flat gears, and a first bevel gear 32 as shown in Fig. 4(a) is placed onto an output shaft 29B3 whose speed is reduced by the reduction mechanism 29C.

[0051] On the other hand, as shown in Fig. 4(a), one end of the thermo switch 42 is connected to the battery and the other end is connected to the plunger 29B3 and also connected to the relay 35.

[0052] Consequently, in the configuration as shown in Fig. 4, when the cooling water is heated up to a temperature higher than the prescribed temperature so that the thermo switch 42 actuates, the electricity to the relay 35 is blocked, the connect 35b is opened to block the control signal from the ECU 21 to the motor 29A. At the same time, since the electricity to the electronic plunger 29B3 is blocked due to the actuation of the thermo switch 42, the clutch mechanism 29B is opened.

[0053] For this reason, due to the resilient force of the return spring 41, the butterfly valve 26 is forcibly opened. This suppresses an abnormal increase in the temperature of the cooling water to conduct a fail safe function which prevents the overheating of the engine E.

[0054] Fig. 5 shows a fifth embodiment of the present invention. In this embodiment, a spring member 45 in the form of a coil is wound around the valve shaft 27. Both ends thereof are communicated with a pair of pin members 27a and 27b standing on the valve shaft 27, respectively. A communication pin 25a projecting toward the valve shaft 27 crossing one end 45a of the spring member 45 is placed on the case 25.

[0055] Here, the pin member 27a standing on the valve shaft 27 near the butterfly valve is made of a thermal fuse or a material which is melted at a temperature higher than the prescribed level. Consequently, when the cooling water is heated up to a temperature higher than the prescribed level, the heat transmitted via the valve shaft 27 acts upon the pin member 27 to fuse and break the pin member 27a.

[0056] Fig. 5(b) shows the state just mentioned. By fusing and breaking the pin member 27a, represented by the symbol (x), one end 45a of the spring member 45 comes into contact with the communication pin 25a projecting toward the valve shaft 25 due to the return force of the spring member 45.

[0057] This makes the pin member 27b placed far from the butterfly valve 26, undergo the counteraction due to the return force of the spring member 45 to thereby cause the valve shaft 27 to rotate in the direction of opening the butterfly valve 26. At this time, the motor 29 is also forced to rotate via gears 31 and 32. By such functions, an abnormal increase in the temperature of the cooling water is suppressed to conduct a fail safe function which prevents the overheating of the engine E.

[0058] Fig. 6 shows a sixth embodiment of the present invention. This embodiment is characterized in the fact that a thermo element possessing a piston rod which makes the rod move when it senses an abnormal temperature of the cooling water, and a cam member which converts the movement of the piston rod to rotation are provided, whereby the butterfly valve is opened due to the rotation by means of the cam member.

[0059] In this embodiment a drive blockage mechanism, which suppresses the transmission of the driving force from motor to the butterfly valve accompanying the movement of the piston rod is further provided.

[0060] In the sixth embodiment, as shown in Fig. 6, the valve shaft is configured with a valve shaft 27A connected to the butterfly valve 26 and a valve shaft 27B having a first bevel gear 31, which is driven by the motor 29 provided thereon. On the side of the valve shaft 27A connected to the butterfly valve 26, a thermo element 47 is positioned.

[0061] Into the thermo element 47, a heat expansion element such as wax W which expands when it senses the heat is incorporated. A piston rod 47 projecting toward the side of the valve shaft 27B which moves in the direction of the shaft due to the expansion of the wax W, i.e., having a first bevel gear 31 placed thereon is positioned on the thermo element 47. Fig. 6(b) shows the state where the piston rod 47a is projected due to the heat being sensed.

[0062] Fig. 6(c) shows the shape of the thermo element 47 except for the piston rod and the shape of the end portion of the valve sheet at the side of the valve shaft 27B connected to the thermo element 47 in the state where they are spilt into right and left sides. As shown in Fig. 6(c), the thermo element 47 is unified with the other end of the valve shaft 27A, which is connected to the butterfly valve 26. On a part of the side of the circumference of the thermo element 47, a groove 47b is formed in the axis direction. On the other hand, on the other end of the valve shaft 27B having the first bevel gear 31 provided thereon, a cylinder portion 27B1 is provided. On the side of the thermo element 47, a communication pin 27B2 which projects toward the inner circumference and which is inserted into the groove 47b is planted onto the cylinder portion 27B1.

[0063] Consequently, in the state shown in Fig. 6(a) or Fig. 6(b), due to the function of the groove 47b and the communication pin 27B2 inserted therein, the valve shalt 27B is connected in the rotating direction and is slidable in the axis direction.

[0064] On the other hand, on the side of the case 25 opposite to the cylinder portion 27B1, a positioning pin 25b is planted facing to the cylinder portion 27B1. The valve shaft 27B is assembled in such a manner that the positioning pin 25b is inserted into a concave portion 274B4 formed into the cylinder portion 27B1.

[0065] The concave portion 27B4 is formed so that the side of the first bevel gear 31 of the cylinder portion 27B1 has an angle of approximately 90° to the circumference direction. The side of the butterfly valve 26 is formed so that the positioning pin 25b can be inserted with a slight clearance. To be specific, when viewed from the direction making a right angle to the outer circumference of the cylinder portion 27B1, the concave portion 27B4 is formed into a shape like a triangle. The portion corresponding to one side of the triangle is a cam face 27B3.

[0066] At the end side, a push spring 48 is placed on the valve shaft 27B. The push spring 48 applies a resilient force to the valve shaft 27B to the side of the valve shaft 27A.

[0067] In the configuration described above, when the cooling water has a temperature within the prescribed range, the piston rod 47a in the thermo element 47 never projects as shown in Fig. 6(a). To be specific, the valve shaft 27B is pushed toward the side of the butterfly valve 26 by the function of the push spring 48. In this state, the positioning pin 25b planted on the case 25 is relatively positioned at one portion of the concave portion 27B4 formed on the cylinder portion 27B1 having an angle of 90° to the circumference direction.

[0068] For this reason, in this state, the butterfly valve 26 can be opened and closed at an angle of approximately 90° by driving the motor 29. This secures the normal temperature control.

