

Description

This invention relates to load cells and method of manufacturing the same.

A load cell has a plurality of resistors formed on strain generating sections of a beam body, and a load applied to the beam body is measured by making use of the fact that the resistance of the resistor is changed according to the strain generated in the strain generating section at the time of the application of the load to the beam body. Hitherto, it has been a practice to form a load cell by bonding a metal foil of constantan, nicrome, etc. to an insulating film of each material as polyimide or epoxy resin, appropriately etching the metal foil to form a resistor pattern to thereby form a load cell element and bonding the load cell element thus formed to the strain generating section of the beam body. This prior art method of manufacture of a load cell, however, requires a number of steps. Particularly, the step of bonding the load cell element to the beam body requires strict process control, and also its automation and mass production scale operation are difficult, thus giving rise to high cost. In addition, there is a lower limit of the thickness of the insulating film that can be obtained, so that it is difficult to permit strain generated in the strain generating section of the beam body to be transmitted with high efficiency to the resistors, thus leading to measurements errors. Further, while the resistor pattern is formed by the metal foil, it is difficult to form the metal foil sufficiently thin and obtain resistors having a high resistance. Consequently, high power is consumed at the time of the measurement, and this high power consumption is accompanied by high heat generation at the time of the measurement so that temperature compensation is called for.

Many of the drawbacks of the older technique described before have been overcome by using the thin-film-technique for depositing thin layers constituting the resistors directly on the supporting substrate by evaporation or sputtering. This procedure of obtaining strain measurement transducers has been developed in recent years and has been described in a paper by K. Bethe and D. Schön called "Thin-film strain-gauge transducers" published in Philips Tech. Rev. 39, 94—101, 1980, No. 3/4. On the surface of the substrate there is produced a thin isolating film, on which a resistive layer and a conductive gold layer are applied by sputtering. The bridge pattern in the resistive film and in the gold film is made in two photolithographic stages. The trimming of a Wheatstone bridge so produced for symmetry is done by burning away strain-gauge material from the resistive film by lasers, until the bridge is balanced. The influence of temperature on the resistance of the strain gauges is made sufficiently small by annealing the elements at around 300°C.

In some instances, however, a satisfying independency from temperature influences cannot be obtained by annealing or the like.

In EP—A1-18 013 there is described a strain-gauge of the common type, i.e. with a plastics foil, which is bonded to the substrate and carries the resistive layers. The foil carries resistors in series with the strain gauges of the bridge having different resistivity as the latter and compensating for temperature effects.

The object of the invention is to provide a load cell of the advanced type, i.e. with thin films immediately applied to the substrate, by which the temperature dependency of the resistor configuration can be effectively decreased.

In one mode of the invention, there is provided a load cell according to the preamble of claim 1, which has been based on the paper of K. Bethe and D. Schön mentioned above. According to the invention, a load cell of this kind further comprises a first temperature compensating resistor connected to one of the power source terminals and having a positive temperature coefficient of resistance, there has been formed on the first resistive layer over a pattern area including said first temperature compensating resistor and connecting means a second resistive layer having a lower resistivity than the resistivity of said first resistive layer, and a first conductive layer has been formed on said second resistive layer.

Instead of changing the properties of the resistance material by annealing, there are used two different resistive materials having different resistivities and cooperating to decrease the temperature influence on the output of the bridge. The problem is how to apply these different resistive materials, and this is solved by applying two resistive and one conductive layer over each other, whereby the advanced structure can be obtained relatively easily and in a manner which can be carried out on an industrial scale.

Useful further developments of the invention defined in claim 1 are subject matter of claims 2 to 8.

The method aspect of the invention is defined in claims 9 to 15.

The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which Figs. 1—7 are intended to illustrate the thin film technique in a known load cell configuration and in which Figs. 8—15 show the invention.

Fig. 1 is a schematic perspective view of a load cell;

Fig. 2 is a sectional view of the same load cell in a state bearing a load applied;

Fig. 3 is a circuit diagram showing an equivalent circuit of the load cell shown in Fig. 1;

Figs. 4A to 4E are sectional views illustrating a method of manufacture of the load cell shown in Fig. 1;

Fig. 5 is a view showing a different method of manufacture of the load cell shown in Fig. 1;

Fig. 6 is a view showing the layout of a different embodiment of a load cell;

Fig. 7 is a circuit diagram showing an equivalent circuit of the load cell shown in Fig. 6;

Fig. 8 is a schematic perspective view showing an embodiment of the load cell according to the invention;

Fig. 9 is a sectional view showing the load cell of Fig. 8 when a load is applied;

Fig. 10 is a circuit diagram showing an equivalent circuit of the load cell shown in Fig. 8;

Figs. 11 to 13 are graphs showing output voltage versus temperature characteristics;

Figs. 14A to 14G are views illustrating a method of manufacture of the load cell shown in Fig. 8; and

Figs. 15A and 15B are views illustrating a method of manufacture of the load cell shown in Fig. 8.

5 The load cell of Fig. 1, includes a beam body 2, which is formed by cutting a metal material such as stainless steel (SUS630) or duralumin (A2014, A2024 or A2218), and a load cell element 4 formed on the beam body 2. The beam body 2 has mounting holes 2-1 and 2-2, in which two mounting bolts 6-1 and 6-2 for mounting the load cell at a stationary end portion thereof on a support base 8 as shown in Fig. 2 are inserted. The beam body 2 also has a thin strain generation portion 2-3 extending from the right side of the
10 stationary end portion of the beam body and on which the load cell element 4 is formed, and a load bearing portion 2-4 extending from the movable end of the strain generating portion 2-3 back toward the stationary end portion. A support member 10 for supporting a sample weighing base (not shown), is mounted on the load bearing section 2-4. When a sample to be measured is placed on the sample weighing base, the strain bearing section 2-3 undergoes a great strain, more particularly a maximum extension strain in its portion
15 near the stationary end portion and a maximum contraction strain in its portion near the movable end portion in Fig. 2.

The load element 4 includes an insulating film 4-1, which is formed on the strain bearing portion of the beam body 2 and formed of a heat-resistive insulating resin such as polyimide, polyamide-imide and epoxy modified polyimide, resistors 4-2 to 4-9 of an equal resistance formed on the insulating film 4-1 and
20 connected to form a bridge circuit as shown in Fig. 3, and an insulating film 4-10 covering the resistors 4-2 to 4-9. In the bridge circuit shown in Fig. 3, resistors R1 to R8 correspond to the respective resistors 4-2 to 4-9 shown in Fig. 1. The resistors 4-2 to 4-9 are connected in series in the mentioned order by leads formed of a conductive layer such as gold layer. A pair of power source lines (not shown), between which an input voltage VI is applied, are connected to central portions of the two conductive connecting leads one
25 connecting the resistors 4-2 and 4-9 and the other connecting the resistors 4-5 and 4-6 (corresponding to points A and B in the bridge circuit of Fig. 3), and two output lines (not shown) are connected to central portions of the two conductive connecting leads one connecting the resistors 4-8 and 4-7 and the other connecting the resistors 4-3 and 4-4 (corresponding to points C and D in the bridge circuit of Fig. 3). The resistors 4-2, 4-3, 4-6 and 4-7 are formed over the region of the beam body 2 that undergoes the maximum
30 extension strain, while the resistors 4-4, 4-5, 4-8 and 4-9 are formed on the region of the beam body 2 that undergoes the maximum contraction strain. In other words, the resistors inserted in the opposing sides of the bridge circuit are formed in the same region. When a sample to be measured is placed on the sample weighing base, therefore, the resistors 4-2, 4-3, 4-6 and 4-7 experience an extension strain corresponding to the load, while the resistors 4-4, 4-5, 4-8 and 4-9 experience a contraction strain to an extent corresponding
35 to the extension strain caused in the resistors 4-2, 4-3, 4-6 and 4-7. Thus, the bridge circuit gets out of the balanced state, and an output voltage VO corresponding to the load appears between the output terminals C and D.

