

PATENT SPECIFICATION

(11) 1 531 277

1 531 277

- (21) Application No. 51000/75 (22) Filed 12 Dec. 1975
 (31) Convention Application No. 7416329
 (32) Filed 16 Dec. 1974 in
 (33) Netherlands (NL)
 (44) Complete Specification published 8 Nov. 1978
 (51) INT CL² H01C 7/02 H04N 9/29
 (52) Index at acceptance

H4T IX11 2D1

H1K 1AU 1D4P 1D4X 2R1E 2R1Y 2S13 2S17 2S26 2S3A
2S3E 4C1PY 5B4 5E2 5EY FD

(54) COMPOSITE THERMISTOR COMPONENT

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2., a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a composite thermistor component comprising a first and second thermistor each having a positive temperature coefficient, said thermistors being thermally coupled such that, in operation, the second thermistor contributes to the heating of the first thermistor.

Such a component which can, for example be used in a degaussing circuit for degaussing the inner shield and the shadow mask of shadow mask colour television tubes is known from United States Patent Specification 3,845,442. In order to reduce the current flowing through a degaussing coil in such a circuit at the end of the degaussing operation, which current would produce undesired residual magnetism in the ferromagnetic parts to be degaussed, the first thermistor is raised by means of the second thermistor to a higher temperature than the temperature which would be produced by the final current alone, which results in a further increase of the resistance value of the first thermistor.

It is an object of the invention to provide a modified composite thermistor component.

The invention provides a composite thermistor component comprising a first and second thermistor each having a positive temperature coefficient, said second thermistor having a resistance which is substantially higher than that of said first thermistor when said thermistors are in the unoperated (cold) condition, said thermistors being thermally coupled such that in operation, said second thermistor

contributes to the heating of said first thermistor and the resistance of said second thermistor at the final operating temperature of said component is lower than the resistance of said first thermistor.

The invention also provides a composite thermistor component embodied in a degaussing circuit, in which the first thermistor is connected in a series arrangement with a degaussing coil to first and second terminals for an alternating mains supply whilst the second thermistor is connected in parallel with the series arrangement.

The invention will be further explained with reference to the accompanying figures which are given by way of non-limitative example, in which

Figure 1 shows a circuit including a composite thermistor component according to the invention,

Figures 2 and 3 show characteristic curves to elucidate the invention, and

Figure 4 shows a thermistor element according to the invention.

In Figure 1 a degaussing coil 1 of, for example, a colour television picture tube of the shadow mask type not shown here, is connected in series with a thermistor 2 having a positive temperature coefficient. The series arrangement formed in this way is connected to the terminals 3 and 4 of an a.c. voltage source 5, for example the electric supply mains via a switch 6. A second thermistor 7 also having a positive temperature coefficient is in parallel with the series arrangement of coil 1 and thermistor 2. The thermistors are thermally coupled as they have been brought into intimate contact with one another which is shown in Figure 1 by means of an arrow.

In the cold state the two thermistors have relatively low resistance values. Immediately after mains switch 6 has been switched on large currents flow therefore through both branches of the circuit. The current through coil 1 has a starting amplitude of approximately 5A or more.

50

55

60

65

70

75

80

85

90

95

Because thermistor 7 is in parallel with source 5 the current therethrough is independent of the degaussing current which flows through the branch 1, 2. Both currents are able to heat the thermistors in a relatively short time (approximately 10s).

In Figure 2 the resistance value R of thermistor 2 (curve a) and of thermistor 7 (curve b) has been plotted on a logarithmic scale as a function of the temperature T . Above the so-called Curie temperature T_0 (approximately 75°C) the resistivity of the material from which thermistor 2 has been made and consequently also its resistance value increases very steeply. Owing to internal heating thermistor 2 would, in the absence of thermistor 7, obtain a temperature T_1 (approximately 130°C) with a corresponding resistance value R_1 of approximately $25\text{ k}\Omega$, whereby the amplitude of the degaussing current attains a value of approximately 8 mA .

