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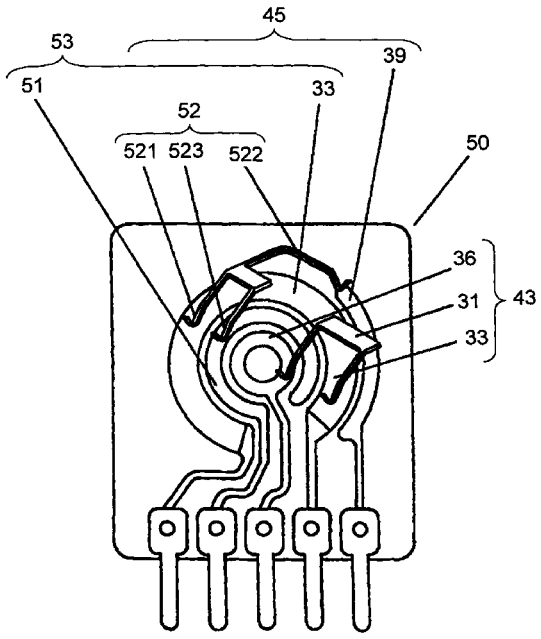
(54) Rotary variable resistor and output regulator using the same

(57) A rotary variable resistor comprising a resistive film (33) formed on an insulating substrate (302), a current collecting conductive member (36) disposed in such a manner as to be concentric with the resistive film (33) and to be spatially isolated from the resistive film (33) and the lead members (34) thereof (33), a circular arc shaped auxiliary conductive member (39) formed in such a manner as to be concentric with the resistive film (33), and to be spatially isolated from the resistive film (33), the current collecting conductive member (36) and the lead members (34, 37) of the patterns (33, 36), also to cover a larger angular range than the angular opening of the resistive film (33), a first brush (31) made of an elastic metal plate and fixed to an operation shaft which is repeatedly ratatable, also having first contact portions (42) which respectively elastically contact to the resistive film (33) and to the current collecting conductive member (36), wherein the first brush (31) forms a first resistor unit (43) together with the resistive film (33) and the current collecting conductive member (36), and, a second brush (32) made of an elastic metal plate and fixed to the operation shaft in such a manner as to be electrically isolated from the first brush (31), also having second contact portions (44) which respectively elastically contact to the resistive film (33) and to the auxiliary conductive member (39) in the rotational angular range of the operation shaft, in which a predetermined output voltage is unobtainable from the first resistor unit (43), wherein the second brush (32) forms a second resistor unit (45) together with the resistor film (33) and the auxiliary conductive member (39). The above structure simplifies the pattern structure of a resistor board (30) and decreases the number of terminals, also simplify the production process.

FIG. 3



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a rotary variable resistor which is operable by repeatedly rotating the operation shaft thereof and used for various electronic apparatuses, and, an output regulator using the same.

BACKGROUND OF THE INVENTION

[0002] A conventional rotary variable resistor which is operable by repeatedly rotating the operation shaft thereof is described hereinafter on reference to Fig. 6, Fig. 7 and Fig. 8.

[0003] In Fig. 6, on the inner surface of the bottom of a case 1 made of insulating resin, a resistor board 2 is fixed by insertion-molding. At the center of the resistor board 2, a round hole 821 is formed in such a manner as to be concentric with a round hole 811 formed at the center of the bottom of the case 1.

[0004] In Fig. 7, which is a schematic diagram showing the main portion of the conventional rotary variable resistor, the resistor board 2 is formed as follows.

[0005] On the upper surface of an insulating substrate 822, a horseshoe-shaped first resistive film 3 is formed. At the outer side of the first resistive film 3, a horseshoe-shaped first current collecting member 4 formed with argentic material by printing is disposed in such a manner as to be concentric with the central round hole 821 and to face the opening thereof toward the same direction with the facing direction of the opening of the first resistive film 3. From the respective ends of the first resistive film 3, lead members 5 extend outward and are respectively connected to terminals 7 (71, 72) by caulking. Also, from one end of the first current collecting member 4, a lead member 6 extends outward and is connected to a terminal 8 by caulking.

[0006] Also, an annular second current collecting member 9 is formed by printing at the innermost position in such a manner as to be concentric with the round hole 821. From the second current collecting member 9, a lead member 10 extends outward and is connected to a terminal 11 by caulking.

[0007] Also, between the first resistive film 3 and the second current collecting member 9, a pair of circular arc shaped conductive members 12 formed with argentic material by printing are disposed between the opening side portion of the first resistive film 3 and the second current collecting member 9 in such a manner as to be concentric with the round hole 821. On the conductive members 12 and the lead member 10 of the second current collecting member 9, insulating resist 13 is applied in such a manner as to cover a larger angular range than the angular opening of the first resistive film 3. In this case, the respective end portions (i.e., upper end portions in Fig.7) of the conductive members 12 are left without applying the resist 13. On the resist 13, a horseshoe-shaped second resistive film 14 is formed by printing in such a manner as to cover a larger angular range than the angular opening of the first resistive film 3. In this case, the respective ends of the second resistive film 14 is electrically connected to the respective end portions (i.e., upper end portions in Fig. 7) of the conductive members 12, where the insulating resist 13 is not applied. From the respective conductive members 12, lead members 15 extend outward and are respectively connected to terminals 16 (161, 162) by caulking.

[0008] In Fig. 6, an operation shaft 17 made of insulating resin is disposed in such a manner as to protrude outward through the hole 181 of a bearing member 18 which is fixed to the case 1 with a metal cover 25. A round protrusion 171 formed at the center of the bottom of the operation shaft 17 engages with the respective round holes (811, 821) of the case 1 and the resistor board 2, whereby the shaft 17 is supported in such a manner as to be repeatedly rotatable.

[0009] To the operation shaft 17, a first brush 21 and a second brush 22 respectively made of elastic metal plates are disposed in such a manner as to be electrically isolated each other. The contact portions 19 (191, 192) of the first brush 21 and the contact portions 20 (201, 202) of the second brush 22 are disposed in such a manner as to be on a straight line extended along the radius of the operation shaft 17 (the radius starts from the rotation axis of the operation shaft).

[0010] As shown in Fig. 7, the contact portion 191 of the first brush 21 elastically contacts to the first resistive film 3, and the contact portion 192 of the same elastically contacts to the first current collecting member 4. The first brushes 21, the first resistive film 3 and the first current collecting member 4 form a first resistor unit 23.

[0011] The contact portion 201 of the second brush 22 elastically contacts to the second resistive film 14, and the contact portion 202 of the same elastically contacts to the second current collecting member 9. The second brush 22, the second resistive film 14 and the second current collecting member 9 form a second resistor unit 24.

