Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2282628 C 2006/11/07

(11)(21) 2 282 628

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 1998/02/27
(87) Date publication PCT/PCT Publication Date: 1998/09/03
(45) Date de délivrance/Issue Date: 2006/11/07
(85) Entrée phase nationale/National Entry: 1999/08/23
(86) N° demande PCT/PCT Application No.: US 1998/003942
(87) N° publication PCT/PCT Publication No.: 1998/038485
(30) Priorité/Priority: 1997/02/27 (US60/039,184)

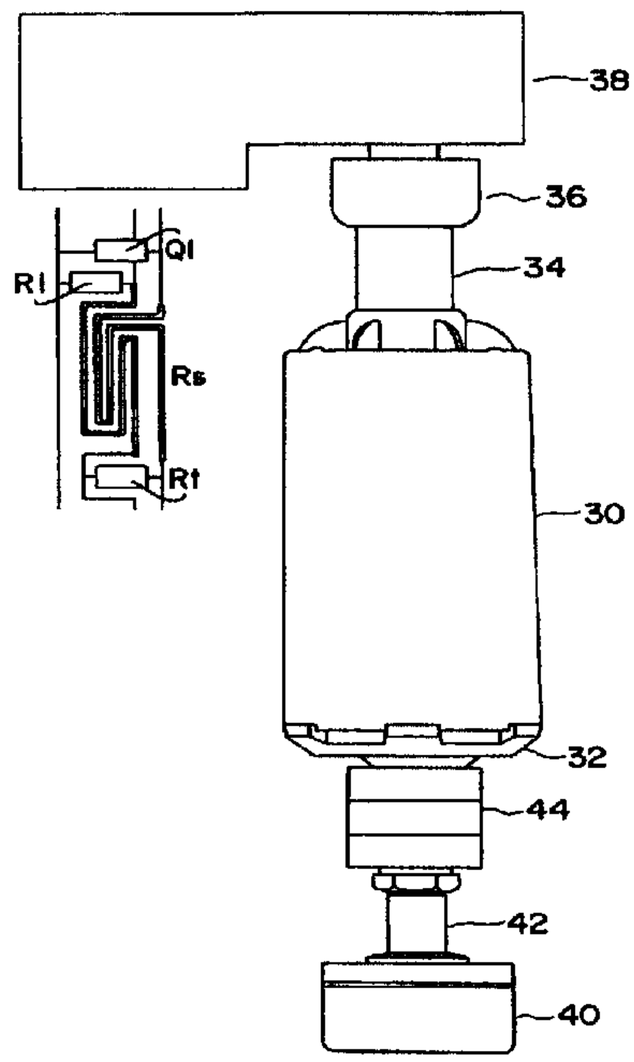
(51) Cl.Int./Int.Cl. *G01M 3/40* (2006.01), *G01M 3/18* (2006.01), *G01M 3/04* (2006.01)

(72) Inventeurs/Inventors:
CARR, RAYMOND A., US;
LAUMAN, BRIAN C., US

(73) Propriétaire/Owner:
BRISTOL-MYERS SQUIBB COMPANY, US

(74) Agent: OSLER, HOSKIN & HARCOURT LLP

(54) Titre : SYSTEME DE DETECTION DE FUITE POUR DISPOSITIF DE TRAITEMENT DE LIQUIDES
(54) Title: LEAK DETECTION SYSTEM FOR LIQUID PROCESSING DEVICE



(57) Abrégé/Abstract:
A leak sensor system for use in liquid processing equipment is disclosed. Liquid is detected by a sensing resistor whose impedance decreases dramatically in the presence of liquid. The effect of this impedance drop on the output voltage of the sensor indicates a wet or moist state which may indicate leakage from the liquid processing. A terminal resistor is in the circuit beyond the sensing resistor to provide a warning indicator when the sensing resistor is damaged or disconnected. The leak sensor system is particularly useful in centrifuge equipment, e.g., for the processing of blood.

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G01M	A2	(11) International Publication Number: WO 98/38485
		(43) International Publication Date: 3 September 1998 (03.09.98)

(21) International Application Number: PCT/US98/03942

(22) International Filing Date: 27 February 1998 (27.02.98)

(30) Priority Data:
60/039,184 27 February 1997 (27.02.97) US

(71) Applicant: BRISTOL–MYERS SQUIBB COMPANY [US/US]; 100 Headquarters Park Drive, Skillman, NJ 08558 (US).