Figure 2 shows that thermistor 7 is chosen such that it has a higher Curie temperature T_0' (approximately 120°C) than thermistor 2. This implies that T_0' is attained at a later instant than that at which thermistor 2 reaches temperature T_0 and thermistor 7 gets warm less quickly than thermistor 2. After a certain time after the temperature T_0 has been reached the current through thermistor 2 becomes so small that the decrease of the factor i^2 in the expression $i^2 R$ of the dissipated power dominates the increase in the factor R . This power becomes smaller than the power dissipated by thermistor 7. Consequently thermistor 7 delivers heat to thermistor 2. As a part of the heat radiated by thermistor 7 is still absorbed by its surrounding casing and air, the temperature of thermistor 2 will be lower than that of the thermistor 7. From the above it appears that thermistor 7 only affects the degaussing current after a certain period of time.

Thermistor 7 reaches a temperature T' , which in a practical circuit is approximately 50°C higher than T_1 , so that thermistor 2 reaches, by means of heat transfer a final temperature T_2 which exceeds T_1 by approximately 20 to 30°C . A stable state occurs in which the final temperature of thermistor 7 is slightly lower than T' , and in which both thermistors are kept at approximately the said final temperatures by the final currents. This state is stable and consequently safe: For, an increase in the temperature produces a decrease of the current which opposes the increase in the temperature. This also prevents the temperature rising too high which might cause the resistance value to decrease. The final value R_2 of thermistor 2 is higher than R_1 , namely approximately $200\text{ k}\Omega$ and the final amplitude of the current through coil 1

is reduced to the desired value, i.e. approximately 1 mA .

In Figure 3 the current i through thermistor 2 is plotted versus the voltage v across it. Curve a holds for a lower temperature than curve b . Due to thermistor 7 the temperature of thermistor 2 becomes higher and it appears from Figure 3 that current i is indeed reduced. A condition herefor is that the power dissipated by thermistor 7 in the final state due to internal heating is higher than that of thermistor 2, which means that the final value of the resistance of thermistor 7 is lower than that of thermistor 2, which also appears from Figure 2. For this the dissipation in coil 1 in the final state is assumed to be negligibly small with respect to that in thermistor 2. This is justified by the fact that the ohmic resistance value of coil 1 is much smaller than value R_2 (approximately 20Ω as compared with approximately $200\text{ k}\Omega$) so that the output voltage drop across coil 1 is negligibly small.

As compared with the case where thermistor 7 is replaced by a linear resistor the above described circuit shows a considerable saving in energy as the final value of the current through thermistor 7 is so small that the power dissipated by it is many times smaller than that produced by the substantially constant current which flows through the linear resistor. An additional saving is obtained by choosing thermistor 7 to have a higher initial resistive value of approximately $1\text{ k}\Omega$ i.e. in the cold condition, than thermistor 2, which is about 25 to 40Ω . The initial value of thermistor 2 is determined by the desired magnitude of the initial amplitude of the degaussing current and must consequently be small.

A saving in cost is also obtained as compared with the circuit which includes the linear resistor for heating the thermistor. Furthermore the price of the component formed by thermistors 2 and 7 is not higher than the corresponding component of the known circuit. Figure 4 is a diagrammatic drawing of the "dual PTC" (PTC=positive temperature coefficient) composite thermistor component according to the invention. The component consists of two disks 2 and 7 of PTC material, for example barium titanate, which are clamped between three spring-fitted contacts 8, 9 and 10 and which are encapsulated in a case 11, made of synthetic material. In Figure 1 contact 9 corresponds with the junction of the two thermistors, whilst reference 8 is the connection shown in Figure 1 at the bottom of thermistor 7 and reference 10 the connection shown at the right of thermistor 2. As both thermistors must be able to

withstand the mains voltage they are of substantially the same thickness, whilst the "dual PTC" used in the circuit including the linear resistor consists of a thin and a thick thermistor. The sintering costs of the thick thermistors are slightly lower, which approximately compensates the higher costs of material.

A higher Curie temperature for thermistor 7 is obtained by partly replacing barium in the PTC-material by lead. A lower Curie temperature for thermistor 2 can be obtained by partly replacing barium by strontium.

It will be clear that the described circuit can also be used for other purposes than degaussing ferromagnetic parts in a colour television receiver. Other applications are possible, for example degaussing tools or erasing magnetic tapes for tape recording- and -reproducing devices.