[0012] In the rotary variable resistor having the above structure, the contact portions 19 (191, 192) of the first brush 21 and the contact portions 20 (201, 202) of the second brush 22 slide on the respective printed patterns elastically contacting to these patterns, whereby output voltage at a predetermined rotational angle of the operation shaft 17 is obtained either from the first resistor unit 23 though the terminals 71 and 8 for instance, or from the second resistor unit 24 through the terminals 162 and 11 for instance.

[0013] As shown in Fig. 8, effective output voltage is obtained alternately from the first resistor unit 23 and the second resistor unit 24 according to the rotation of the operation shaft 17. In this case, the beginning and the ending portions of the effective output voltage of the respective resistor units (23, 24) overlap (i.e., effective

voltage is obtainable from both).

[0014] In the practical use of the rotary variable resistor having the above structure, either of the effective output voltage is selected on the overlapping portions based on the judgment of a computer or the like, whereby effective output voltage is successively obtained either from the first resistor unit 23 or from the second resistor unit 24.

[0015] However, in the above conventional structure, the second resistive film 14 is formed on resist 13 applied on the predetermined portions of the conductive member 12 and the lead member 10 of the second current collecting member 9, also, for the input and the output to and from the first and the second resistor units (23, 24), six terminals (71, 72, 8, 11, 161 and 162) are needed. Therefore, the pattern structure is complicated, which requires many and complicated production processes.

SUMMARY OF THE INVENTION

[0016] The object of the present invention is to address the above conventional problems and to provide a rotary variable resistor which is operable by repeatedly rotating the operation shaft thereof and has simple pattern structure on the resistor board thereof, also has a few terminals. It is a further object of the present invention to provide an output regulator which uses the above rotary variable resistor.

[0017] For realizing the above object, the rotary variable resistor of the present invention comprises:

(a) a resistive film disposed on an insulating substrate,

(b) a current collecting conductive member disposed in such a manner as to be concentric with the resistive film, and, to be spatially isolated from the resistive film and the lead members thereof,

(c) a circular arc shaped auxiliary conductive member formed in such a manner as to be concentric with the resistive film, and, to be spatially isolated from the resistive film, the current collecting conductive member and the lead members of these patterns, also to cover a larger angular range than the angular opening of the resistive film,

(d) a first brush made of an elastic metal plate, and fixed to an operation shaft which is repeatedly rotatable, also having a first contact portions which respectively elastically contact to the resistive film and to the current collecting conductive member, wherein the first brush forms a first resistor unit together with the resistive film and the current collecting conductive member; and

(e) a second brush made of an elastic metal plate, and fixed to the operation shaft in such a manner as to be electrically isolated from the first brush, also having a second contact portions which respectively elastically contact to the resistive film and to the auxiliary conductive member in the rotational angular range of the operation shaft, in which a predetermined output voltage is unobtainable from the first resistor unit, wherein the second brush forms a second resistor unit together with the resistive film and the auxiliary conductive member.

[0018] In the rotary variable resistor of the present invention having the above structure, one resistive film is commonly used for the first and the second resistor units, and the multilayer pattern as in the conventional structure is eliminated, whereby the pattern structure of the resistor board is simplified, also the number of terminals is decreased, accordingly the production process is simplified and the cost is also decreased.

[0019] For realizing the further object of the present invention, the output regulator of the present invention comprises:

(a) the above rotary variable resistor,

(b) a power source unit for applying a predetermined voltage to the rotary variable resistor,

(c) an analog-to-digital converter having an input port through which the output voltage of the first resistor unit of the rotary variable resistor, the output voltage of the second resistor unit of the same and the voltage applied to the rotary variable resistor are respectively input,

(d) a detecting unit for detecting the output voltage value of the second resistor unit,

(e) a comparing unit for comparing the output voltage value of the second resistor unit, which is detected by the detecting unit, with the voltage applied to the rotary variable resistor,

(f) an arithmetic processing unit for outputting an output code corresponding to the output voltage value of the first resistor unit when the comparing unit judges the output voltage value of the first resistor unit to be effective as a result of the comparison, and for outputting an output code corresponding to the output voltage value of the second resistor unit or a predetermined output code stored in advance when the comparing unit judges the output voltage value of the first resistor unit to be ineffective as a result of the comparison, and

(g) an output port for outputting the output codes.

[0020] In the rotary variable resistor of the present invention having the above structure, successive proper output codes are obtainable in the repeated rotation of the operation shaft by performing simple signal processing with a microcomputer or the like based on the output voltage value of the first or the second resistor unit of the rotary variable resistor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a schematic diagram showing the main portions (i.e., the upper side of the resistor board) of a rotary variable resistor in a first exemplary embodiment of the present invention,
Fig. 2 shows the characteristics of the output voltage of the rotary variable resistor in the same,
Fig. 3 is a schematic diagram showing the main portions (i.e., the upper side of the resistor board) of a rotary variable resistor in a second exemplary embodiment of the present invention,
Fig. 4 is a schematic diagram showing an output regulator in a third exemplary embodiment of the present invention,
Fig. 5 is a flow chart showing the signal processing of the output regulator in the same,
Fig. 6 is a cross sectional view of a conventional rotary variable resistor.
Fig. 7 is a schematic diagram showing the main portions (i.e., the upper side of the resistor board) of the same, and
Fig. 8 shows the characteristics of the output voltage of the same.

DETAILED DESCRIPTION OF THE INVENTION

[0022] Hereinafter the exemplary embodiments of the present invention are described on reference to illustrations.

First Exemplary Embodiment

[0023] Fig. 1 is a schematic diagram showing the main portions of a rotary variable resistor in a first exemplary embodiment of the present invention, and Fig. 2 shows the characteristics of the output voltage of the rotary variable resistor in the same.

[0024] As shown in Fig. 1, the rotary variable resistor of this exemplary embodiment is different from the conventional rotary variable resistor in the pattern structure, the terminal structure and the elastically contacting positions of a first brush 31 and a second brush 32, which are respectively disposed on a resistor board 30. Regarding the other components of the rotary variable resistor of this exemplary embodiment, structure and functions are same with the conventional rotary variable resistor. Therefore the illustrations and the descriptions on these components are omitted.

[0025] In Fig. 1, the resistor board 30 of this exemplary embodiment is formed as follows. That is, a horseshoe-shaped resistive film 33 is formed by printing on an insulating substrate 302 which has a round hole 301 at the center thereof. From the respective ends of the resistive film 33, lead members 34 made of argentic material extend outward and are respectively connected to terminals 35 (351, 352).

[0026] Also, at the inner side of the resistive film 33, an annular current collecting conductive member 36 formed with argentic material by printing is disposed in such a manner as to be concentric with the resistive film 33 and to be spatially isolated from the resistive film 33 and the lead members 34. From the current collecting conductive member 36, a lead member 37 extends outward and is connected to a terminal 38.