(72) Inventors: CARR, Raymond, A.; 1718 Clement Road, Lutz, FL 33549 (US). LAUMAN, Brian, C.; 14128 Spoonbill Lane, Clearwater, FL 34622 (US).

(74) Agents: FURMAN, Theodore, R., Jr. et al.; Bristol–Myers Squibb Company, 100 Headquarters Park Drive, Skillman, NJ 08558 (US).

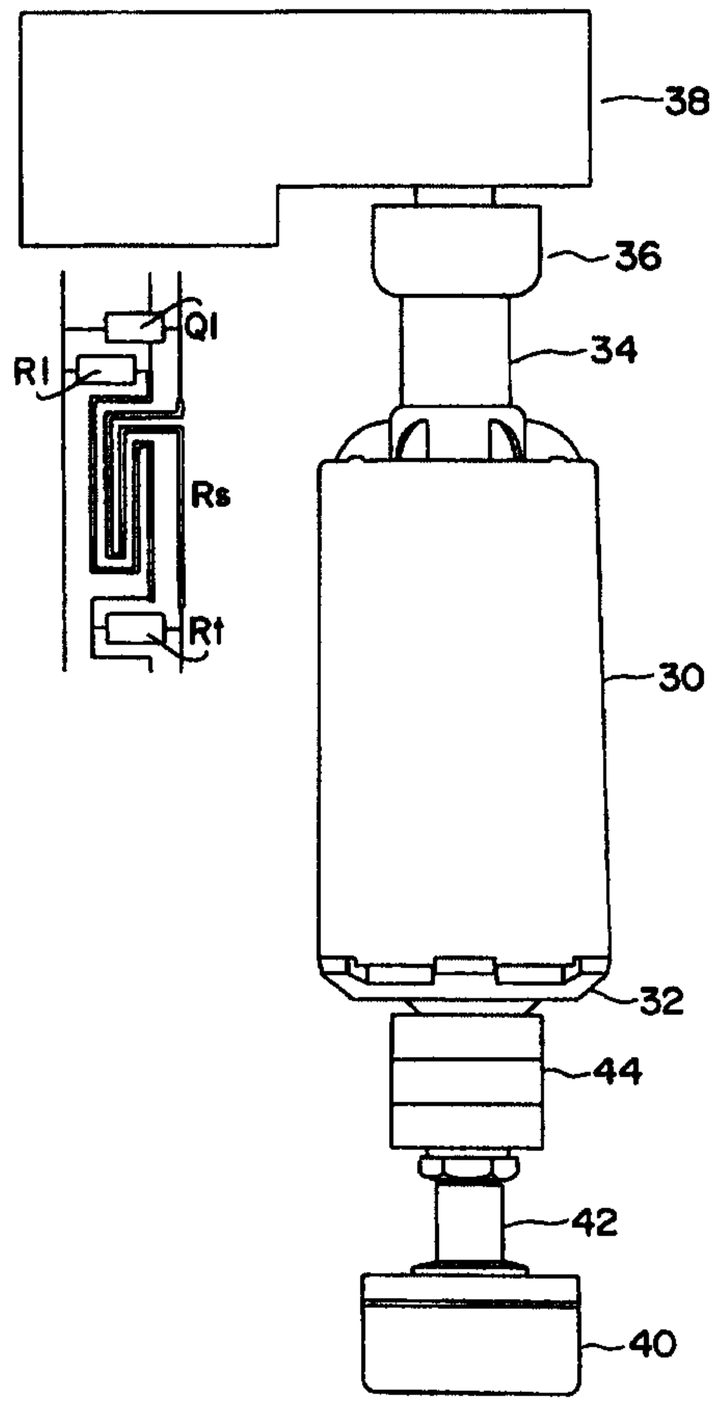
(81) Designated States: AU, CA, IL, JP, NZ, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: LEAK DETECTION SYSTEM FOR LIQUID PROCESSING DEVICE

(57) Abstract

A leak sensor system for use in liquid processing equipment is disclosed. Liquid is detected by a sensing resistor whose impedance decreases dramatically in the presence of liquid. The effect of this impedance drop on the output voltage of the sensor indicates a wet or moist state which may indicate leakage from the liquid processing. A terminal resistor is in the circuit beyond the sensing resistor to provide a warning indicator when the sensing resistor is damaged or disconnected. The leak sensor system is particularly useful in centrifuge equipment, e.g., for the processing of blood.