Now, the method of manufacturing the load cell shown in Figs. 1 and 2 will be described with reference to Figs. 4A and 4B.

40 In the first place, the surface of the strain generating section of the beam body 2 obtained by the cutting process is rinsed to remove fat, and varnish-like heat-resistant insulating resin, for instance polyimide, epoxy, polyamide-imide, epoxy-modified polyimide, etc. with a viscosity of 1,000 cp is dripped on the rinsed surface. Then, the beam body 2 is rotated with a spinner at a speed of 1,000 rpm to obtain uniform coating of the heat-resistant insulating resin over the surface of the beam body. The system is then heated
45 to about 350°C in a fluorine gas atmosphere, whereby the insulating resin is hardened to form a heat-resistant insulating film 4-1 with a thickness of about 6μ over the surface of the strain bearing section. Subsequently, a metal having a high resistivity and a low temperature coefficient of resistance for forming resistors on the insulating film 4-1, for instance, nicrome, constantan, etc., is deposited by such means as electron beam deposition or sputtering to form a resistive thin film 12 with a thickness of about 1,000 Å.
50 Further, a metal layer 14 of gold or chromium for forming leads is formed on the resistive thin film 12 to a thickness of about 2 μ by means of electron beam deposition or sputtering.

The metal layer 14 and resistive thin film 12 are then successively photo-etched with liquid etchants suited to the respective metals and also using a pattern defining the region where the leads and resistors are formed as shown in Fig. 4B. In this way, a two-layer pattern formed of the resistive thin film 12 and
55 metal layer 14, is formed on the insulating layer 4-1.

Thereafter, a portion of the metal layer 14 corresponding to the region of the resistors 4-2 to 4-9 is photo-etched as shown in Fig. 4C. Thus, the resistors 4-2 to 4-9 obtained are each formed of the single resistive thin film 12, while the conductive lead layers for connecting the resistors 4-2 to 4-9 in series each have a two-layer structure formed of the resistive thin film 12 and metal layer 14.

60 Afterwards, an insulating film 4-10 of a heat-resistant insulating resin is formed over the pattern of the resistors and leads as shown in Fig. 4D.

Finally, the insulating film 4-10 is selectively etched as shown in Fig. 4E to form electrode holes. These electrode holes are formed to expose a central portion of the conductive leads respectively connecting the
65 resistors 4-2, 4-3, 4-6 and 4-7 to the resistors 4-9, 4-4, 4-5 and 4-8. Metal electrodes of aluminum, gold or the

like are then formed in these electrode holes. The power source lines and output lines which are also made of aluminum, gold or the like are connected to these electrodes.

In the load cell obtained in this way, in which the conductive layers 12 are formed substantially on a flat surface, there is no possibility of breakage of the conductive layer caused by any stepped surface. In addition, since the resistors 4-2 to 4-9 are formed thinly on the insulating film 41, it is possible to obtain resistors of high resistance. Thus, it is possible to reduce power consumption and heat generation in the load cell at the time of the operation thereof and permit high precision measurement.

Fig. 5 shows a method of manufacture of a different embodiment of the load cell according to the invention. In this method, the metal film 14 of the structure shown in Fig. 4A is selectively etched to leave only the conductive layers as shown by solid lines, which are used to connect the resistors (shown by broken lines in Fig. 5) which are formed in the next step. The resistive film 12 is then selectively etched to leave the portions shown by the broken line in Fig. 5 and also portions underlying the conductive layers shown by the solid lines. In this way, the same structure as that of Fig. 4C can be obtained.

Fig. 6 shows a load cell pattern in a further embodiment of the invention. In this load cell, a correction resistor 4-11 is connected between the resistors 4-2 and 4-3, and a correction resistor 4-12 is connected between the resistors 4-8 and 4-9, the rest being the same as the load cell shown in Fig. 4C. The correction resistors 4-11 and 4-12 each have a structure formed of a plurality of serially connected ladder-type resistor elements. More particularly, each ladder-type resistor element includes first and second resistive layers extending parallel to each other and a plurality of bypass resistive layers connected between the first and second resistive layers. The resistance of the ladder-type resistor element can be adjusted by selectively breaking the bypass resistors.

The correcting resistors 4-11 and 4-12 may be formed with the same material and by the same process as for the resistors 4-2 and 4-9. Also, they are formed on a portion of the beam body 2 that substantially undergoes no strain when a load is applied so that they would not be influenced by the strain produced in the beam body 2.

To establish the balanced state of the bridge circuit shown in Fig. 3, i.e., to meet a condition

$$(R_1 + R_2)(R_5 + R_6) = (R_3 + R_4)(R_7 + R_8),$$

it is required to form the resistors 4-2 to 4-9 with a high precision. With the embodiment of Fig. 6, however, it is not necessary to form the resistors 4-2 to 4-9 with high precision, because the correction resistors 4-11 and 4-12 are ladder-type resistor elements, and the resistance thereof is adjustable. That is, in the equivalent circuit shown in Fig. 7 corresponding to the load cell of Fig. 6, the resistors R9 and R10 which correspond to the respective correction resistors 4-11 and 4-12 are variable, and thus the bridge circuit can be set to the balanced state by adjusting one or both of the resistors R9 and R10. These correction resistors 4-11 and 4-12 are formed, for instance, together with the resistors 4-2 to 4-9 in the step shown in Fig. 4C. Then, a bridge balance test is conducted, and the resistances of the correction resistors are adjusted on the basis of the data obtained as a result of the test.

Fig. 8 shows a schematic perspective view of an embodiment of the load cell according to the invention. This load cell has a beam body 20 made of the same material as the aforementioned beam body 2 and a load cell element 22 formed on the beam body 20. The beam body 20 is formed in its stationary end portion with through holes 20-1 and 20-2, in which mounting screws for mounting the load cell on a support are received, and also in its movable end portion with a through hole 20-3, in which a mounting member for mounting a sample base (not shown) is received. The beam body 20 further has transversally formed circular holes 20-4 and 20-5 communicated with each other by a transversal hole portion 20-6. With the beam body 20 secured as shown in Fig. 9 and with a load applied to the movable end portion of the beam body 20, the region over the through hole 20-4 is relatively extended while the region over the through hole 20-5 is relatively contracted.