[0069] On the other hand, when the cooling water is heated up to a temperature over the prescribed level, the heat is transmitted to the valve shaft 27A to heat the thermo element 47. Into the thermo element, the wax W is incorporated and, thus, the piston rod 47a is projected to have a state as shown in Fig. 6(b). To be specific, the valve shaft 27B is pushed by the piston rod 47a to go backward.

[0070] In this state, the positioning pin 25b planted on the case 25 relatively moves along the cam face 27B3 formed on the concave portion 27B4 of the cylinder portion 27B1 and, thus, the valve shaft 27B is regulated within a prescribed angle. To be specific, the butterfly valve 26 is locked in the open state.

[0071] At this time, according to the valve shaft 27B going backward, the first bevel gear 31 provided o the valve shaft 27B releases its engagement relation with the second bevel gear whereby the drive blockage mechanism is actuated to prevent the transmission of the driving force of the motor 29 to the butterfly valve 26. This suppresses an abnormal increase in the temperature of the cooling water to conduct a fail safe function which prevents the overheating of the engine E.

[0072] Fig. 7 shows a seventh embodiment of the present invention. This embodiment is characterized in the fact that a member for blocking the driving force of the motor 29 which controls opening and closing the butterfly valve 26 according to the movement of the piston rod 47a of the thermo element is provided on the valve shaft, and that when the connection of the member is released, the butterfly valve is opened by the return spring.

[0073] To be specific, in Fig. 7, a retainer 51 is positioned on the thermo element 47 in such a manner that the retainer 51 surrounds the piston rod 47a embedded in the thermo element 47. A coil spring 52 is placed between the retainer 51 and the valve shaft 27B, and the coil spring 52 draws the retainer 51 up to the side of the thermo element 47. A pair of rods 51a are unified with the retainer 51, and the pair of the rods 51a are configured to be slidable along the shaft pore positioned in the valve shaft 27B.

[0074] On the other hand, communication pores 27A1 are perforated on the end face of the valve shaft 27a opposite the pair of rods 51a.

[0075] In Fig. 7(a), which shows the state where the cooling water has a temperature within the prescribed level, the piston rod 47a on the thermo element 47 is in an embedded state. Consequently, the retainer 51 is also pushed by the spring 52, and the pair of the rods 51a making up the connecting member are communicated with the communication pores 27A1 formed in the valve shaft 27A.

[0076] Accordingly, in this state, the valve shafts 27A and 27B rotate together with each other via the pair of rods 51a making up the connecting member. Consequently, in this state, the butterfly valve 26 can be opened and closed according to the drive of the motor 29, ensuring the control of the cooling water at a normal temperature.

[0077] On the other hand, when the cooling water is heated up to a temperature higher than the prescribed level, the thermo element is heated by transmitting the heat via the valve shaft 37A. Since the thermo element includes the wax W as the heat expansion element as described above, the piston rod 47a is projected to come into the state as shown in Fig. 7(b). To be specific, the retainer 51 and the pair of rods 51 a unified therewith cause the spring to shrink and they move toward the side of valve shaft 27B.

[0078] For this reason, the communication between the pair of rods 51a and the communication pores 27A1 formed in the valve shaft 27A is broken and they are disconnected. Consequently, the butterfly valve 26 is opened due to the function of the return spring 26, and a fail safe function to prevent the engine E from overheating is carried out.

[0079] Fig. 8 shows an eighth embodiment of the present invention. This embodiment is characterized in the fact that a heat actuating member using a heat sensitive element which changes its shape when it senses an abnormal temperature of the cooling water, such as a shape memory alloy or a bimetal shaped, for example, into a coil spring is utilized, the cooling controller is configured so that the driving force of the motor is blocked on the valve shaft which controls opening and closing the flow controlling valve due to the actuation of the heat actuating member, and the butterfly valve is opened by the return spring.

[0080] To be specific, as shown in Fig. 8, the left half portion of the valve shaft 27 is formed into a prism 27d. The first bevel gear 31 is slidable on the prism 27d and can be connected in the rotating direction. Between an approximately middle portion of the valve shaft 27 and the first bevel gear 31, a coil spring 56 is positioned around the shaft, and the first bevel gear 31 is configured to be always engaged with the second bevel gear 32.

[0081] On the other hand, between the first bevel gear 31 and the end portion of the valve shaft 27, the heat actuating member 55 is positioned around the shaft.

[0082] In such a configuration, when the cooling water is heated up to a temperature higher than the prescribed temperature, the heat actuating member 55 made from the shape memory alloy is heated by transmitting the heat through the valve shaft 27. This expands the heat actuating element 55, which is in the direction of the shaft to push the first bevel gear 31 against the coil spring 56. To be specific, the heat actuating element 55 moves the first bevel gear 31 as shown in the ideal line of Fig. 8. Due to this function, the engagement of the first bevel gear 31 with the second bevel gear 32 positioned on the side of the motor is released. Consequently, the butterfly valve 26 is opened due to the function of the return spring to conduct a fail safe function which prevent the engine E from being overheated.

[0083] In this case, if a heat actuating element 55 made from a bimetal is used in place of the heat actuating element 55 made from the shape memory alloy, a similar function and a similar effect may be obtained.

[0084] In the embodiments described above, the cooling controller of the present invention has been configured so that the butterfly valve is forcibly opened based on the electric detection of an abnormal state or an abnormal increase in the temperature of the cooling water. However, it should be noted that the present invention is not restricted to the butterfly valve, and that similar functions and effects can be obtained even when any other flow controlling valve which can control the flow of the cooling water by means of the rotation of the valve shaft is applied.

[0085] Also, while the present invention has been described on the basis of the embodiments applied to the automobile engine, the present invention is not restricted to such specific embodiments, and similar functions and effects may be obtained by applying the present invention to any other internal combustion engine.

[0086] As is clear from the description described above, according to the cooling controller of the present invention having a configuration which has, in addition to the usual drive circuits, the flow controlling valve which is forcibly opened by detecting an electric abnormal state, even if the motor which controls opening and closing the flow controlling valve cannot be driven, e.g., due to the trouble in the ECU, the problem such as overheating of the internal combustion engine can be prevented and, thus, a secure fail safe function can be exhibited.

[0087] Furthermore, since the forcible drive mechanism is unified with the flow controlling valve, similarly even if the motor which controls opening and closing the flow controlling valve cannot be driven, e.g., due to the trouble in the ECU, a secure fail safe function can be exhibited, and a flow controlling valve having a light weight and good wearability can be provided.