[0027] Also, at the outer side of the resistive film 33, a circular arc shaped auxiliary conductive member 39 formed with argentic material by printing is disposed in such a manner as to be concentric with the resistive film 33 and the current collecting conductive member 36, and, to be spatially isolated from the resistive film 33, the current collecting conductive member 36 and the lead members (34, 37), also to cover a larger angular range than the angular opening of the resistive film 33. From the auxiliary conductive member 39, a lead member 40 extends outward and is connected to a terminal 41.

[0028] Also, a first brush 31 and a second brush 32, which respectively elastically contact to the respective patterns formed on the resistor board 30, are fixed to an operation shaft (not illustrated), which is repeatedly rotatable, in such a manner as to be electrically isolated each other.

[0029] Also, as shown in Fig. 1, the first brush 31 has contact portions 42 (421, 422) which respectively slide on the resistive film 33 and on the current collecting conductive member 36 elastically contacting to these patterns (33, 36). The first brush 31, the resistive film 33 and the current collecting conductive member 36 form a first resistor unit 43.

[0030] Also, the second brush 32 has contact portions 44 (441, 442) which respectively slide on the resistive film 33 and on the auxiliary conductive member 39 elastically contacting to these patterns (33, 39) in an angular range in which predetermined output voltage is unobtainable from the first resistor unit 43. The second brush 32, the resistive film 33 and the auxiliary conductive member 39 form a second resistor unit 45.

[0031] In the rotary variable resistor having the above structure, the contact portions 42 of the first brush 31 and the contact portions 44 of the second brush 32 respectively slide on the respective patterns formed on the resistor board 30 elastically contacting to these patterns according to the rotation of the operation shaft (not illustrated), and, output voltage at a predetermined rotational angle is obtained either from the first resistor unit 43 or from the second resistor unit 45 through the respective terminals (35, 38, 41) as in the case of the conventional rotary variable resistor. However, in this exemplary embodiment, different from the conventional structure, both first brush 31 and second brush 32 elastically contact to the one resistive film 33, whereby the number of the terminals can be decreased to four (i.e., terminals 351, 352, 38 and 41), and, for

instance, the output voltage of the first resistor unit 43 is obtained through the terminals 351 and 38, and, the output voltage of the second resistor unit 45 is obtained through the terminals 351 and 41.

[0032] In Fig. 2, the effective output voltage of the first resistor unit 43 is obtained in an angular range where the horseshoe-shaped resistive film 33 is formed, and the effective output voltage of the second resistor unit 45 is obtained in the other angular range. In this case, the beginning and the ending portions of the respective effective output voltage of the first and the second resistor units (43, 45) overlap (i.e., effective output voltage is obtainable from both).

[0033] As described in the above, in the rotary variable resistor in this exemplary embodiment, the output voltage of the first and the second resistor units (43, 45) is obtained by elastically contacting both first and second brushes (31, 32) to the one resistive film 33, whereby the pattern structure of the resistor board 30 is simplified, accordingly the process for forming the pattern is simplified, also the number of the terminals is decreased. Thus a rotary variable resistor, with which desired output voltage is successively obtained by repeatedly rotating the operation shaft, can be realized with less production processes effectively.

[0034] In the above description, the auxiliary conductive member 39 is disposed at the outermost position on the resistor board 30. However, the same effect can be obtained by disposing the auxiliary conductive member 39 between the resistive film 33 and the current collecting conductive member 36. Also, by forming the current collecting member 36 to have a horseshoe-shape having an angular opening corresponding to the angular opening of the resistive film 33, instead of the annular shape as in the above description, the same effect can be obtained. Also, by disposing the resistive film, the current collecting conductive member and the auxiliary conductive member in the other order than the above description, the same effect can be obtained if these patterns are disposed in such a manner as to be spatially isolated each other.

Second Exemplary Embodiment

[0035] Fig. 3 is a schematic diagram showing the main portion (i.e. the upper side of the resistor board) of a rotary variable resistor in a second exemplary embodiment.

[0036] In this exemplary embodiment, the pattern structure of the resistor board 50 is different from that of the first exemplary embodiment. That is, a horseshoe-shaped current collecting conductive member 51 is additionally formed with argentic material by printing between the horseshoe-shaped resistive film 33 and the annular current collecting conductive member 36 in such a manner as to be spatially isolated from these patterns (33, 36). Also, different from the first exemplary embodiment, a second brush 52 having three contact portions (521, 522, 523) is disposed. The three contact portions (521, 522, 523) respectively slide on the resistive film 33, the auxiliary conductive member 39 and the current collecting conductive member 51 elastically contacting to these patterns (33, 39, 51). As a result, a third resistor unit 53 comprising the second brush 52, the resistive film 33 and the current collecting conductive member 51 is formed in addition to the first and the second resistor units (43, 45).

[0037] In the rotary variable resistor of this exemplary embodiment having the above structure, effective output voltage having the same voltage value is obtainable from both second and third resistor units (45, 53) in a rotational angular range in which effective output voltage is unobtainable from the first resistor unit 43. Therefore, the output voltage of either the second resistor unit 45 or the third resistor unit 53 can be selectively used according to the necessity.

Third Exemplary Embodiment

[0038] Fig. 4 is a schematic diagram showing an output regulator in a third exemplary embodiment of the present invention, and Fig. 5 is a flow chart showing signal processing of the output regulator in the same.

[0039] First, the structure of the output regulator which uses the rotary variable resistor of the first exemplary embodiment is described on reference to Fig. 4.

[0040] As shown in Fig. 4, a minus terminal of a power source unit 60 is connected to the terminal 351 of the resistive film 33 of the rotary variable resistor, and a plus terminal of the power source unit 60 is connected to the other terminal 352 of the resistive film 33, whereby a predetermined voltage is applied to the resistive film 33 from the power source 60.

[0041] The output voltage of the first resistor unit 43, which is obtained through the terminal 351 of the resistive film 33 and the terminal 38 of the current collecting conductive member 36, the output voltage of the second resistor unit 45, which is obtained through the terminal 351 of the resistive film 33 and the terminal 41 of the auxiliary conductive member 39, and, the output voltage of the power source 60 (i.e., voltage applied to the rotary variable resistor) are input to the input port 63 of the analog-to-digital converting unit 62 of the microcomputer 61.

[0042] The analog-to-digital converting unit 62 converts the voltage signals (i.e., analog voltage signals) received through the input port 63 to digital voltage signals and sends the digital voltage signals to a detecting unit 64.

[0043] Then the detecting unit 64 detects the value of the digital voltage signal of the second resistor unit 45. Then the comparing unit 65 compares the value of the second resistor unit 45 with the voltage value applied to the rotary variable resistor.