The load cell 22, like the load cell shown in Figs. 1 and 2, includes an insulating film 22-1 formed on the top surface of the beam body 20, resistors 22-2 to 22-11, and an insulating film 22-12 formed to cover the resistors 22-2 to 22-11. The resistors 22-2 to 22-5 are strain gauge resistors having substantially an equal resistance and formed of a material having a high resistivity and a low temperature coefficient of resistance, i.e., with the resistance changing little with changes in temperature. The resistor 22-2 has one end connected to one end of the resistor 22-3 and the other end connected through the resistor 22-6 serving as a bridge balancing resistor and the resistor 22-7 serving as a temperature compensation resistor to one end of the resistor 22-4. The other end of the resistor 22-3 is connected through the resistor 22-8 as bridge balancing resistor and resistor 22-9 as temperature compensation resistor to one end of the resistor 22-5. The other ends of the resistors 22-4 and 22-5 are connected to each other and also to temperature compensation resistor 22-10 and temperature characteristic compensation resistor 22-11 connected in parallel. The resistances of the bridge balancing resistors 22-6 and 22-8 can be adjusted like the bridge balancing resistors 4-11 and 4-12 shown in Fig. 6. The temperature compensation resistors 22-7 and 22-9 serve to compensate for temperature drift in the bridge balance. They are made of a metal such as titanium having a positive temperature coefficient of resistance. The temperature compensation resistors 22-7 and 22-9 also have a ladder-type structure for adjustment of the resistance. The temperature compensation resistor 22-10 serves to compensate for fluctuations of the output voltage (or span) due to temperature

change, and is made of a metal such as titanium having a positive temperature coefficient of resistance. The temperature dependency of the output voltage mainly stems from the temperature dependency of the Young's modulus of the beam body 20. The temperature characteristic compensation resistor 22-10 for reliably compensating for the output voltage fluctuations due to temperature change.

The function of temperature compensation by the resistors 22-10 and 22-11 will now be described with reference to the equivalent circuit shown in Fig. 10. In the equivalent circuit, the resistors R11 and R20 correspond to the resistors 22-2 to 22-11 shown in Fig. 8.

Now, assume that the beam body 20 is made of stainless steel (SUS630) and the strain gauge resistors 22-2 to 22-5 are made of nicrome (Ni 40%, Cr 60%) such that their resistance is 3.0 kΩ and their temperature coefficient of resistance is +5 PPM/°C. The output voltage (span) of the bridge circuit gradually increases with temperature rise as shown in Fig. 11 if the temperature compensation resistor 22-10 and temperature characteristic compensation resistor 22-11, i.e., the resistors R19 and R20 in Fig. 10, are not used. For example, the output voltage at 40°C is higher than the output voltage at 0°C by about 0.7%. Next, suppose that the temperature compensation resistor 22-10 which is formed of the lamination of titanium and nicrome layers and has a resistance of 312 Ω and a temperature coefficient of resistance of +2,800 PPM/°C, is used for improving the span temperature characteristic. In this case, the output voltage V0 is given as

$$V_0 = \frac{R}{R + R_{19}} \times V_1 \times K \times E \quad (1)$$

where R is the compound resistance of the bridge circuit, and K is the gauge factor of the strain gauge resistors 22-2 and 22-5 and have a value of 1.79 in case of nicrome (Ni 40%, Cr 60%). E represents the strain generated in the beam body 20 according to the load.

In this example, the output voltage has substantially the same value at 0°C and at 40°C, and is slightly increased in the neighborhood of 20°C. The voltage variation in the neighborhood of 20°C is, however, about 0.03%. Thus, the span temperature characteristic is widely improved.

Now, assume that the temperature characteristic compensation resistor 22-11 which is made of nicrome (Ni 40%, Cr 60%) and has a resistance of 1.952 kΩ and a small temperature coefficient of resistance like the strain gauge resistors 22-2 and 22-5, is used for improving the non-linearity of the span temperature characteristic.

In this case, the output voltage V0 is given as follows:

$$V_0 = \frac{R}{R + \frac{R_{19} \cdot R_{20}}{R_{19} + R_{20}}} \times V_1 \times K \times E \quad (2)$$

By using the temperature compensation resistor R19 and temperature characteristic compensation resistor R20 in this way, a substantially flat span temperature characteristic over the actual operating temperature range as shown in Fig. 13 can be obtained.

Now, the case when the load cell shown in Fig. 8 is given a load so that an extension strain is generated in the resistors 22-2 and 22-5 to increase the resistance thereof respectively by ΔR11 and ΔR14 and that a contractional strain is generated in the resistors 22-3 and 22-4 to reduce the resistance thereof respectively by ΔR12 and ΔR13 will be considered. In this case, the output voltage V0 is given as follows:

$$V_0 = \frac{R}{R + \frac{R_{19} \cdot R_{20}}{R_{19} + R_{20}}} \times V_1 \times \left\{ \frac{\Delta R_{11}}{R_{11} + R_{15} + R_{16}} + \frac{\Delta R_{12}}{R_{12} + R_{17} + R_{18}} + \frac{\Delta R_{13}}{R_{13}} + \frac{\Delta R_{14}}{R_{14}} \right\} \quad (3)$$

Assuming that the resistors 22-2 and 22-5 have an equal resistance R0 sufficiently higher than the sum of the resistance of the resistors 22-6 and 22-7 and that the resistors 22-3 has a resistance sufficiently higher than the sum of the resistances of the resistors 22-8 and 22-9, the equation (3) is rewritten as follows:

$$V_0 = \frac{R}{R + \frac{R_{19} \cdot R_{20}}{R_{19} + R_{20}}} \times V_1 \times \frac{\Delta R_0}{R_0} \quad (4)$$

where ΔR0 is a change in resistance produced in the resistors 22-2 to 22-5 due to the strain according to the load.

Generally, there holds a relation $\Delta R_0/R_0 = K \cdot E$. Substituting this equation into the equation (4), the following equation is obtained

$$V_0 = \frac{R}{R_{19} + R_{20}} \times V_i \times K \times E \quad (5)$$

Since the strain E changes according to the load impressed upon the load cell, the output voltage V_0 changes according to the load. Since the strain E and gauge factor K change with temperature change, the output voltage changes with temperature change. The change in the output voltage with temperature change can be suppressed to a minimum by appropriately setting the resistances of the temperature compensating resistor R_{19} and temperature characteristic compensating resistor R_{20} to proper values on the basis of measurement data.

The method of manufacture of the load cell shown in Fig. 8 will be described with reference to Figs. 14A and 14B.

First, the pattern formation surface of the beam body 20 having the through holes 20-1 to 20-6 as shown in Fig. 8, is made smooth to have a flat surface. Then, the pattern formation surface is rinsed to remove fat, and varnish-like polyimide resin with a viscosity of 1,000 cp is dripped on the clean pattern formation surface. The beam body 20 is then rotated with a spinner at a speed of about 1,600 rpm to uniformly coat the polyimide resin on the pattern formation surface. Subsequently, the beam body 20 is heated at 100°C for one hour, then at 250°C for one hour and then at 350°C for one hour, thereby forming a polyimide resin film 22-1 with a thickness of 4 to 5 μ on the pattern formation surface of the beam body 20 as shown in Fig. 14A. A 500-Å nicrome (Ni 40%, Cr 60%) layer 30 is then formed by means of sputtering on the polyimide film 22-1. As the conditions for the sputtering, the initial vacuum degree may be set to 3×10^{-6} Torr (approx. 4×10^{-4} Pa), the argon pressure to 8×10^{-3} Torr (approx. 1 Pa), the radio frequency output to 1.0 kW and the ambient temperature to 25°C.