Claims

1. A cooling controller for an internal combustion engine (E) including a flow controlling valve (19), which is placed on a circulation channel for cooling water between the internal combustion engine and a heat exchanger (R) and which controls the flow of the cooling water depending on the degree of the opening of the valve, characterized in that it further possesses:

a control unit (21) which transfers a signal for driving a motor (29) depending on the drive state of the internal combustion engine,
a motor (29) which is driven by the signal for driving the motor from the control unit,
a flow controlling valve (17) whose degree of opening is controlled by the driving force of the motor, and
an electric control circuit (35, 35a, 35b, 35c) which forcibly drives the flow controlling valve in the direction of opening the flow controlling valve based on an electric signal in the case where any abnormality of the internal combustion engine is detected.

2. The cooling controller as claimed in Claim 1, wherein said electric circuit (35, 35a, 35b, 35c) blocks the circuit for connecting the control unit (21) and the motor (29) and supplies a drive signal for opening the flow controlling valve (17) to said motor, when any abnormality of the internal combustion engine is detected.

3. The cooling controller as claimed in Claim 1, which further possesses a second motor (38) which drives the flow controlling valve (17), and wherein the electric control circuit (35, 35a, 35b, 35c) transfers a drive signal to the second motor to open the flow controlling valve in the case where any abnormality of the internal combustion engine is detected.

4. The cooling controller as claimed in Claim 1, which further possesses a return spring (41) which applies a resilient force to the flow controlling valve in the direction of opening the valve, and a thermo switch (42) which senses the temperature of the cooling water and switches according to the prescribed level is used in the electric control, whereby the flow controlling valve (17) can be opened by the resilient force of the return spring by blocking the circuit (35, 35a, 35b, 35c) for connecting the control unit (21) and the motor (29).

5. The cooling controller as claimed in Claim 1, which further possesses a return spring (41) which applies a resilient force to the flow controlling valve in the direction of opening the valve and a clutch mechanism (29B) which can control the connecting and disconnecting between the motor (29) and the flow controlling valve (17) by an electric signal, and a thermo switch (42) which senses the temperature of the cooling water and switches according to the prescribed level is used in the electric control, whereby the flow controlling valve is opened by the resilient force of the return spring by releasing the clutch based on the actuation of the thermo switch.

6. A cooling controller for an internal combustion engine (E) including a flow controlling valve (19), which is placed on a circulation channel of a cooling water between the internal combustion engine and a heat exchanger (R) and which controls the flow of the cooling water depending on the degree of the opening of the valve, characterized in that it further possesses:

   a control unit (21) which transfers a signal for driving a motor (29) depending on the drive state of the internal combustion engine,
   a motor (29) which is driven by the signal for driving the motor from the control unit,
   a flow controlling valve (17) whose degree of opening is controlled by the driving force of the motor, and
   a forcible driving mechanism which is placed within the flow controlling valve and which applies the resilient force to the flow controlling valve in the direction of opening the valve, when an abnormal temperature of the cooling water is sensed.

7. The cooling controller as claimed in Claim 6, wherein the forcible driving mechanism is configured by a spring member (45), which control opening and closing of the flow controlling valve (17), provided by winding it on the valve shaft (27), and a pair of pin members (27a, 27b) communicated with both ends of the spring member respectively to hold the spring member, and the cooling controller is configured so that any one of the pins is formed from a heat-sensitive material which senses an abnormal temperature of the cooling water in which case the pin is released from the communication to the spring member, and the flow controlling valve is opened by the return force accompanying the release of the communication of the pin member.

8. The cooling controller as claimed in Claim 6, wherein the forcible driving mechanism possesses a thermo element (47) having a piston rod (47a) which moves when an abnormal temperature of the cooling water is sensed, and a cam member (27B4) which converts the movement of the piston rod to a rotation, whereby the flow controlling valve is opened based on the rotation.

9. The cooling controller as claimed in Claim 6, which further possess a power blockage mechanism to prevent the transmission of the driving force of the motor to the flow controlling valve according to the movement of the piston rod of the thermo element (47).

10. The cooling controller as claimed in Claim 6, which further possesses a return spring (41) which applies a resilient force to the flow controlling valve (17) in the direction of opening the valve, and wherein the forcible driving mechanism possesses a thermo element (47) having a piston rod (47a) which moves when an abnormal temperature of the cooling water is sensed, and a connecting member for blocking the driving force of the motor (29) on a valve shaft (27) which controls opening and closing the flow controlling valve (26) according to the movement of the piston rod of the thermo element, whereby the flow controlling valve is opened by the resilient force of the return spring through the blockage of the connecting member.

11. The cooling controller as claimed in Claim 6, which further possesses a return spring (41) which applies a resilient force to the flow controlling valve (26) in the direction of opening the valve, and wherein the forcible driving mechanism possesses a heat actuating member (55) formed from a shape

memory alloy which changes its shape when an abnormal temperature of the cooling water is sensed, and a connecting member for blocking the driving force of the motor (29) on a valve shaft which controls opening and closing the flow controlling valve (26) by the actuation of the heat actuating member, whereby the flow controlling valve is opened by the resilient force of the return spring through the blockage of the connecting member.