Leak Detection System for Liquid Processing Device

Field of the Invention

The present invention pertains to a method and device useful for sensing the presence of moisture or moisture leakage and is more particularly involved with an apparatus used to process a liquid which incorporates such a novel leak sensor.

Background of the Invention

In the design of liquid processing equipment it is usually critical to substantially alleviate liquid leakage. Such leakage can be detrimental to the equipment itself and can adversely affect the desired product. Also, the liquid may present a hazard to the equipment operator. A specific example of this is blood processing equipment such as centrifuges, blood separators, plasmapheresis apparatus and the like.

Centrifugal blood separators useful for separating blood into desired fractions and isolating specific coagulation factors are disclosed in, e.g., US 5,480,378, US 5,603,845, PCT/US95/15669, WO 97/20635, PCT/US95/15667 and PCT/US95/15675. These devices are useful for the precise, automated preparation of blood coagulation products useful, for example, as surgical sealants. It is important for the process, product and processor to avoid leakage of the blood or blood products. Also, when such processors are used to process autologous blood, i.e., to generate blood products from the patient's own blood, the blood is typically untreated and leakage needs to be minimized to protect the operators and caregivers using such equipment.

Brief Description of the Drawing

Figure 1 shows a schematic diagram of the Leak Sensor System of the present invention.

Figure 2 shows a schematic diagram of the Leak Sensor Assembly Geometry of the device of the present invention.

Figure 3 shows a diagram of a centrifuge apparatus including the leak sensor system of the present invention.

Description of Preferred Embodiments

The present invention comprises a novel leak detection system useful in liquid processing equipment and is particularly useful in blood processing equipment. The leak sensor of this invention provides a highly sensitive and accurate indication of liquid leakage with circuitry to significantly alleviate electromagnetic interference from the surrounding, or nearby, devices. The present sensor also incorporates safety design features which provide an error message if the sensor system is damaged or disconnected.

The leak sensor system is designed as a resistive system which is able to detect leaks by the shorting of a conductive fluid across its leads. The use of a resistive geometry for leak detection is not unique in and of itself, but the unique implementation of the accompanying circuit provides error signals if the sensor is damaged or disconnected. The present invention is described with specific reference to resistors, but any impedance devices or components could be used.

The leak sensor system 10 of the present invention is shown if Figure 1 comprising a leak sensor assembly 12 as it is aligned with the leak sensor interface 14.

The sensing impedance component Rs is in series with an initial impedance component, e.g., a pullup resistor R_1. This

forms a circuit whose output voltage at the union of these two devices decreases with the application of a conductive fluid to Rs, which results in lowering the effective impedance of Rs. The impedance of a non-wet Rs is in the MOhm range thereby forcing a non-wet output at saturation. The use of a parallel resistor to Rs, e.g., a terminal impedance component, Rt, generates a non-saturated known output voltage at the union of the initial impedance component R_1, the terminal impedance component Rt and the sensing impedance component Rs. The terminal impedance component Rt is attached at the endpoint of the circuit through the use of the non-wet conductive path of Rs, the sensing impedance component, thereby forming a circuit whose output goes to saturation in an error state, when the sensing impedance component Rs is broken due to mishandling during installation or routine user cleaning.

In viewing Figure 1 it can be appreciated that a prior art leak sensor assembly would not include the terminal impedance component, Rt. Accordingly, in a dry state, i.e., where Rs is not shorted by the presence of a liquid, the output voltage would be nearly identical to the output voltage if Rs were broken or missing. This is because in each case the output voltage is substantially a function of the source voltage and R_1. Thus, the prior art leak sensor assembly could detect moisture, but an incorrect "dry" reading may actually be noticed in a situation where the assembly is broken and malfunctioning.

In the present invention, the use of a terminal impedance component, Rt, varies the output voltage sufficiently from that realized with R_1 alone so that the presence or absence of Rt is clearly detectable. Thus, the integrity of the Rt/Rs

subassembly is readily detectable in the present invention. Accordingly, the present leak sensor assembly is capable of producing "wet", "dry" and "broken" signals. Further, in accordance with the present invention, the placement of the terminal impedance component Rt allows for the attachment of multiple sensing impedance components Rs. The detection of the mis-connection or damage of any one or all of the sensing impedance components is accomplished by connecting them in series of the non-wet conductive path with the terminal impedance component Rt at the end of the chain.