Thereafter, a titanium layer 32 is formed by sputtering to a thickness of 2,000 Å on the nicrome layer 30, and then a gold layer 34 is formed by sputtering to a thickness of 1 μ on the titanium layer 32. The conditions of the sputtering of titanium and gold may be set to be the same as for the sputtering of nicrome.

Afterwards, a pattern formation process by photoetching method is carried out, which will now be described. First, a pattern corresponding to the resistors 22-2 to 22-11 and conductive layers connecting these resistors is formed by forming a photo-resist film on the gold layer 34 shown in Fig. 14A. Then, the gold layer 34 is selectively etched by using an etchant for gold, i.e., an iodide etchant. Subsequently, the titanium layer 32 is selectively etched by using an etchant for titanium, i.e., a fluoride etchant. Finally, the nicrome layer 30 is selectively etched by using an etchant for nicrome, i.e., a ceric ammonium nitrate etchant, thus obtaining a three-layer structure formed of the nicrome layer 30, titanium layer 32 and gold layer 34 having a pattern shown in Fig. 14B.

Then, the gold layer is selectively etched to leave the conductive layers connecting the resistors 22-2 to 22-11 as shown in Fig. 14C. That is, the shaded portions of the gold layer shown in Fig. 14C are etched out to expose the corresponding intermediate titanium layer. Thus, the gold conductive layer pattern and temperature compensation resistors 22-7, 22-9 and 22-10 are completed.

Subsequently, the exposed titanium layer in Fig. 14C is selectively etched to expose portions of the nicrome layer other than the portions in the region of the resistors 22-7, 22-9 and 22-10. That is, shaded portions of titanium layer shown in Fig. 14D are etched out to expose the nicrome layer in the shaded regions. Thus, the strain gauge resistors 22-2 to 22-5, bridge balancing resistors 22-6 and 22-8 and temperature characteristic compensation resistor 22-11 are completed. After the end of this step, bridge balancing test and temperature test are conducted, and the resistances of the resistors 22-6 and 22-8 are adjusted according to the results of tests.

Then, a polyimide insulating film 36, for instance, is formed on the pattern region obtained in the step of Fig. 14D. For the formation of the polyimide insulating film, varnish polyimide resin with a viscosity of about 1,000 cp is dripped onto the pattern region and then the beam body 20 is rotated with a spinner at a speed of 1,400 rpm, thereby uniformly coating the polyimide layer on the pattern region. Then, the polyimide layer is dried at 100°C for one hour, and is then hardened by heat treatment at 250°C for one hour.

Thereafter, for the formation of the electrodes for connecting the power source lines or output lines thereto, the corresponding portions of the polyimide film 36 are selectively photo-etched as shown in Fig. 14F, followed by heat treatment at about 350°C to completely harden the polyimide film.

Fig. 14G shows a sectional view of the region including the bridge balancing resistor 22-6, temperature compensating resistor 22-7 and a conductive layer connecting both the resistors. As is shown, the conductive layer is constituted by the nicrome layer, titanium layer and gold layer, the temperature compensation resistor 22-7 is constituted by the nicrome layer and titanium layer, and the bridge balancing resistor 22-6 is constituted by the nicrome layer.

Figs. 15A and 15B show the method of manufacture of a load cell different from that shown in Figs. 14A to 14G. After forming a lamination structure formed of nicrome layer 30, titanium layer 32 and gold layer 34 as shown in Fig. 14A, the gold layer 34 is selectively etched to leave portions in Fig. 15A connecting the regions where the resistors 22-2 to 22-11 are formed.

5 Then, the titanium layer is selectively etched to leave its portions corresponding to the resistors 22-7, 22-9 and 22-10 and its portions underlying the conductive layers formed in the step of Fig. 15A, as shown in Fig. 15B. Afterwards, selective etching is effected to leave portions of the nicrome layer underlying the remaining titanium layer shown in Fig. 15B and portions of the nicrome layer corresponding to the resistors 22-2 to 22-6, 22-8 and 22-11. The manufacture is then carried out in the same manner as in the steps shown
10 in Figs. 14E and 14G.

While the invention has been described in connection with embodiments thereof, this invention is not limited thereto but is applicable in various modifications. For example, in the example shown in Figs. 8 and 9, the first and second resistive layers and conductive layer are respectively formed of nicrome, titanium and gold so that they can be selectively etched using different etchants. However, it is also possible to use
15 nicrome, nickel and aluminum to respectively form the first and second resistive layers and conductive layer in order to attain the same effect.

Claims

- 20 1. A load cell comprising
a beam body (20),
an insulating film (22-1) formed on one surface of the beam body (20)
and a load cell element (22) formed on the insulating film (22-1), said load cell element including
25 first and second power source terminals (A, B),
first and second output terminals (C,D),
a first strain gauge resistor (22-3) and a first bridge balancing resistor (22-8) connected in series
between said first power source terminal (A) and first output terminal (C),
a second strain gauge resistor (22-2) and a second bridge balancing resistor (22-6) connected in series
30 between said first power source terminal (A) and second output terminal (D),
a third strain gauge resistor (22-5) connected between said second power source terminal (B) and first
output terminal (C),
a fourth strain gauge resistor (22-4) connected between said second power source terminal (B) and
second output terminal (D),
35 with a first resistive layer (30) having been formed over a pattern area including said first to fourth
strain gauge resistors (22-3, 22-2, 22-5, 22-4), first and second bridge balancing resistors (22-8, 22-6), and
connecting means for connecting these resistors,
and with a conductive layer (34) having been formed outside of said first resistive layer (30) over a
pattern area of said connecting means, characterized
40 in that the load cell further comprises a first temperature compensating resistor (22-10) connected to
the second power source terminal (B) and having a positive temperature coefficient of resistance,
in that a second resistive layer (32) having a lower resistivity than the resistivity of said first resistive
layer (30) has been formed on said first resistive layer (30) over a pattern area including said first
temperature compensating resistor (22-10) and connecting means,
45 and in that said conductive layer (34) has been formed on said second resistive layer (32).
2. A load cell according to claim 1, characterized by a second temperature compensating resistor (22-9)
connected in series with said first strain gauge resistor (22-3) and first bridge balancing resistor (22-8)
between said first power source terminal (A) and first output terminal (C) and having a positive temperature
coefficient of resistance, and a third temperature compensating resistor (22-7) connected in series with said
50 second strain gauge resistor (22-2) and second bridge balancing resistor (22-6) between said first power
source terminal (A) and second output terminal (D) and having a positive temperature coefficient of
resistance, said second and third temperature compensating resistors being constituted by the lamination
of said first and second resistive layers (30,32).
3. A load cell according to claim 2, characterized in that said first and third temperature compensating
55 resistors (22-10, 22-9, 22-7), and first and second bridge balancing resistors (22-8, 22-6) each include at least
one ladder-type resistor element.
4. A load cell according to claim 2 or 3, characterized in that said first and second resistive layers and
conductive layer are respectively made of nicrome, titanium and gold.
5. A load cell according to claim 2 or 3, characterized in that said first and second resistive layers and
60 conductive layer are respectively formed of nicrome, nickel and aluminum.
6. A load cell according to claim 1, 2 or 3, characterized by further comprising a span adjustment
resistor (22-11) connected in parallel with said first temperature compensation resistor (22-10).
7. A load cell according to claim 6, characterized in that said first temperature compensating resistor
(22-10), first and second bridge balancing resistors (22-8, 22-6) and span adjustment resistor (22-11) each
65 include at least one ladder-type resistor element.