[0044] The reason of the comparison is that, as described in the first exemplary embodiment, in the

rotary variable resistor of the present invention, the first and the second resistor units (43, 45) respectively have operational angular ranges for outputting effective output voltage, and, the beginning and the ending portions of the effective output voltage of the first and the second resistor units (43, 45) overlap (i.e., effective voltage is obtainable from both). Therefore, in the angular ranges in which the effective voltage is obtainable from both, judgment based on the comparison is required for selecting either of the output voltage.

[0045] Next, the process for selecting the effective voltage is described on reference to Fig. 5. In Fig. 5, the comparing unit 65 judges the output voltage of the first resistor unit 43 to be effective when the output voltage of the second resistor unit 45 is lower than 90% of the voltage applied to the rotary variable resistor, and, to be ineffective when the output voltage of the second resistor unit 45 is equal or higher than 90% of the voltage applied to the rotary variable resistor.

[0046] When the comparing unit 65 judges the output voltage value of the first resistor unit 43 to be effective, an arithmetic processing unit 66 reads out an output code corresponding to the output voltage value of the first resistor unit 43 from a setting storing unit 67, and sends the code to an output port 68.

[0047] On the other hand, when the comparing member 65 judges the output voltage value of the first resistor unit 43 to be ineffective, the arithmetic processing unit 66 reads out an output code corresponding to the output voltage value of the second resistor unit 45 or a predetermined code which is stored in advance from the setting storing unit 67 and send the code to the output port 68.

[0048] In the above description, the judgment of the effectiveness of the output voltage is performed based on the value of 90% of the voltage applied to the rotary variable resistor. However, the same effect can be obtained by performing the judgment based on the other voltage value.

[0049] As described in the above, the output regulator of this exemplary embodiment can be formed to have simple structure and small size by using the rotary variable resistor of the present invention having a few terminals and operable by repeatedly rotating the operation shaft.

[0050] Also when the setting storing unit 67 is a rewritable type, output codes are changeable according to purpose by changing the setting of codes stored in advance.

[0051] In the above description, the output voltage value of the second resistor unit 45 is compared with the voltage value applied to the rotary variable resistor. However, the same effect can be obtained by comparing the output voltage value of the first resistor unit 43 with the voltage value applied to the rotary variable resistor.

[0052] As described in the above, in the rotary variable resistor of the present invention, one resistive film is used for both first and second resistor units, and, the multilayer pattern as in the conventional structure is eliminated, also the number of terminals is decreased, whereby the pattern of the resistor board is simplified. Thus a low cost rotary variable resistor is obtained with simplified production process effectively.

[0053] Also, by using the rotary variable resistor of the present invention, an output regulator, with which successive proper output codes are obtainable in the repeated rotation of the operation shaft by performing simple signal processing with a microcomputer or the like based on the output voltage value of the first or the second resistor unit, can be realized.

[0054] Also, in the output regulator, output codes are changeable according to necessity by changing the setting of codes stored in advance.

Claims

1. Rotary variable resistor comprising:

(a) a resistive film (33) disposed on an insulating substrate (302);
(b) a current collecting conductive member (36) disposed in such a manner as to be concentric with said resistive film (33) and to be spatially isolated from said resistive film (33) and a lead member (34) thereof (33);
(c) a circular arc shaped auxiliary conductive member (39) disposed in such a manner as to be concentric with said resistive film (33), and to be spatially isolated from said resistive film (33), said current collecting conductive member (36) and lead members (34, 37) of said resistive film (33) and said current collecting conductive member (36), also to cover a larger angular range than an angular opening of said resistive film (33);
(d) a first brush (31) made of an elastic metal plate and fixed to a repeatedly rotatable operation shaft, also having first contact portions (42) which respectively elastically contact to said resistive film (33) and to said current collecting conductive member (36), wherein said first brush (31) forms a first resistor unit (43) together with said resistive film (33) and said current collecting conductive member (36); and
(e) a second brush (32) made of an elastic metal plate and fixed to said operation shaft in such a manner as to be electrically isolated from said first brush (31), also having second contact portions (44) which respectively elastically contact to said resistive film (33) and to said auxiliary conductive member (39) in a rotational angular range of said operation shaft, in the rotational angular range predetermined output voltage is unobtainable from said first resistor unit (43), wherein said second brush (32) forms a second resistor unit (45) together

with said resistive film (33) and said auxiliary conductive member (39).

2. An output regulator comprising:

(a) a rotary variable resistor, said rotary variable resistor including

(a-1) a resistive film (33) disposed on an insulating substrate (302),
(a-2) a current collecting conductive member (36) disposed in such a manner as to be concentric with said resistive film (33), and to be spatially isolated from said resistive film (33) and a lead member (34) thereof (33),
(a-3) a circular arc shaped auxiliary conductive member (39) disposed in such a manner as to be concentric with said resistive film (33), and to be spatially isolated from said resistive film (33), said current collecting conductive member (36) and lead members (34, 37) of said resistive film (33) and said current collecting conductive member (36), also to cover a larger angular range than an angular opening of said resistive film (33),
(a-4) a first brush (31) made of an elastic metal plate and fixed to a repeatedly rotatable operation shaft, also having first contact portions (42) which respectively elastically contacts to said resistive film (33) and to said current collecting conductive member (36), wherein said first brush (31) forms a first resistor unit (43) together with said resistive film (33) and said current collecting conductive member (36), and
(a-5) a second brush (32) made of an elastic metal plate and fixed to said operation shaft in such a manner as to be electrically isolated from said first brush (31), also having second contact portions (44) which respectively elastically contact to said resistive film (33) and to said auxiliary conductive member (39) in a rotational angular range of said operation shaft, in the rotational angular range predetermined output voltage is unobtainable from said first resistor unit (43), wherein said second brush (32) forms a second resistor unit (45) together with said resistive film (33) and said auxiliary conductive member (39);

(b) a power source unit (60) for applying predetermined voltage to said rotary variable resistor;

(c) an analog-to-digital converter (62) having an input port through which output voltage of said first resistor unit (43) of said rotary variable resistor, output voltage of said second resistor unit (45) of the same and the voltage applied to said rotary variable resistor are respectively input;

(d) a detecting unit (64) for detecting value of the output voltage of said second resistor unit (45);

(e) a comparing unit (65) for comparing the value of the output voltage of said second resistor unit (45), the value detected by said detecting unit (64), with value of the voltage applied to said rotary variable resistor;

(f) an arithmetic processing unit (66) for outputting an output code corresponding to value of the output voltage of said first resistor unit (43) when said comparing unit (65) judges the value of the output voltage of said first resistor unit (43) to be effective, and for outputting one of an output code corresponding to the value of the output voltage of said second resistor unit (45) and a predetermined output code stored in advance when said comparing unit (65) judges the value of the output voltage of said first resistor unit (43) to be ineffective; and

(g) an output port (68) for outputting the output codes.