12. The cooling controller as claimed in Claim 1 or 6, wherein said flow controlling valve is a butterfly valve (26).

Fig.1

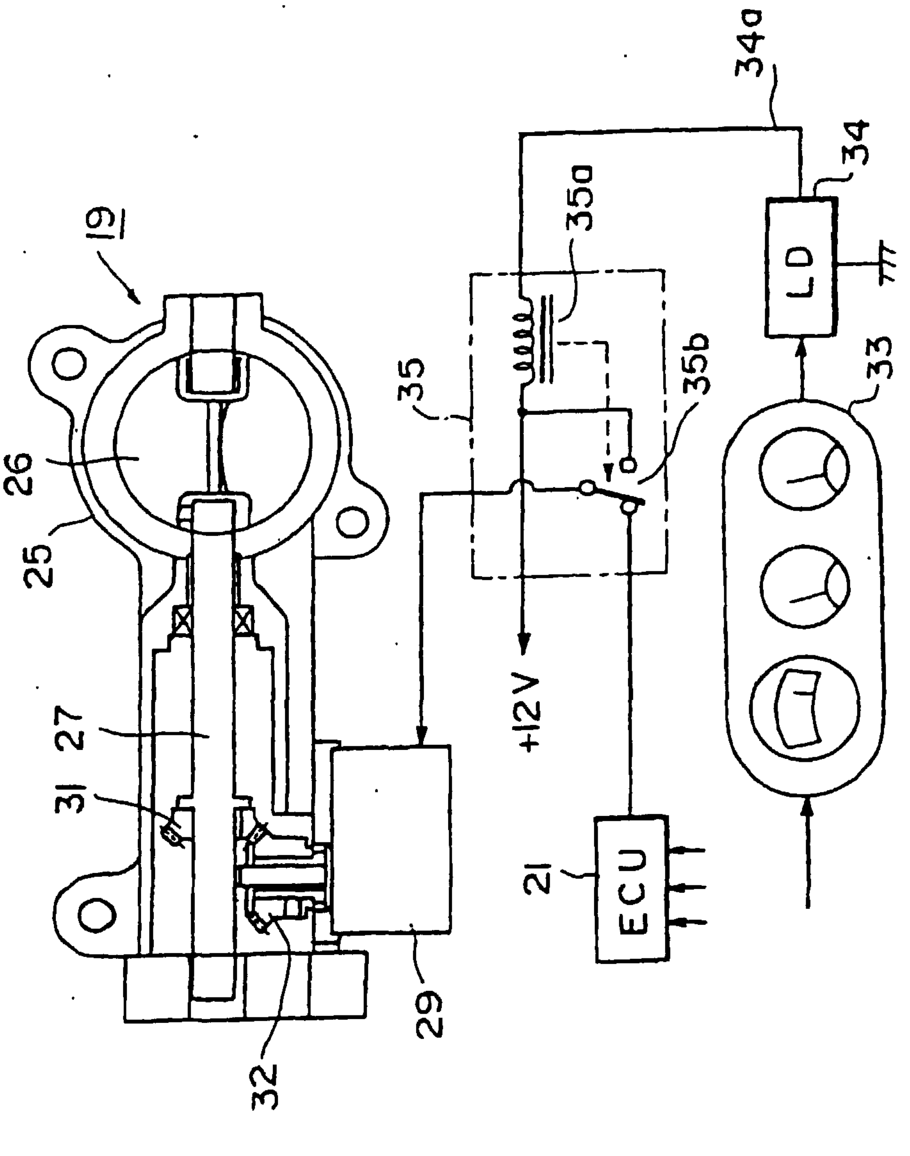


Fig.2

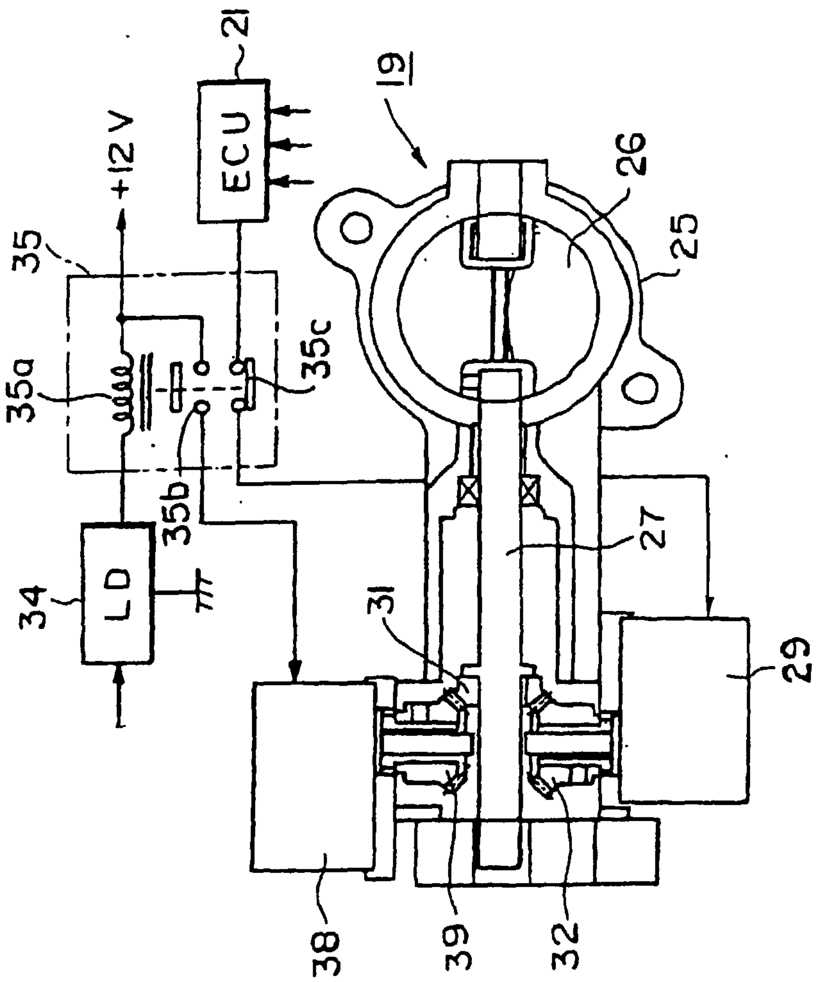


Fig.3