Reduction of susceptibility to electromagnetic interference is allowed through the use of a voltage following transistor Q_1 configuration with Gain >> 1. This design allows the termination impedance of the device to be effectively lowered to a value dictated by Rp and reduce its electrical noise susceptibility.

The placement of voltage following transistor Q_1 also allows for the termination of the sensor at the leak sensor interface. In this way, a pulldown resistor, Rp, is placed on the leak sensor interface. This configuration allows the detection of a disconnected sensor. If the sensor is connected then the input voltage will be in some known state above the return reference Rtn, or ground. However, if the sensor is disconnected Rp will pull the detected voltage to the return reference Rtn, or ground, and indicate an error.

Figure 2 shows a preferred geometry of the leak sensor assembly 12 of the present invention where the sensing impedance component Rs is shown to be a bare wire arrangement. This can be obtained by any known means, e.g., by stripping or baring a portion of the metallic wiring on a printed wiring board. It can be appreciated that a liquid being introduced

across the bare wiring of Rs will short the component and greatly lower the impedance, hence providing the "wet" or "leak" signal.

The present leak sensor system is connected by known means to appropriate indicators to indicate a wet or dry condition, a broken sensing impedance component or an unplugged or disconnected leak sensor assembly. These signals can further be used to carry out specific control steps for the apparatus in which it is used, such as a shut down of the processing in the case of any of the error messages.

As will be understood by those skilled in the art, the leak sensor assembly and leak sensor interface are in electrical communication via known cable and/or plug means. The values of the various components will be selected as appropriate by the skilled worker in the art. As mentioned above, the present leak sensor can be used with any liquid processing equipment. It is especially useful when used in centrifugal liquid separation/fractionation equipment, such as blood separation equipment. Such equipment is illustrated in, for example, WO 97/20635 which is directed to a centrifuge apparatus which rotates a blood processing container about is longitudinal axis at high speeds, e.g., 2,000-10,000 RPM.

Figure 3 is an illustration of such a device wherein a container 30 is locked onto a turntable 32 at the container 30 bottom and where the container neck 34 is secured by a top locking means 36. The top locking means 36 is integral with a shaft in rotary communication with a bearing housing 38. A motor 40 rotates the container 30 via the coupling 42 and bearing 44 integral with the turntable 32. Leak sensor assembly 10 should be arranged normal to the expected path of leaking liquid. In Figure 3 the assembly 10 is shown normal

to the upper edge of the container 30. A second leak sensor assembly could also be arranged at the bottom corner of the container 30 or along the entire height of the container 30 as appropriate.

Claims

1. A leak sensor system comprising a leak sensor assembly for use in a device which processes liquid and which is adapted to be in electrical communication with a leak sensor interface, which interface provides a source voltage to said sensor assembly and which receives input voltage which is the output voltage from said sensor assembly wherein a comparison of said source and input voltages can be correlated to a wet or dry condition within said device, said leak sensor assembly comprising:

a) an initial impedance component which provides a known voltage from said source voltage;

b) a sensing impedance component which provides a first sensing impedance to said known voltage in a dry state and a second sensing impedance when in contact with a conductive liquid;

c) a terminal impedance component being electrically connected to said sensing impedance component whereby the output voltage in said dry state is altered by said terminal impedance component such that an output voltage substantially equal to the source voltage is indicative of damage or breakage to the sensing impedance component;

d) a voltage following transistor with gain significantly greater than 1 said voltage following transition being located at the junction of said initial, sensing and terminal

impedance components whereby an improved signal-to-noise ratio of the signal to the leak sensor interface is provided; and

e) a pulldown impedance component within said leak sensor interface and connected to the input voltage received as output voltage from said leak sensor assembly such that if said assembly is disconnected the pulldown impedance component will pull the input voltage to ground and indicate an error.