Figs. 15A and 15B show the method of manufacture of a load cell different from that shown in Figs. 14A to 14G. After forming a lamination structure formed of nicrome layer 30, titanium layer 32 and gold layer 34 as shown in Fig. 14A, the gold layer 34 is selectively etched to leave portions in Fig. 15A connecting the regions where the resistors 22-2 to 22-11 are formed.

Then, the titanium layer is selectively etched to leave its portions corresponding to the resistors 22-7, 22-9 and 22-10 and its portions underlying the conductive layers formed in the step of Fig. 15A, as shown in Fig. 15B. Afterwards, selective etching is effected to leave portions of the nicrome layer underlying the remaining titanium layer shown in Fig. 15B and portions of the nicrome layer corresponding to the resistors 22-2 to 22-6, 22-8 and 22-11. The manufacture is then carried out in the same manner as in the steps shown in Figs. 14E and 14G.

While the invention has been described in connection with embodiments thereof, this invention is not limited thereto but is applicable in various modifications. For example, in the example shown in Figs. 8 and 9, the first and second resistive layers and conductive layer are respectively formed of nicrome, titanium and gold so that they can be selectively etched using different etchants. However, it is also possible to use nicrome, nickel and aluminum to respectively form the first and second resistive layers and conductive layer in order to attain the same effect.

Claims

1. A load cell comprising
a beam body (20),
an insulating film (22-1) formed on one surface of the beam body (20)
and a load cell element (22) formed on the insulating film (22-1), said load cell element including
first and second power source terminals (A, B),
first and second output terminals (C,D),
a first strain gauge resistor (22-3) and a first bridge balancing resistor (22-8) connected in series
between said first power source terminal (A) and first output terminal (C),
a second strain gauge resistor (22-2) and a second bridge balancing resistor (22-6) connected in series
between said first power source terminal (A) and second output terminal (D),
a third strain gauge resistor (22-5) connected between said second power source terminal (B) and first
output terminal (C),
a fourth strain gauge resistor (22-4) connected between said second power source terminal (B) and
second output terminal (D),
with a first resistive layer (30) having been formed over a pattern area including said first to fourth
strain gauge resistors (22-3, 22-2, 22-5, 22-4), first and second bridge balancing resistors (22-8, 22-6), and
connecting means for connecting these resistors,
and with a conductive layer (34) having been formed outside of said first resistive layer (30) over a
pattern area of said connecting means, characterized
in that the load cell further comprises a first temperature compensating resistor (22-10) connected to
the second power source terminal (B) and having a positive temperature coefficient of resistance,
in that a second resistive layer (32) having a lower resistivity than the resistivity of said first resistive
layer (30) has been formed on said first resistive layer (30) over a pattern area including said first
temperature compensating resistor (22-10) and connecting means,
and in that said conductive layer (34) has been formed on said second resistive layer (32).
2. A load cell according to claim 1, characterized by a second temperature compensating resistor (22-9)
connected in series with said first strain gauge resistor (22-3) and first bridge balancing resistor (22-8)
between said first power source terminal (A) and first output terminal (C) and having a positive temperature
coefficient of resistance, and a third temperature compensating resistor (22-7) connected in series with said
second strain gauge resistor (22-2) and second bridge balancing resistor (22-6) between said first power
source terminal (A) and second output terminal (D) and having a positive temperature coefficient of
resistance, said second and third temperature compensating resistors being constituted by the lamination
of said first and second resistive layers (30,32).
3. A load cell according to claim 2, characterized in that said first and third temperature compensating
resistors (22-10, 22-9, 22-7), and first and second bridge balancing resistors (22-8, 22-6) each include at least
one ladder-type resistor element.
4. A load cell according to claim 2 or 3, characterized in that said first and second resistive layers and
conductive layer are respectively made of nicrome, titanium and gold.
5. A load cell according to claim 2 or 3, characterized in that said first and second resistive layers and
conductive layer are respectively formed of nicrome, nickel and aluminum.
6. A load cell according to claim 1, 2 or 3, characterized by further comprising a span adjustment
resistor (22-11) connected in parallel with said first temperature compensation resistor (22-10).
7. A load cell according to claim 6, characterized in that said first temperature compensating resistor
(22-10), first and second bridge balancing resistors (22-8, 22-6) and span adjustment resistor (22-11) each
include at least one ladder-type resistor element.



8. A load cell according to claim 1, 3, 6 or 7, characterized by an insulating film (36) covering said load cell element.

9. A method of manufacturing a load cell comprising

a step of making smooth one surface of a beam body,

a step of forming an insulating film on the smoothed surface,

a step of forming on said insulating film a load cell element including

first and second output terminals,

a first strain gauge resistor and a first bridge balancing resistor connected in series between said first power source terminal and first output terminal,

10 a second strain gauge resistor and a second bridge balancing resistor connected in series between said first power source terminal and second output terminal,

a third strain gauge resistor connected between said second power source terminal and first output terminal,

15 a fourth strain gauge resistor connected between said second power source terminal and second output terminal,

and a first temperature compensating resistor connected to the second power source terminal and having a positive temperature coefficient of resistance,

a step of forming a first resistive layer on said insulating film,

20 a step of forming on said first resistive layer a second resistive layer having a positive temperature coefficient of resistance a lower resistivity than the resistivity of said first resistive layer,

a step of forming a conductive layer on said second resistive layer,

and a step of selectively etching said first and second resistive layers and conductive layer to form said first to fourth strain gauge resistors, said first temperature compensating resistor, and connecting means.

10. A method of manufacturing a load cell according to claim 9, characterized in that
25 said etching step includes step of selectively etching portions of said first and second resistive layers and conductive layer other than the portions corresponding to a pattern area including said first to fourth strain gauge resistors, said first and second bridge resistors, said first temperature compensating resistor, and said connecting means,

30 a step of etching portions of said conductive layer other than the portions corresponding to a pattern area of said connecting means,

and a step of selectively etching out portions of said second resistive layer other than the portions corresponding to a pattern area including said first temperature compensating means and connecting means.

11. A method of manufacturing a load cell according to claim 9, characterized in that

35 said etching step includes a step of selectively etching out portions of said conductive layer other than the portions corresponding to a pattern of said connecting means,

a step of selectively etching out portions of said second resistive layer other than portions corresponding to a pattern area including said first temperature compensating means and said connecting means,

40 and a step of selectively etching out portions of said first resistive layer other than the portions corresponding to a pattern area including said first to fourth strain gauge resistors, first and second bridge balancing resistors, first temperature compensating resistor, and said connecting means.

12. A method of manufacturing a load cell according to claim 9, 10 or 11, characterized by further comprising a step of forming an insulating film covering said load cell element.

45 13. A method of manufacturing a load cell according to claim 9, 10 or 11, characterized in that said load cell element further includes a second temperature compensating resistor connected in series with said first strain gauge resistor and first bridge balancing resistor between said first power source terminal and first output terminal and a third temperature compensating resistor connected in series with said second strain gauge resistor and second bridge balancing resistor between said first power source terminal and
50 second output terminal, said second and third temperature compensating resistors being formed of said first and second resistive layers in the same manner as the formation of said first temperature compensating resistor.