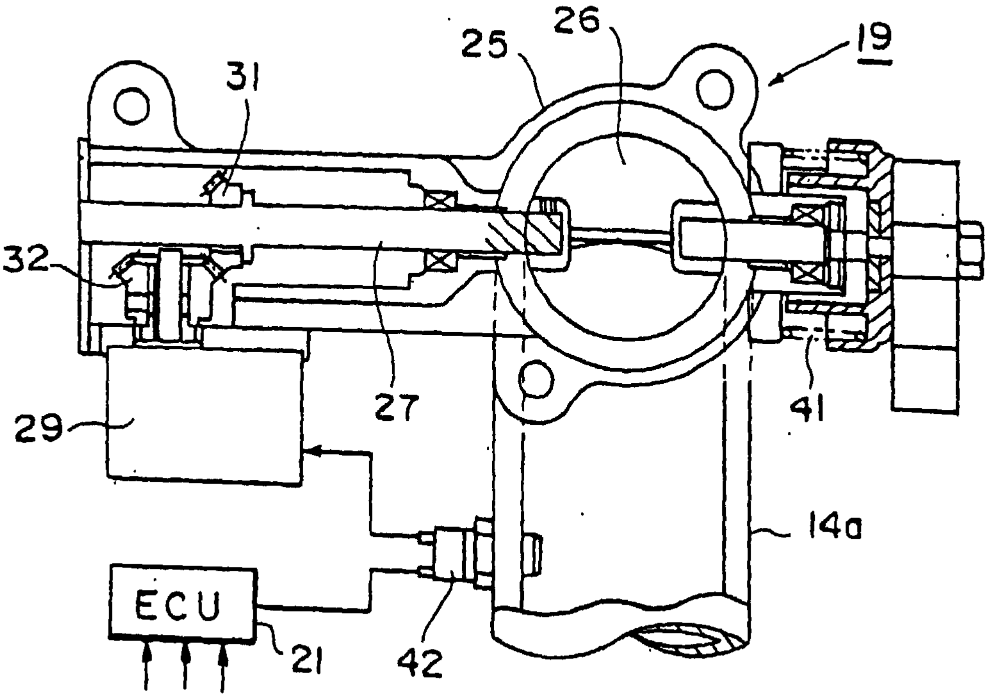
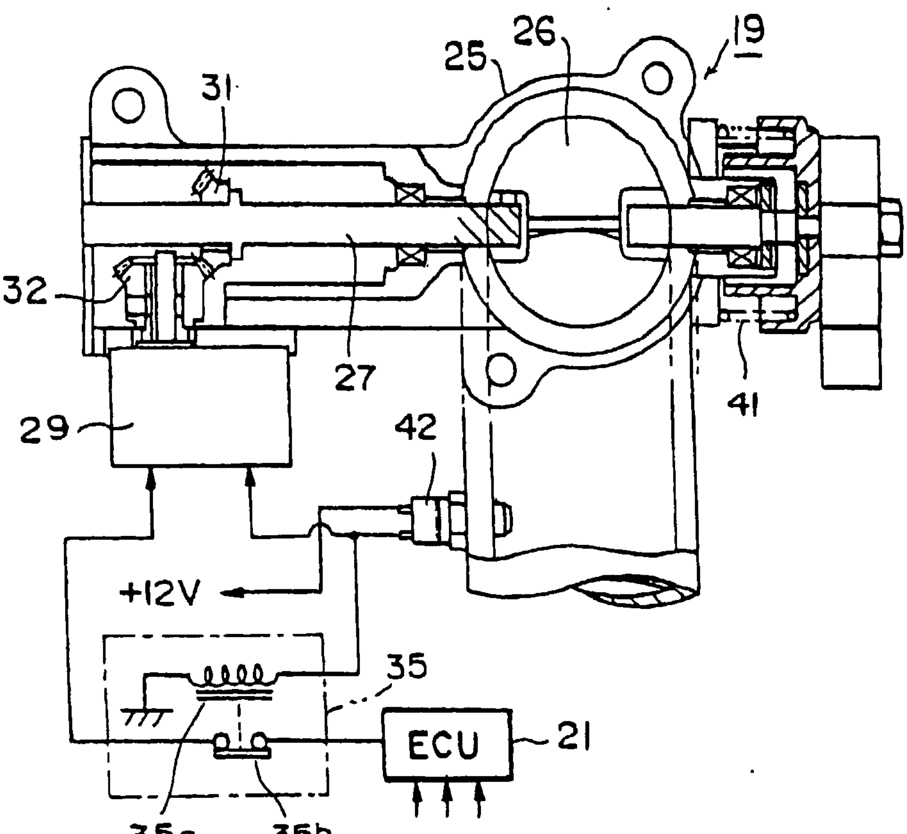


Fig.4

(a)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21
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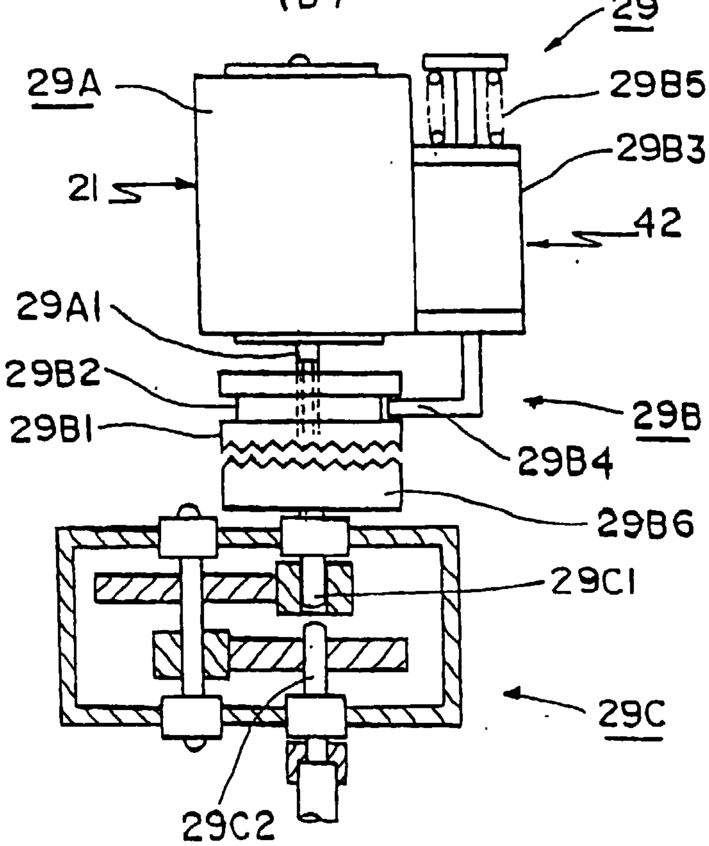
35b