WHAT WE CLAIM IS:—

1. A composite thermistor component comprising a first and second thermistor each having a positive temperature coefficient, said second thermistor having a resistance which is substantially higher than that of said first thermistor when said thermistors are in the unoperated (cold) condition, said thermistors being thermally coupled such that, in operation, said second thermistor contributes to the heating of said first thermistor and the resistance of said second thermistor at the final operating temperature of said component is lower than the resistance of said first thermistor.

2. A component as claimed in claim 1 in which the resistance of said second thermistor is between 25 and 40 times the resistance of said first thermistor in the unoperated condition.

3. A component as claimed in claim 1 or

2 in which the resistance of the second thermistor when operating at a temperature higher than the Curie temperature of either thermistor is lower than the resistance of the first thermistor at the said temperature.

4. A component as claimed in claim 1, 2, or 3, in which said thermistors have different Curie temperatures, the Curie temperature of the second thermistor being higher than the Curie temperature of the first thermistor.

5. A component as claimed in claim 4 in which the thermistors are made from barium titanate, the barium in the second thermistor being partly replaced by lead.

6. A component as claimed in claim 4, in which the thermistors are made from barium titanate, the barium in the first thermistor being partly replaced by strontium.

7. A composite thermistor component as claimed in any of the preceeding claims embodied in a degaussing circuit, in which said first thermistor is connected in a series arrangement with a degaussing coil to a first and second terminals for an alternating mains supply whilst said second thermistor is connected in parallel with said series arrangement.

8. A colour television receiver comprising a picture display tube of the shadow mask type and a degaussing circuit incorporating a composite thermistor component as claimed in claim 7.

9. A composite thermistor component substantially as herein described with reference to the accompanying drawing.

C. A. CLARK,
Chartered Patent Agent,
Berkshire House,
168—173 High Holborn,
London, WC1V 7AQ.
Agent for the Applicants.



15

3

1,531,277

3

withstand the mains voltage they are of substantially the same thickness, whilst the "dual PTC" used in the circuit including the linear resistor consists of a thin and a thick thermistor. The sintering costs of the thick thermistors are slightly lower, which approximately compensates the higher costs of material.

A higher Curie temperature for thermistor 7 is obtained by partly replacing barium in the PTC-material by lead. A lower Curie temperature for thermistor 2 can be obtained by partly replacing barium by strontium.

It will be clear that the described circuit can also be used for other purposes than degaussing ferromagnetic parts in a colour television receiver. Other applications are possible, for example degaussing tools or erasing magnetic tapes for tape recording- and -reproducing devices.

WHAT WE CLAIM IS:—

1. A composite thermistor component comprising a first and second thermistor each having a positive temperature coefficient, said second thermistor having a resistance which is substantially higher than that of said first thermistor when said thermistors are in the unoperated (cold) condition, said thermistors being thermally coupled such that, in operation, said second thermistor contributes to the heating of said first thermistor and the resistance of said second thermistor at the final operating temperature of said component is lower than the resistance of said first thermistor.

2. A component as claimed in claim 1 in which the resistance of said second thermistor is between 25 and 40 times the resistance of said first thermistor in the unoperated condition.

3. A component as claimed in claim 1 or

2 in which the resistance of the second thermistor when operating at a temperature higher than the Curie temperature of either thermistor is lower than the resistance of the first thermistor at the said temperature.

4. A component as claimed in claim 1, 2, or 3, in which said thermistors have different Curie temperatures, the Curie temperature of the second thermistor being higher than the Curie temperature of the first thermistor.

5. A component as claimed in claim 4 in which the thermistors are made from barium titanate, the barium in the second thermistor being partly replaced by lead.

6. A component as claimed in claim 4, in which the thermistors are made from barium titanate, the barium in the first thermistor being partly replaced by strontium.

7. A composite thermistor component as claimed in any of the preceeding claims embodied in a degaussing circuit, in which said first thermistor is connected in a series arrangement with a degaussing coil to a first and second terminals for an alternating mains supply whilst said second thermistor is connected in parallel with said series arrangement.

8. A colour television receiver comprising a picture display tube of the shadow mask type and a degaussing circuit incorporating a composite thermistor component as claimed in claim 7.

9. A composite thermistor component substantially as herein described with reference to the accompanying drawing.

C. A. CLARK,
Chartered Patent Agent,
Berkshire House,
168—173 High Holborn,
London, WC1V 7AQ.
Agent for the Applicants.