1/2

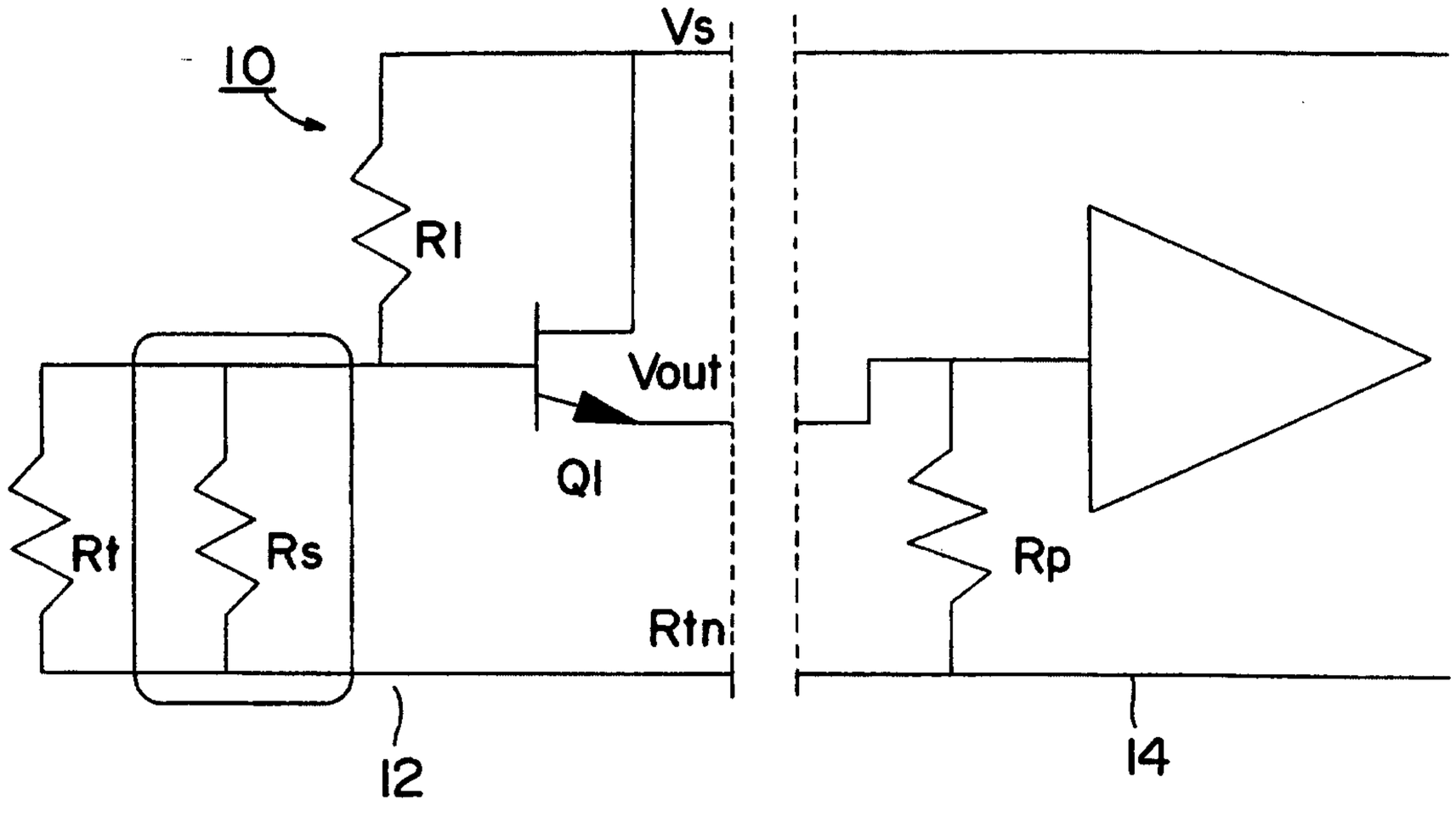


FIG. 1

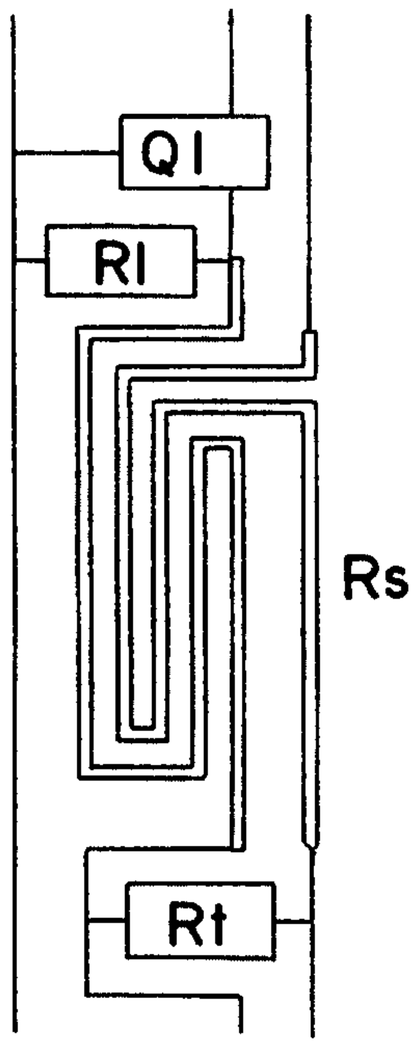