14. A method of manufacturing a load cell according to claim 9, 10 or 11, characterized in that said load cell further includes a span adjustment resistor connected in parallel with said first temperature
55 compensation resistor, said span adjustment resistor being formed of said first and second resistive layers in the same manner as the formation of said first to fourth strain gauge resistors and first and second bridge balance resistors.

15. A method of manufacturing a load cell according to claim 9, 10 or 11, characterized in that the step of forming said insulating film includes a step of dripping polyimide resin in liquid-like state onto the
60 smoothed surface of said beam body, a step of rotating said beam body to form a film of polyimide, and a step of heating said film of polyimide to harden the same.

Patentansprüche

1. Lastmeßvorrichtung

65 mit einem stabförmigen Teil (20),



mit einem auf einer Fläche des stabförmigen Teils (20) ausgebildeten isolierenden Film (22-1) und mit einem auf dem isolierenden Film (22-1) ausgebildeten Lastmeßelement (22), welches erste und zweite Anschlüsse (A,B) für die Spannungsquelle, erste und zweite Ausgangs-Anschlüsse (C,D),

5 einen ersten Dehnungsmeßwiderstand (22-3) und einen ersten Brücken abgleichwiderstand (22-8), die zwischen dem ersten Anschluß (A) für die Spannungsquelle und dem ersten Ausgangs-Anschluß (C) hintereinandergeschaltet sind,

10 einen zweiten Dehnungsmeßwiderstand (22-2) und einen zweiten Brückenabgleichwiderstand (22-6), die zwischen dem ersten Anschluß (A) der Spannungsquelle und dem zweiten Ausgangs-Anschluß (D) hintereinandergeschaltet sind,

einen dritten Dehnungsmeßwiderstand (22-5), der zwischen den zweiten Anschluß (B) für die Spannungsquelle und dem ersten Ausgangs-Anschluß (C) eingeschaltet ist und

einen vierten Dehnungsmeßwiderstand (22-4), der zwischen den zweiten Anschluß (B) der Spannungsquelle und dem zweiten Ausgangs-Anschluß (D) eingeschaltet ist, umfaßt,

15 wobei über einen die ersten bis vierten Dehnungsmeßwiderstände (22-3, 22-2, 22-5, 22-4), die ersten und zweiten Brückenabgleichwiderstände (22-8, 22-6) und die diese Widerstände verbindenden Verbindungsmittel enthaltenden Musterbereich eine erste Widerstandsschicht (30) gebildet ist

und wobei außerhalb der ersten Widerstandsschicht (30) über einen Musterbereich der Verbindungsmittel eine leitfähige Schicht (34) ausgebildet ist, dadurch gekennzeichnet,

20 daß die Lastmeßzelle weiterhin einen ersten mit dem zweiten Anschluß (B) für die Spannungsquelle verbundenen Temperaturkompensationswiderstand (22-10) mit einem positiven Temperaturkoeffizienten des Widerstands aufweist,

25 daß eine zweite Widerstandsschicht (32) mit einem niedrigeren spezifischen Widerstand als der spezifische Widerstand der ersten Widerstandsschicht (30) auf der ersten Widerstandsschicht (30) über einen Musterbereich gebildet ist, der den ersten Temperaturkompensationswiderstand (22-10) und die Verbindungsmittel enthält,

und daß die zweite leitfähige Schicht (34) auf der zweiten Widerstandsschicht (32) ausgebildet ist.

2. Lastmeßvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß ein zweiter Temperaturausgleichswiderstand (22-9) vorgesehen ist, der mit dem ersten Dehnungsmeßwiderstand (22-3) und dem ersten Brückenabgleichwiderstand (22-8) zwischen dem ersten Anschluß (A) der Spannungsquelle und dem ersten Ausgangs-Anschluß (C) hintereinandergeschaltet ist und einen positiven Temperaturkoeffizienten des Widerstands aufweist, daß ein dritter Temperaturkompensationswiderstand (22-7) mit dem zweiten Dehnungsmeßwiderstand (22-2) und dem dritten Brückenabgleichwiderstand (22-6) zwischen dem ersten Anschluß (A) der Spannungsquelle und dem zweiten Ausgangs-Anschluß (D) hintereinandergeschaltet ist und einen positiven Temperaturkoeffizienten des Widerstands aufweist, und daß die zweiten und dritten Temperaturkompensationswiderstände durch die Übereinanderschichtung der ersten und zweiten Widerstandsschichten (30,32) gebildet sind.

3. Lastmeßvorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die ersten bis dritten Temperaturkompensationswiderstände (22-10, 22-9, 22-7) und die ersten und zweiten Brückenabgleichwiderstände (22-8, 22-6) jeweils mindestens ein leiterartiges Widerstandselement umfassen.

4. Lastmeßvorrichtung nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß die ersten und zweiten Widerstandsschichten und die leitfähige Schicht aus Nicrome, Titan bzw. Gold hergestellt sind.

5. Lastmeßvorrichtung nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß die ersten und zweiten Widerstandsschichten und die leitfähige Schicht aus Nicrome, Nickel bzw. Aluminium hergestellt sind.

45 6. Lastmeßvorrichtung nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß sie einen Widerstand (22-11) zur Justierung der Brückenausgangsspannung umfaßt, der parallel mit dem ersten Temperaturkompensationswiderstand (22-10) geschaltet ist.

7. Lastmeßvorrichtung nach Anspruch 6, dadurch gekennzeichnet, daß der erste Temperaturkompensationswiderstand (22-10), die ersten und zweiten Brückenabgleichwiderstände (22-8, 22-6) und der Widerstand (22-11) zur Justierung der Brückenausgangsspannung jeweils mindestens ein leiterartiges Widerstandselement umfassen.

8. Lastmeßvorrichtung nach Anspruch 1, 3, 6 oder 7, dadurch gekennzeichnet, daß das Lastmeßelement von einem isolierenden Film (36) überdeckt ist.

9. Verfahren zur Herstellung einer Lastmeßvorrichtung, welches folgende Verfahrensschritte umfaßt:

55 eine Fläche eines stabförmigen Teils wird geglättet;
auf der geglätteten Fläche wird ein isolierender Film gebildet;
auf dem isolierenden Film wird ein Lastmeßelement gebildet welches erste und zweite Ausgangsanschlüsse,

60 einen ersten Dehnungsmeßwiderstand und einen ersten Brückenabgleichwiderstand, die zwischen dem ersten Anschluß für die Spannungsquelle und dem ersten Ausgangs-Anschluß hintereinandergeschaltet sind,

einen zweiten Dehnungsmeßwiderstand und einen zweiten Brückenabgleichwiderstand, die zwischen dem ersten Anschluß für die Spannungsquelle und dem zweiten Ausgangs-Anschluß hintereinandergeschaltet sind,



einen dritten Dehnungsmeßwiderstand, der zwischen den zweiten Anschluß für die Spannungsquelle und dem ersten Ausgangs-Anschluß eingeschaltet ist,
einen vierten Dehnungsmeßwiderstand, der zwischen den zweiten Anschluß für die Spannungsquelle und dem zweiten Ausgangs-Anschluß eingeschaltet ist, und

einen ersten Temperaturkompensationswiderstand, der mit dem zweiten Anschluß für die Spannungsquelle verbunden ist und einen positiven Temperaturkoeffizienten des Widerstandes aufweist, umfaßt;
es wird auf dem isolierenden Film eine erste Widerstandsschicht gebildet;

es wird auf der ersten Widerstandsschicht eine zweite Widerstandsschicht gebildet, die einen positiven Temperaturkoeffizienten des Widerstandes und einen niedrigeren spezifischen Widerstand als der spezifische Widerstand der ersten Widerstandsschicht aufweist;

es wird auf der zweiten Widerstandsschicht eine leitfähige Schicht gebildet;
und es werden die ersten und zweiten Widerstandsschichten und die leitfähige Schicht selektiv geätzt, um die ersten bis vierten Dehnungsmeßwiderstände, den ersten Temperaturkompensationswiderstand und die Verbindungsmittel zu bilden.