FIG. 1

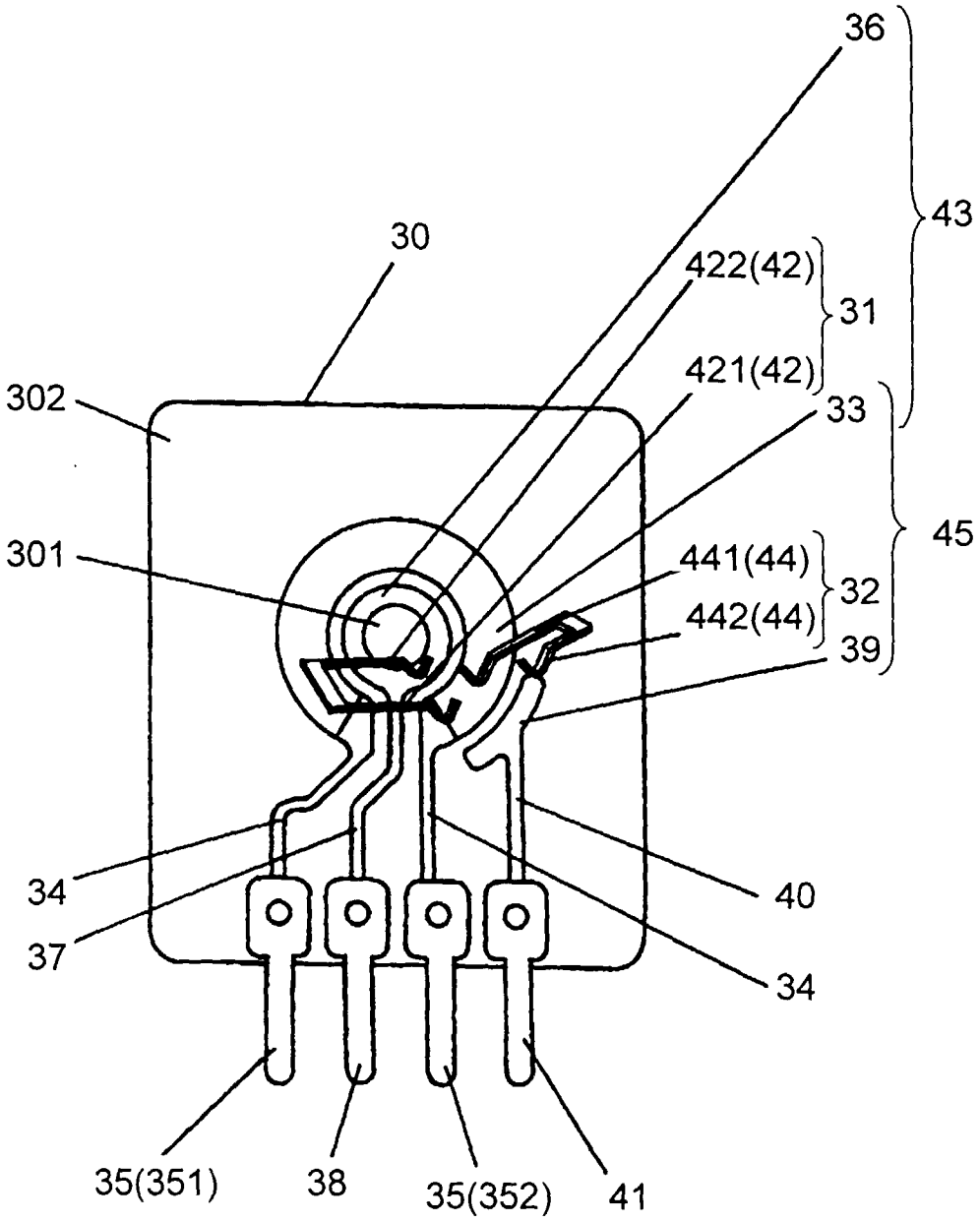
36
43
30
422(42)
31
421(42)
302
33
45
301
441(44)
32
442(44)
39
34
40
37
34
35(351)
38
35(352)
41

FIG. 2

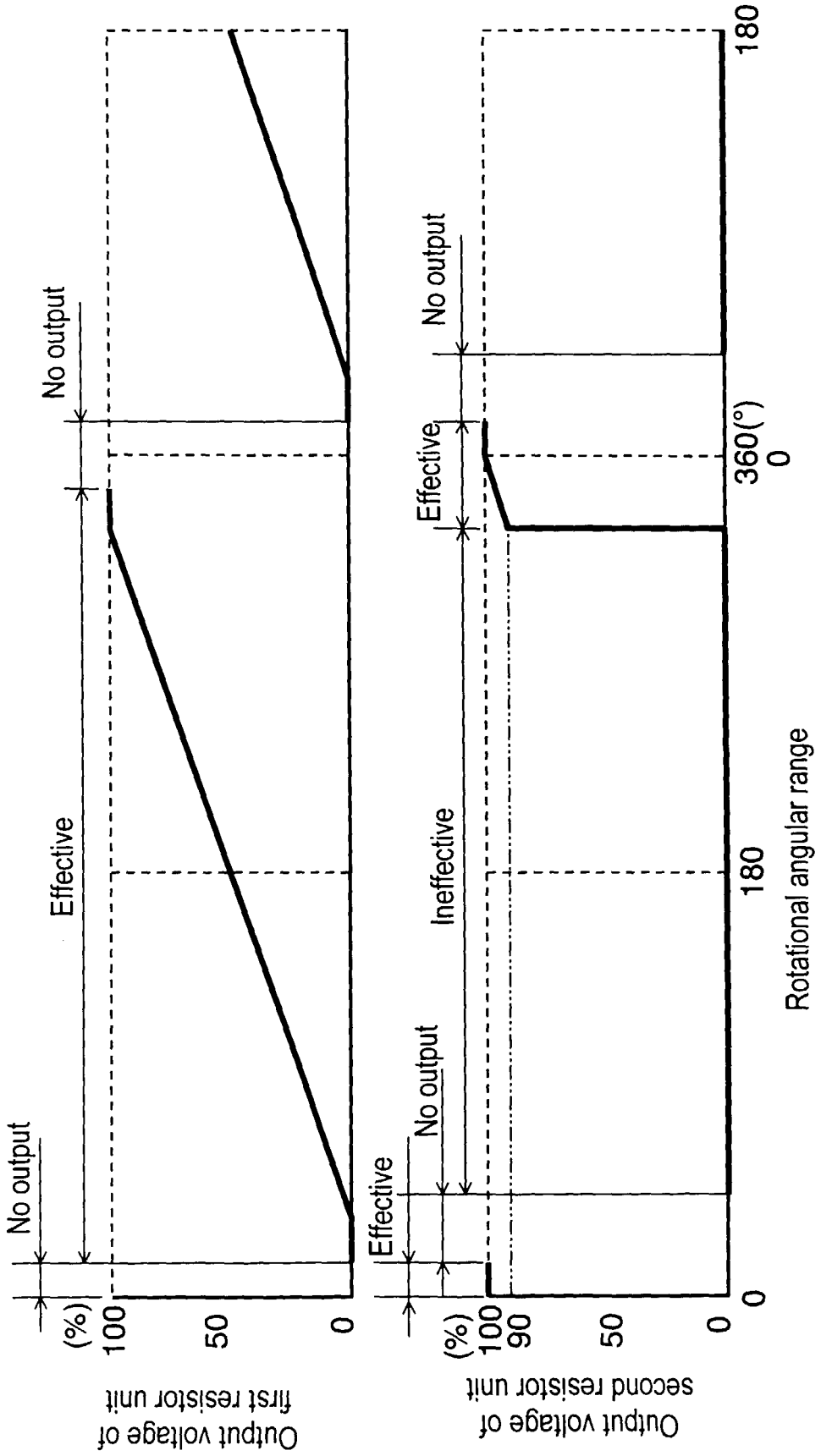
Output voltage of first resistor unit
(%)
100
50
0
No output
Effective
Output voltage of second resistor unit
(%)
100
90
50
0
Effective
No output
Ineffective
No output
Effective
0
180
360(°)
0
180
Rotational angular range