FIG. 2

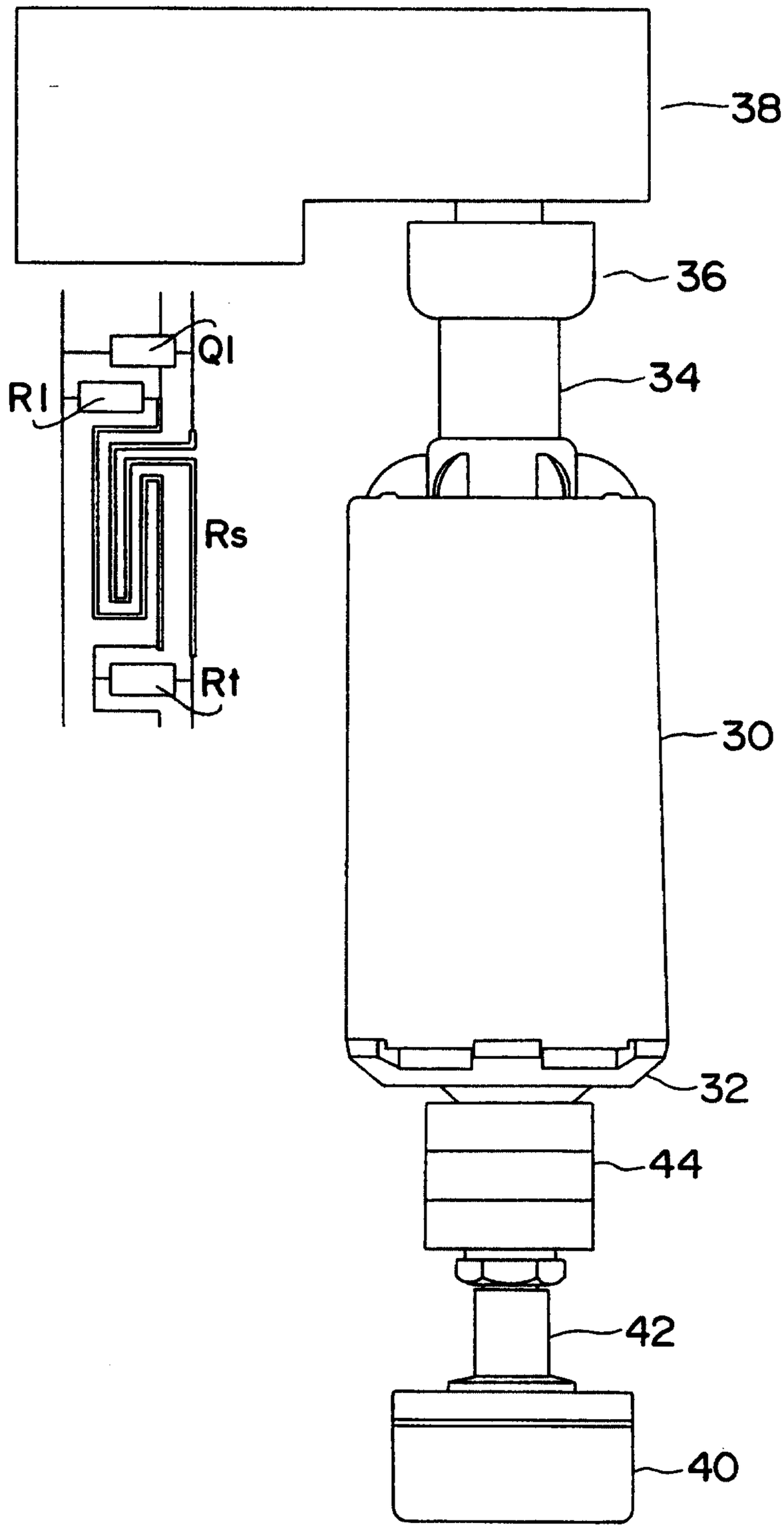