(b)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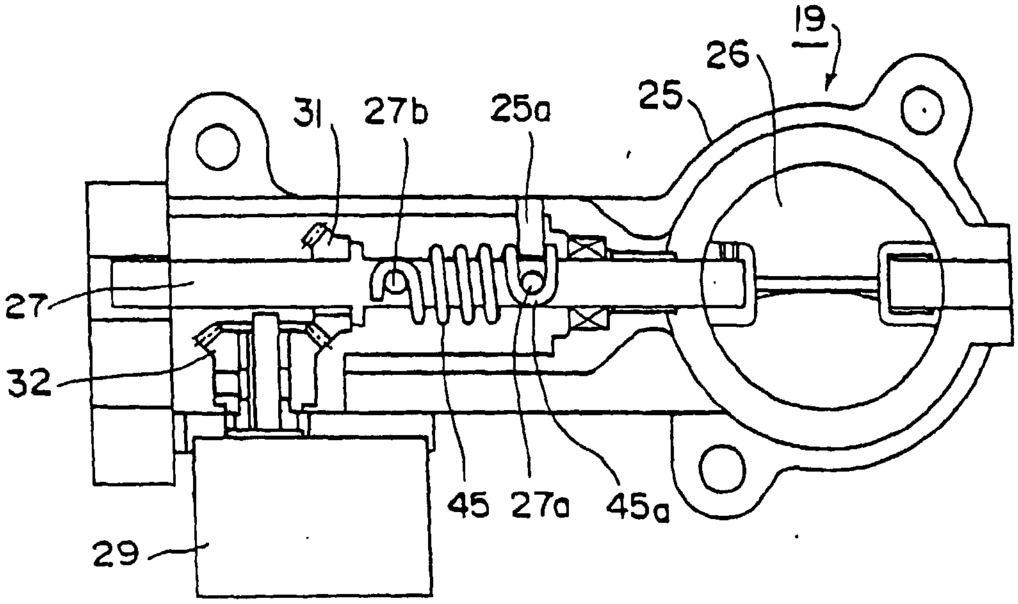
29C2

Fig.5

(a)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(b)

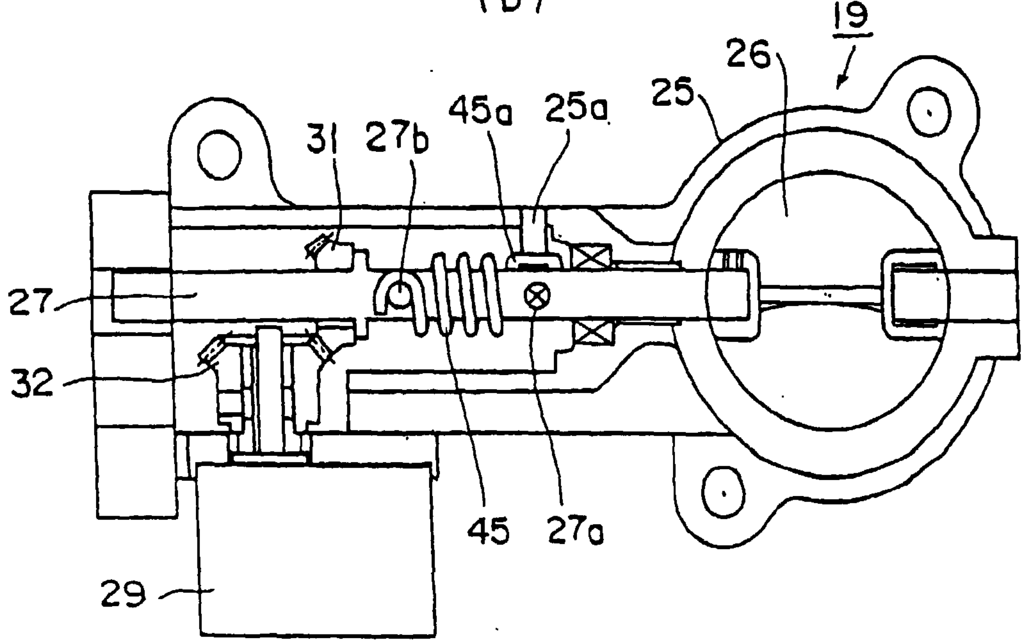
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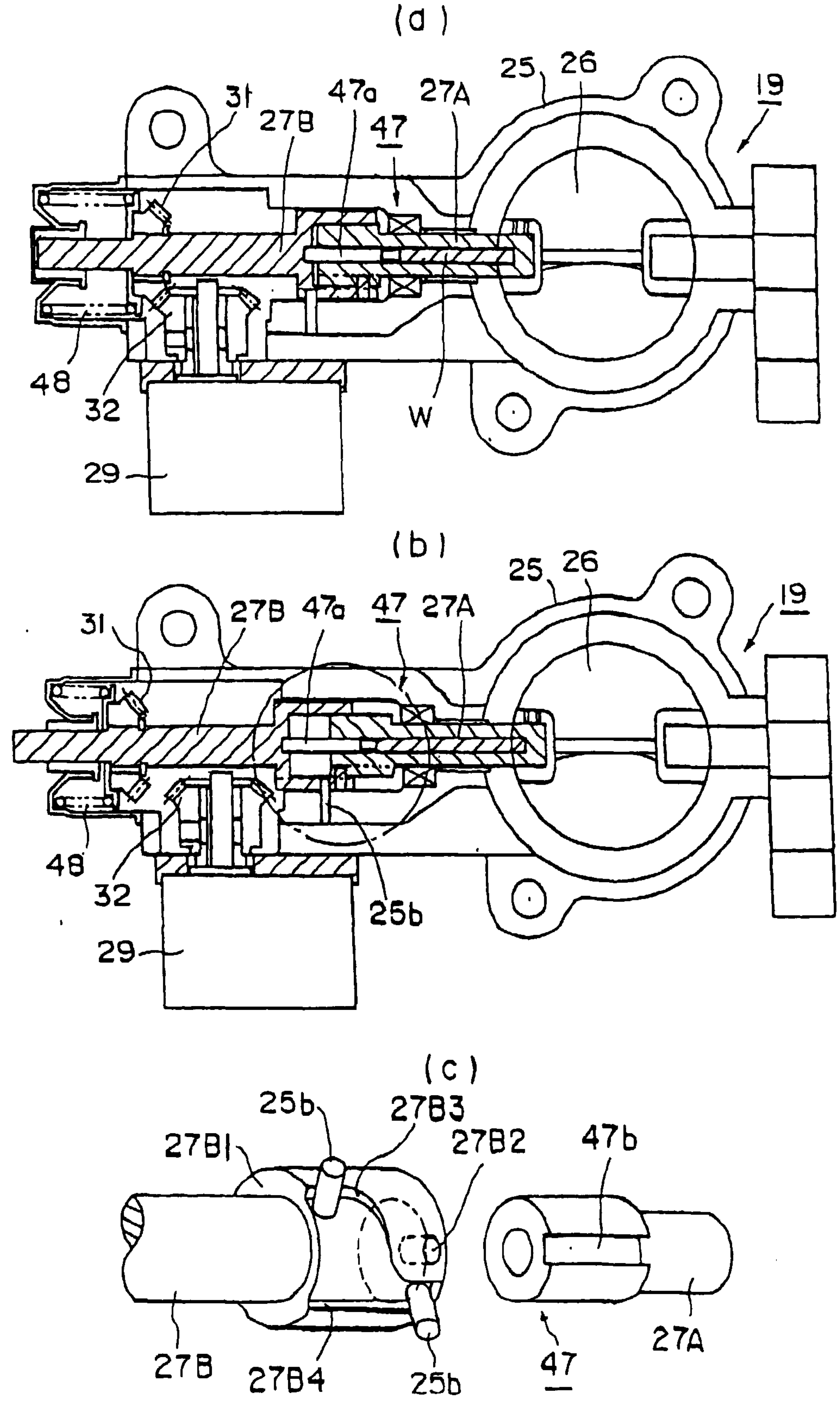
Fig.6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(b)
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47a
47
27A
48
32
25b
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(c)
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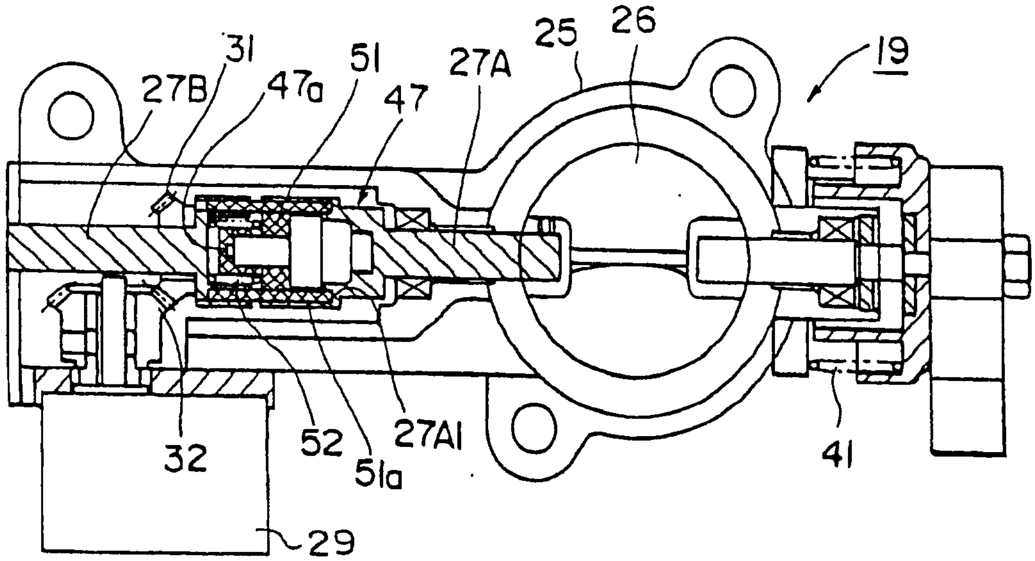
27A