10. Verfahren zur Herstellung einer Lastmeßvorrichtung nach Anspruch 9, dadurch gekennzeichnet, daß der Verfahrensschritt des Ätzens

den Schritt des selektiven Wegätzens von Teilen der ersten und zweiten Widerstandsschichten und der leitfähigen Schicht außerhalb der Teile, die dem Musterbereich entsprechen, der die ersten bis vierten Dehnungsmeßwiderstände, die ersten und zweiten Brückenabgleichwiderstände, den ersten Temperaturkompensationswiderstand und die Verbindungsmittel enthält,

den Schritt des Wegätzens von Teilen der leitfähigen Schicht außerhalb der Teile, die dem Musterbereich der Verbindungsmittel entspricht,

und den Schritt des selektiven Wegätzens von Teilen der zweiten Widerstandsschicht, die außerhalb der Teile gelegen sind, die einem Musterbereich entsprechen, der den ersten Temperaturkompensationswiderstand und die Verbindungsmittel enthält, umfaßt.

11. Verfahren zur Herstellung einer Lastmeßvorrichtung nach Anspruch 9, dadurch gekennzeichnet, daß der Verfahrensschritt des Ätzens

den Schritt des selektiven Wegätzens von Teilen der leitfähigen Schicht außerhalb der Teile, die dem Muster der Verbindungsmittel entsprechen,

den Schritt des selektiven Wegätzens von Teilen der zweiten Widerstandsschicht außerhalb der Teile, die dem Musterbereich entsprechen, welcher den ersten Temperaturkompensationswiderstand und die Verbindungsmittel enthält,

und den Schritt des selektiven Wegätzens von Teilen der ersten Widerstandsschicht, die außerhalb der Teile gelegen sind, die einem Musterbereich entsprechen, der die ersten bis vierten Dehnungsmeßwiderstände, den ersten und zweiten Brückenabgleichwiderstand, den ersten Temperaturkompensationswiderstand und die Verbindungsmittel enthält, umfaßt.

12. Verfahren zur Herstellung einer Lastmeßvorrichtung nach den Ansprüchen 9, 10 oder 11, dadurch gekennzeichnet, daß ein isolierender Film gebildet wird, der das Lastmeßelement überdeckt.

13. Verfahren zur Herstellung einer Lastmeßvorrichtung nach den Ansprüchen 9, 10 oder 11, dadurch gekennzeichnet, daß das Lastmeßelement einen zweiten Temperaturkompensationswiderstand, der mit dem ersten Dehnungsmeßwiderstand und dem ersten Brückenabgleichwiderstand zwischen dem ersten Anschluß für die Spannungsquelle und dem ersten Ausgangs-Anschluß hintereinandergeschaltet ist, sowie einen dritten Temperaturkompensationswiderstand umfaßt, der mit dem zweiten Dehnungsmeßwiderstand und dem zweiten Brückenabgleichwiderstand zwischen dem ersten Anschluß für die Spannungsquelle und dem zweiten Ausgangs-Anschluß hintereinandergeschaltet ist, und daß die zweiten und dritten Temperaturkompensationswiderstände aus den ersten und zweiten Widerstandsschichten in der gleichen Weise gebildet sind wie der ersten Temperaturkompensationswiderstand.

14. Verfahren zur Herstellung einer Lastmeßvorrichtung nach den Ansprüchen 9, 10 oder 11, dadurch gekennzeichnet, daß die Lastmeßvorrichtung einen Widerstand zur Justierung der Brückenausgangsspannung umfaßt, der parallel zu dem ersten Temperaturkompensationswiderstand liegt und aus den ersten und zweiten Widerstandsschichten in der gleichen Weise wie die ersten bis vierten Dehnungsmeßwiderstände und die ersten und zweiten Brückenabgleichwiderstände gebildet ist.

15. Verfahren zur Herstellung einer Lastmeßvorrichtung nach den Ansprüchen 9, 10 oder 11, dadurch gekennzeichnet, daß bei der Herstellung des isolierenden Films Polyimidharz in einem flüssigkeitsähnlichen Zustand auf die geglättete Fläche des stabförmigen Teils tropfen gelassen wird, der stabförmige Teil zur Bildung eines Polyimidfilms rotieren gelassen wird und der Polyimidfilm zur Aushärtung beheizt wird.

Revendications

1. Cellule de mesure de charge comportant: un corps de poutre (20), une pellicule isolante (22-1) formée sur une surface du corps de poutre (20) et un élément de cellule de mesure de charge (22) formée sur la pellicule isolante (22-1), ledit élément de cellule de mesure de charge comportant: une première et une seconde borne d'alimentation (A, B), une première et une seconde borne de sortie (C, D), une première résistance de jauge de contrainte (22-3) et une première résistance d'équilibrage de pont (22-8) connectées



en série entre ladite première borne d'alimentation (A) et une première borne de sortie (C), une seconde résistance de jauge de contrainte (22-2) et une seconde résistance d'équilibrage de pont (22-6) connectées en série entre ladite première borne d'alimentation (A) et une seconde borne de sortie (D), une troisième résistance de jauge de contrainte (22-5) connectée entre ladite seconde borne d'alimentation (B) et une première borne de sortie (C), une quatrième résistance de jauge de contrainte (22-4) connectée entre ladite seconde borne d'alimentation (B) et ladite seconde borne de sortie (D), avec une première couche résistive (30) formée sur une région de configuration comprenant ladite première à ladite quatrième résistance de jauge de contrainte (22-3, 22-2, 22-5, 22-4), la première et la seconde résistance d'équilibrage de pont (22-8, 22-6) et un dispositif de connexion pour connecter lesdites résistances et avec une couche conductrice (34) formée à l'extérieur de ladite première couche résistive (30) sur une région de configuration dudit dispositif de connexion, caractérisée en ce que ladite cellule de mesure de charge comporte en outre une première résistance de compensation de température (22-10) connectée à la seconde borne d'alimentation (B) et ayant un coefficient positif de résistance en température, en ce qu'une seconde couche résistive (32) ayant une plus faible résistivité que celle de ladite première couche résistive (30) a été formée sur ladite première couche résistive (30) sur une région de configuration comprenant ladite première résistance de compensation en température (22-10) et le dispositif de connexion et en ce que ladite couche conductrice (24) a été formée sur ladite seconde couche résistive (32).