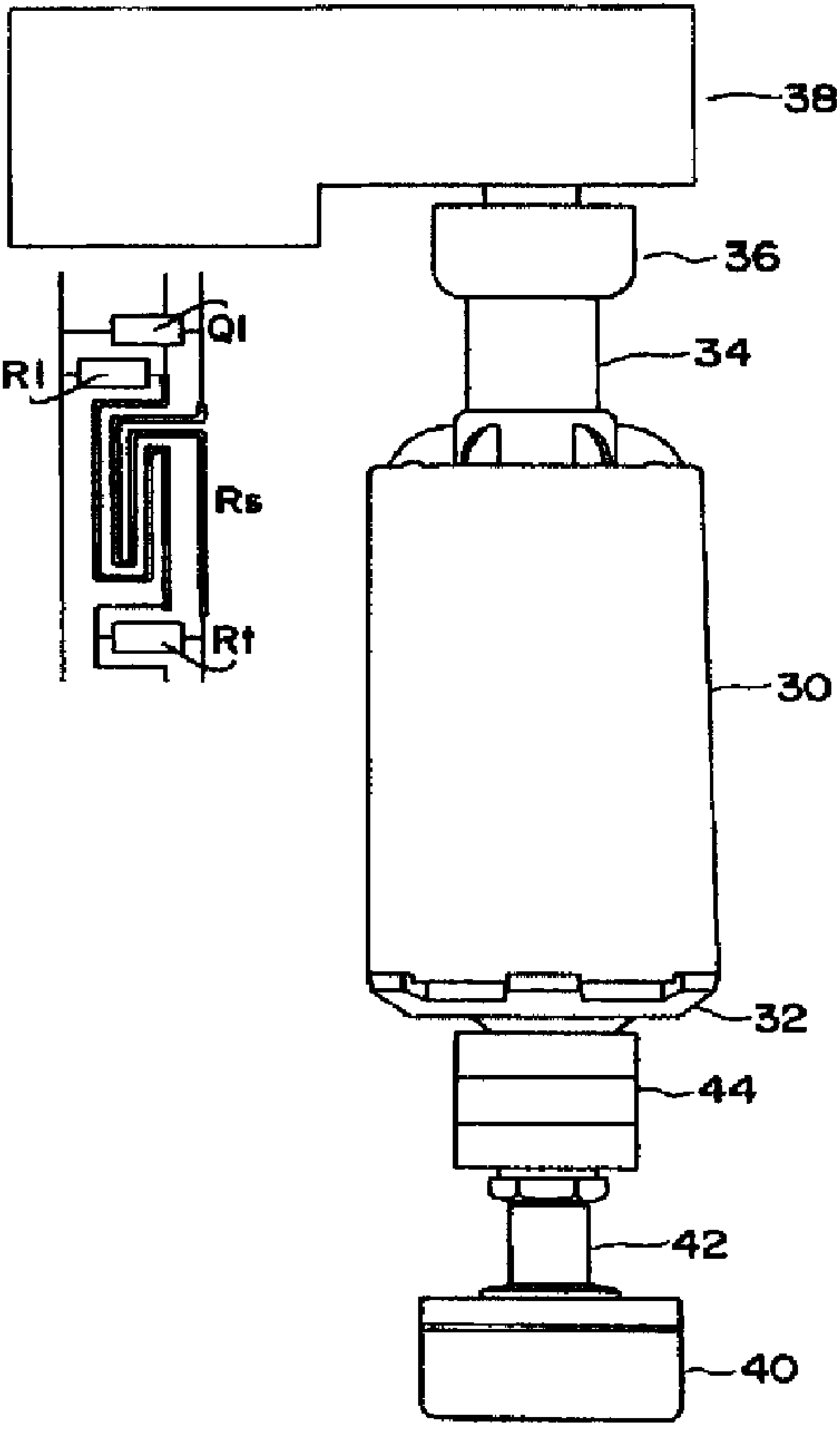


FIG. 3


38
36
34
Q1
R1
Rs
Rt
30
32
44
42
40