Fig.7

(a)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27A1
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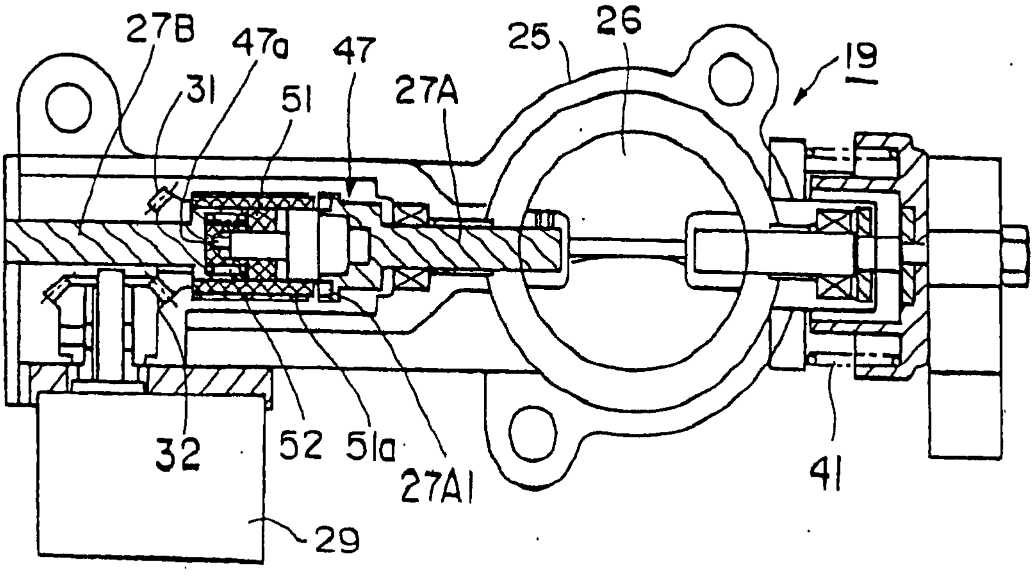
29