2. Cellule de mesure de charge selon la revendication 1, caractérisée par une seconde résistance de compensation de température (22-9) connectée en série avec ladite première résistance de jauge de contrainte (22-3) et la première résistance d'équilibrage de pont (22-8) entre ladite première borne d'alimentation (A) et la première borne de sortie (C) et ayant un coefficient positif de résistance en température et une troisième résistance de compensation de température (22-4) connectée en série avec ladite seconde résistance de jauge de contrainte (22-2) et la seconde résistance d'équilibrage de pont (22-6) entre ladite première borne d'alimentation (A) et la seconde borne de sortie (D) et ayant un coefficient positif de résistance en température, ladite seconde et ladite troisième résistance de compensation de température étant constituée par la superposition de ladite première et de ladite seconde couche résistives (30, 32).

3. Cellule de mesure de charge selon la revendication 2, caractérisée en ce que ladite première à ladite troisième résistance de compensation de température (22-10, 22-9, 22-7) et la première et la seconde résistance d'équilibrage de pont (22-8, 22-6) comprennent chacune au moins un élément de résistance du type en échelle.

4. Cellule de mesure de charge selon la revendication 2 ou 3, caractérisée en ce que ladite première et la seconde couche résistives et la couche conductrice sont faites respectivement de nichrome, de titane et d'or.

5. Cellule de mesure de charge selon la revendication 2 ou 3, caractérisée en ce que ladite première et ladite seconde couche résistives et la couche conductrice sont faites respectivement de nichrome, de nickel et d'aluminium.

6. Cellule de mesure de charge selon la revendication 1, 2 ou 3, caractérisée en ce qu'elle comporte en outre une résistance de réglage d'étendue (22-11) connectée en parallèle avec ladite première résistance de compensation de température (22-10).

7. Cellule de mesure de charge selon la revendication 6, caractérisée en ce que ladite première résistance de compensation de température (22-10), la première et la seconde résistance d'équilibrage de pont (22-8, 22-6) et la résistance de réglage d'étendue (22-11) comprennent chacune au moins un élément de résistance du type en échelle.

8. Cellule de mesure de charge selon la revendication 1, 3, 6 ou 7, caractérisée par une pellicule isolante (36) recouvrant ledit élément de cellule de mesure de charge.

9. Procédé de fabrication d'une cellule de mesure de charge, comprenant: une opération de polissage d'une surface d'un corps de poutre, une opération de formation d'une pellicule isolante sur la surface régularisée, une opération de formation, sur ladite pellicule isolante, d'un élément de cellule de mesure de charge comportant: une première et une seconde borne de sortie, une première résistance de jauge de contrainte et une première résistance d'équilibrage de pont connectées en série entre ladite première borne d'alimentation et ladite première borne de sortie, une seconde résistance de jauge de contrainte et une seconde résistance d'équilibrage de pont connectées en série entre ladite première borne d'alimentation et la seconde borne de sortie, une troisième résistance de jauge de contrainte connectée entre ladite seconde borne d'alimentation et la première borne de sortie, une quatrième résistance de jauge de contrainte connectée entre ladite seconde borne d'alimentation et la seconde borne de sortie et une première résistance de compensation de température connectée à la seconde borne d'alimentation et ayant un coefficient positif de résistance en température, le procédé comprenant en outre une opération de formation d'une première couche résistive sur ladite pellicule isolante, une opération de formation, sur ladite première couche résistive, d'une seconde couche résistive ayant un coefficient positif de résistance en température, une résistivité inférieure à celle de ladite première couche résistive, une opération de formation d'une couche conductrice sur ladite seconde couche résistive, et une opération de gravure sélective de ladite première et de ladite seconde couche résistives et de la couche conductrice pour former ladite première à ladite quatrième résistance de jauge de contrainte, ladite première résistance de compensation de température et ledit dispositif de connexion.



10. Procédé de fabrication d'une cellule de mesure de charge selon la revendication 9, caractérisé en ce que ladite opération de gravure comporte une opération de gravure sélective de parties de ladite première et ladite seconde couche résistives et de ladite couche conductrice autres que les parties correspondant à une région de configuration comprenant ladite première à ladite quatrième résistance de jauge de contrainte, ladite première et ladite seconde résistance de pont, ladite première résistance de compensation de température et ledit dispositif de connexion, une opération de gravure de parties de ladite couche conductrice autres que les parties correspondant à une région de configuration dudit dispositif de connexion et une opération de gravure sélective de parties de ladite seconde couche résistive autres que les parties correspondant à une région de configuration comprenant ledit premier dispositif de compensation de température et le dispositif de connexion.

11. Procédé de fabrication d'une cellule de mesure de charge selon la revendication 9, caractérisé en ce que ladite opération de gravure comprend une opération d'attaque sélective de parties de ladite couche conductrice autres que les parties correspondant à une configuration dudit dispositif de connexion, une opération d'attaque sélective de parties de ladite seconde couche résistive autres que des parties correspondant à une région de configuration comprenant ledit premier dispositif de compensation de température et ledit dispositif de connexion, et une opération de gravure sélective de parties de ladite première couche résistive autres que les parties correspondant à une région de configuration comprenant la première à la quatrième résistance de jauge de contrainte, la première et la seconde résistance d'équilibrage de pont, la première résistance de compensation de température et ledit dispositif de connexion.

12. Procédé de fabrication d'une cellule de mesure de charge selon la revendication 9, 10 ou 11, caractérisé en ce qu'il consiste en outre à former une pellicule isolante recouvrant ledit élément de cellule de mesure de charge.

13. Procédé de fabrication d'une cellule de mesure de charge selon la revendication 9, 10 ou 11, caractérisé en ce que ledit élément de cellule de mesure de charge comporte en outre une seconde résistance de compensation de température connectée en série avec ladite première résistance de jauge de contrainte et la première résistance d'équilibrage de pont entre ladite première borne d'alimentation et ladite première borne de sortie et une troisième résistance de compensation de température connectée en série avec ladite seconde résistance de jauge de contrainte et ladite seconde résistance d'équilibrage de pont, entre ladite première borne d'alimentation et ladite seconde borne de sortie; ladite seconde et ladite troisième résistance de compensation de température étant formées de ladite première et de ladite seconde couche résistives de la même manière que la formation de ladite première résistance de compensation de température.

14. Procédé de fabrication d'une cellule de mesure de charge selon la revendication 9, 10 ou 11, caractérisé en ce que ladite cellule de mesure de charge comporte en outre une résistance de réglage d'étendue connectée en parallèle avec ladite première résistance de compensation de température, ladite résistance de réglage d'étendue étant formée de ladite première et de ladite seconde couche résistive de la même manière que la formation de ladite première à ladite quatrième résistance de jauge de contrainte et ladite première et ladite seconde résistance d'équilibrage de pont.

15. Procédé de fabrication d'une cellule de mesure de charge selon la revendication 9, 10 ou 11, caractérisé en ce que l'opération de formation de ladite pellicule isolante comporte une opération d'écoulement d'une résine de polyimide à l'état liquide sur la surface polie dudit corps de poutre, une opération de mise en rotation dudit corps de poutre pour former une pellicule de polyimide et une opération de chauffage de ladite pellicule de polyimide pour la durcir.