FIG. 3

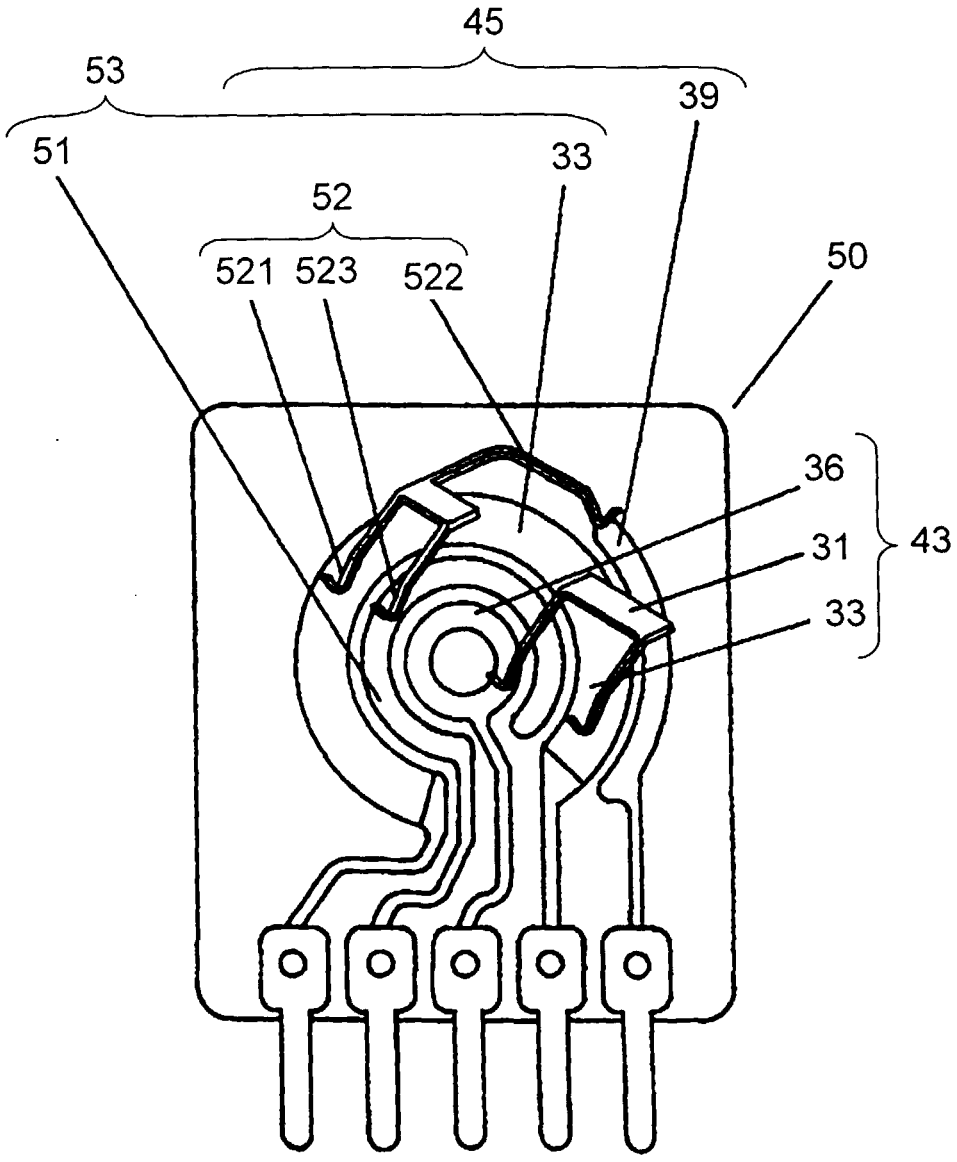

FIG. 4

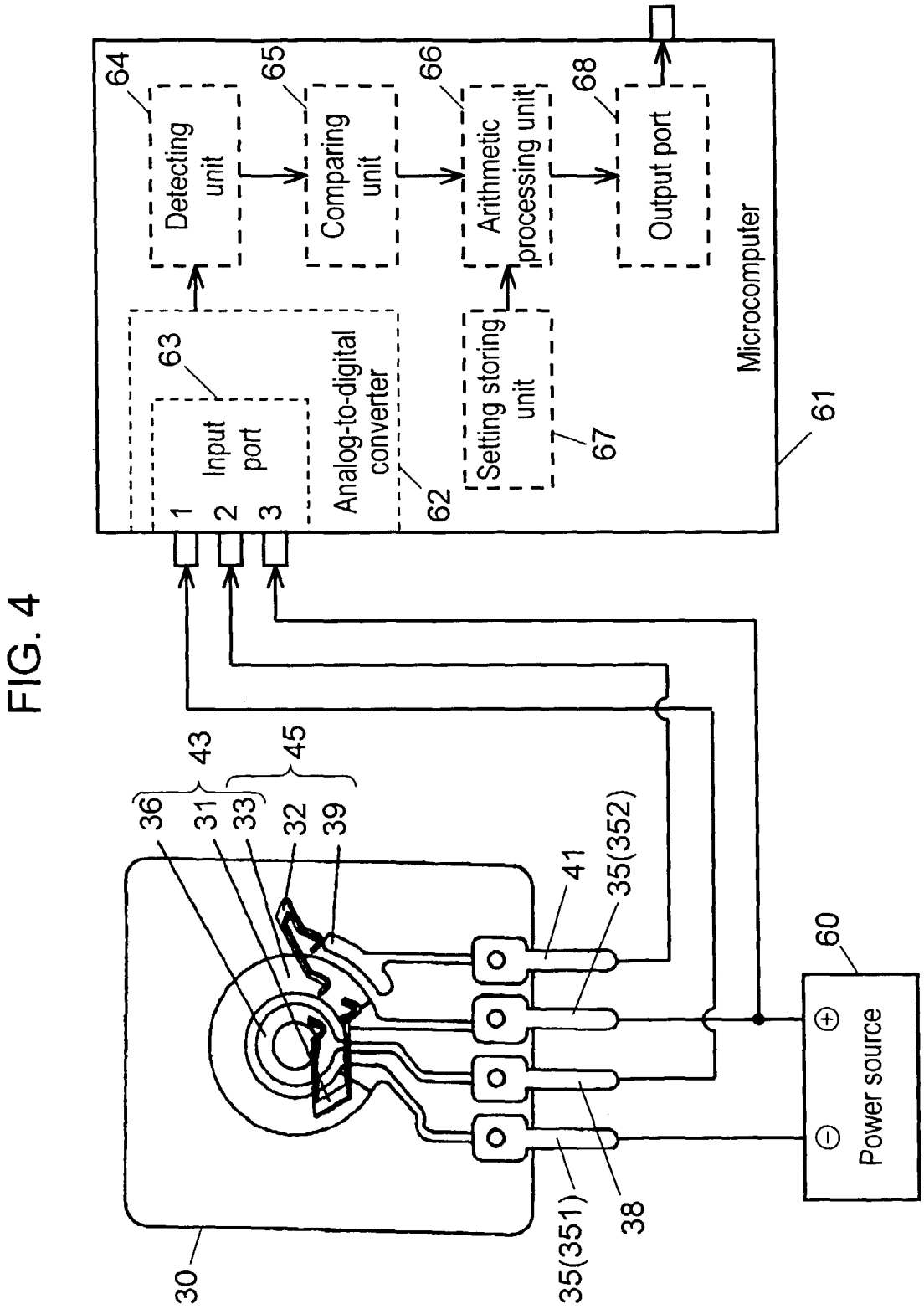
64
Detecting unit
65
Comparing unit
66
Arithmetic processing unit
68
Output port
Microcomputer
61
63
Input port
1
2
3
Analog-to-digital converter
62
Setting storing unit
67
43
45
36
31
33
32
39
41
35(352)
60
Power source
30
35(351)
38

FIG. 5

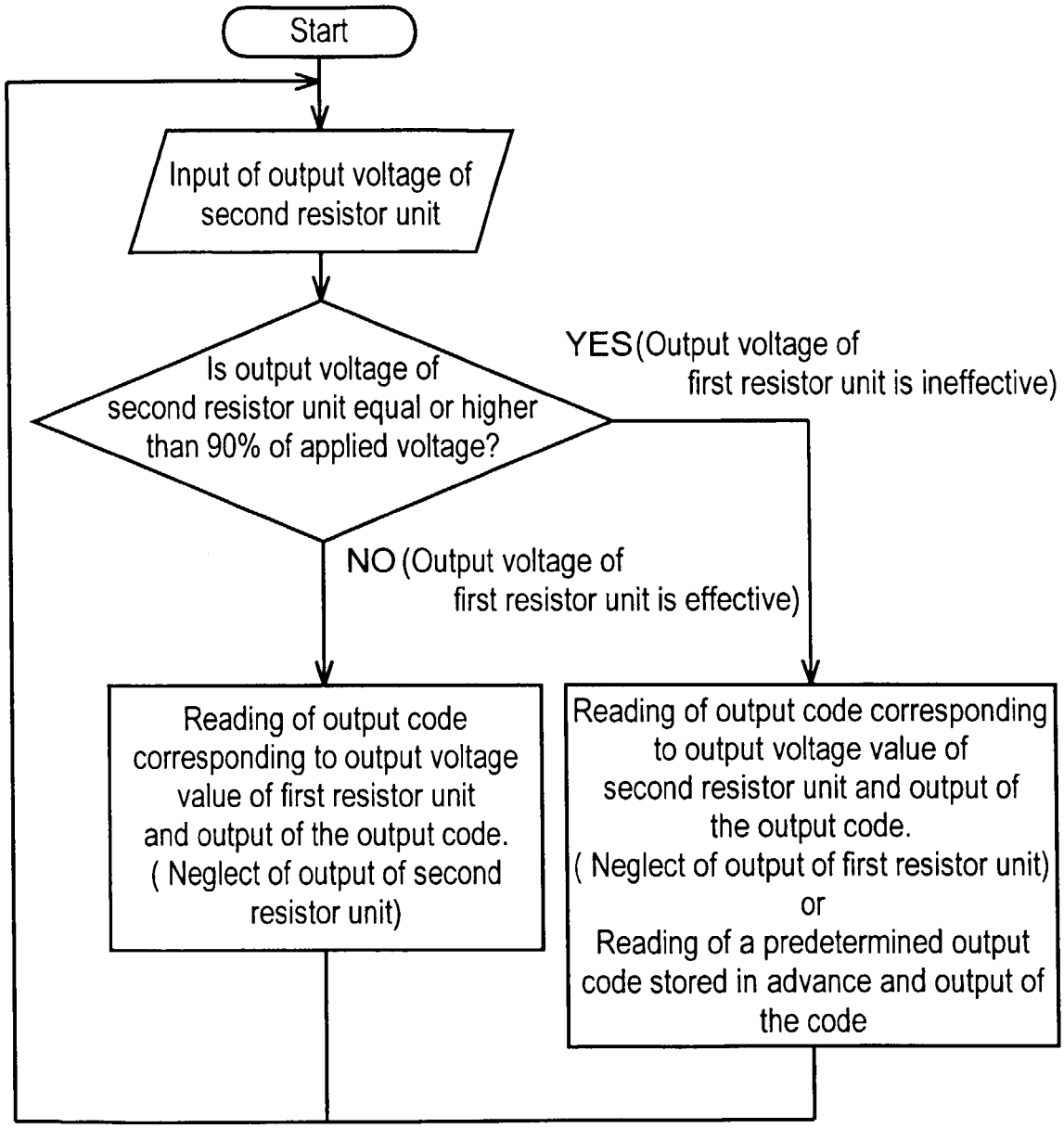
Start
Input of output voltage of second resistor unit
Is output voltage of second resistor unit equal or higher than 90% of applied voltage?
YES (Output voltage of first resistor unit is ineffective)
NO (Output voltage of first resistor unit is effective)
Reading of output code corresponding to output voltage value of first resistor unit and output of the output code. (Neglect of output of second resistor unit)
Reading of output code corresponding to output voltage value of second resistor unit and output of the output code. (Neglect of output of first resistor unit) or Reading of a predetermined output code stored in advance and output of the code