(b)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29

Fig.8

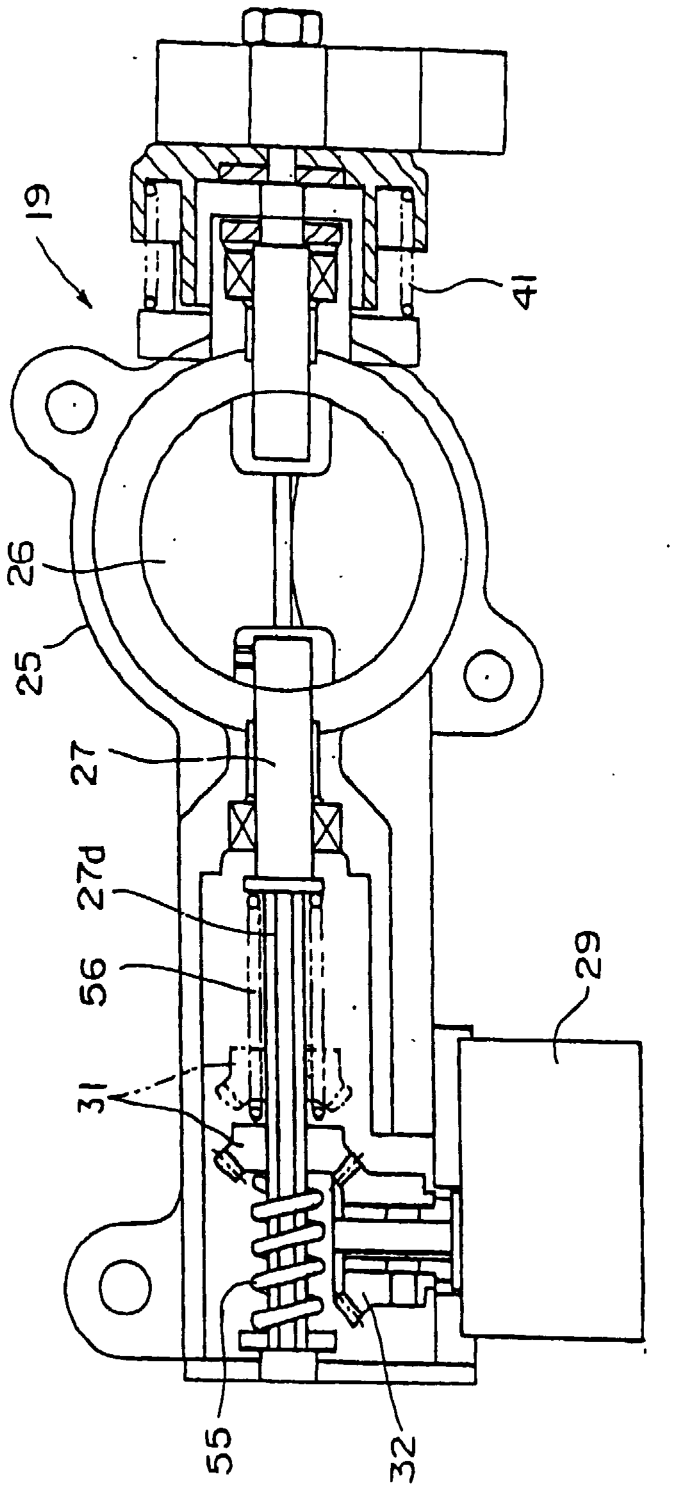

Fig.9

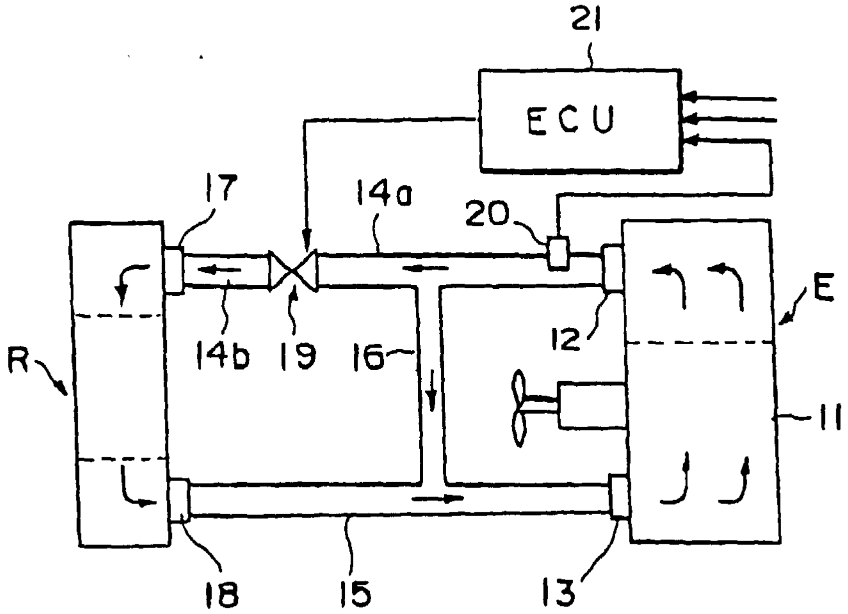
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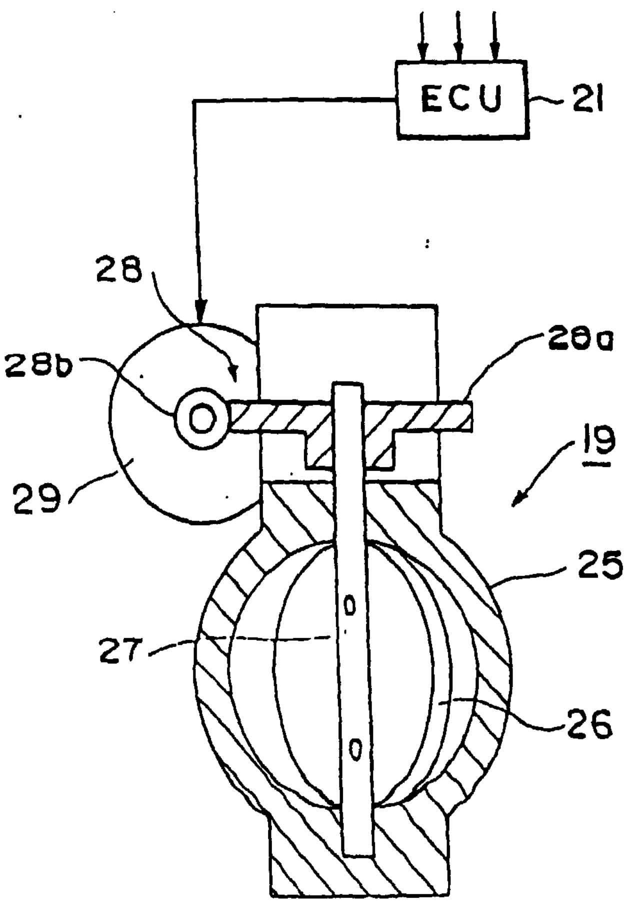
Fig.10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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/01814

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl^6 F01P7/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl^6 F01P7/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-1999
Kokai Jitsuyo Shinan Koho	1971-1999	Jitsuyo Shinan Toroku Koho	1996-1999

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 4-91314, A (Calsonic Corp.), 24 March, 1992 (24. 03. 92)	1
A	JP, 3-258916, A (Mitsubishi Electric Corp.), 19 November, 1991 (19. 11. 91)	6
A	JP, 5-27463, U (Nippon Thermostat Co., Ltd.), 9 April, 1993 (09. 04. 93)	6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 June, 1999 (25. 06. 99)	6 July, 1999 (06. 07. 99)

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Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)