FIG. 6 PRIOR ART

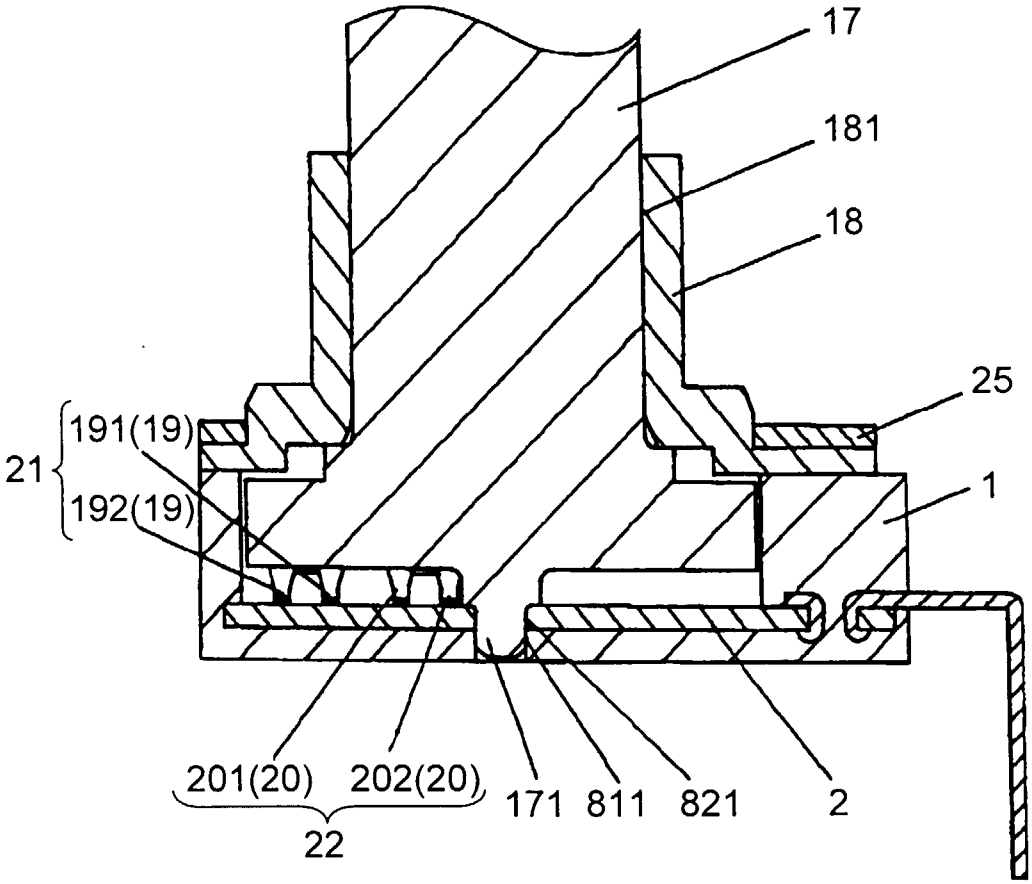

FIG. 7 PRIOR ART

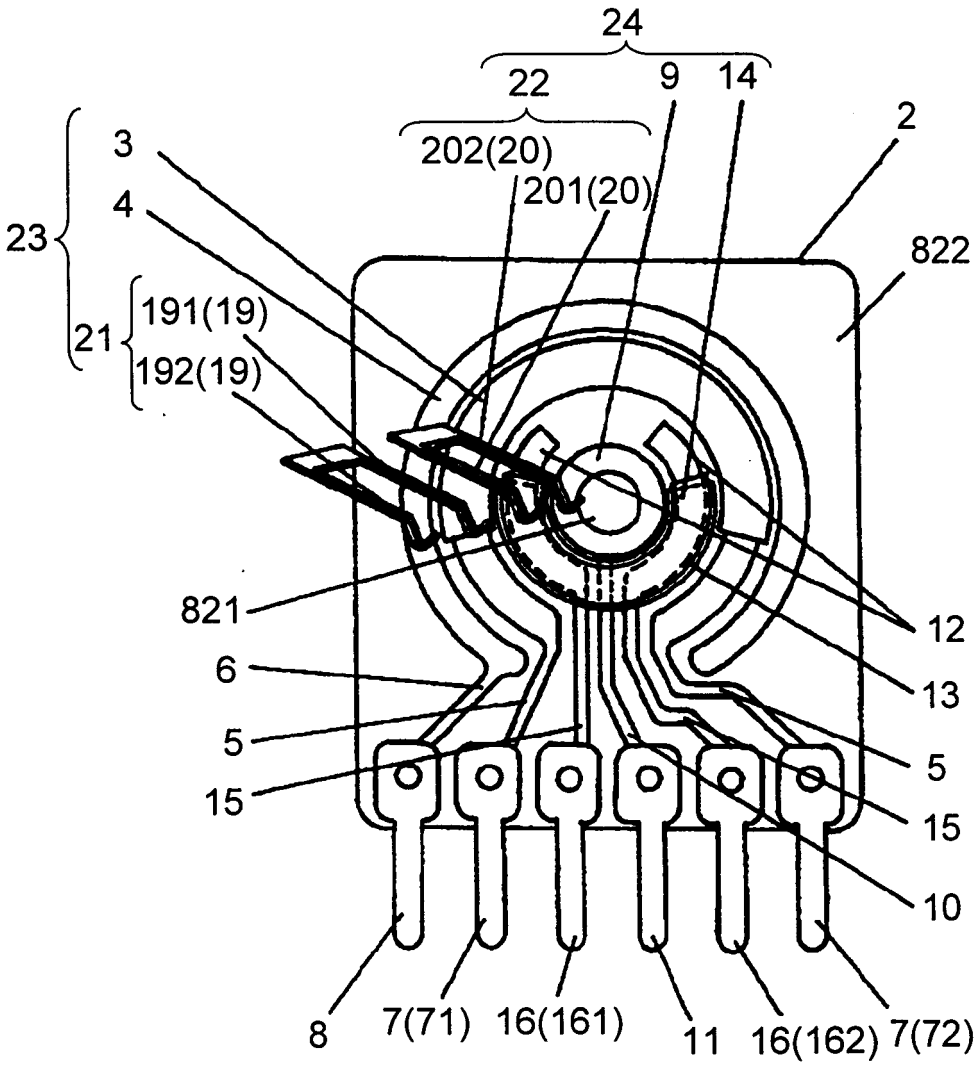

FIG. 8 PRIOR ART