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(54) DEGAUSSING CIRCUIT FOR A COLOUR TELEVISION RECEIVER

(71) We, *N.V. GLOEILAMPENFABRIEKEN*, a limited liability Company, organised and established under the laws of the Kingdom of the Netherlands, of Emmasingel 29, Eindhoven, the Netherlands, 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 degaussing circuit for demagnetizing ferromagnetic components in a colour television receiver, comprising the series arrangement of a degaussing coil and a thermistor having a positive temperature co-efficient, means for connecting the series arrangement to a terminal of an a.c. voltage source, the circuit further comprising a resistance element for heating the thermistor.

Such a circuit is known from German Patent Specification 1,282,679. In order to reduce the current which flows through the degaussing coil when the receiver is warmed up, which current might produce an unwanted magnetic residual field in the ferromagnetic component to be demagnetized the thermistor is raised by means of a resistance element already present in the receiver to a higher temperature than the temperature which would be produced by the final current alone, this resulting in a further increase in the resistance value of the thermistor.

In practice, in the known circuit a high-wattage wire-wound resistor can be used as the resistance element, which wire-wound resistor is arranged in the immediate vicinity of the thermistor. However, the drawback of this measure is that the temperature of the wire-wound resistor cannot be readily controlled so that the difference between the maximum permissible temperature of the thermistor and the ambient temperature cannot be controlled with certainty. Consequently, the risk of overheating, which may be destructive to the thermistor, cannot be excluded. For this reason the circuit is not usually used.

It is an object of the invention to provide a circuit which can avoid the drawback of the known circuit, and to that end the circuit according to the invention is characterized in that the resistance element is a second thermistor having a negative temperature co-efficient means for connecting the second thermistor to a or the same terminal of the a.c. voltage source, said first and second thermistors being thermally coupled with each other, the second thermistor additionally serving as a protection resistance for a rectifier circuit in the receiver.

By means of heat transfer from the second to the first thermistor the latter attains, as wanted, a higher temperature. As the current through the second thermistor soon assumes a value which substantially does not depend on the degaussing circuit and which cannot exceed a given maximum, an equilibrium condition is obtained whereafter the temperature cannot increase to an appreciable extent so that the circuit according to the invention can be safe.

The above and other features of the invention will be explained by way of example with reference to the accompanying drawings wherein:—

Figure 1 shows a first embodiment of a circuit according to the invention.

Figure 2 is a characteristic curve for explaining the invention.

Figure 3 shows a second embodiment of a circuit according to the invention.

Figure 4 shows a third embodiment of a circuit according to the invention.

Figures 5a and 5b are waveforms occurring therein, and

Figure 6 shows a fourth embodiment of a circuit according to the invention.

In Figure 1 a degaussing coil 1 for use in a colour television receiver having a display tube of the shadow mask type, is in series with a thermistor 2. The series arrangement of a second thermistor 7 and a rectifier circuit 8 is in parallel with the series arrangement of coil 1 and the first mentioned thermistor 2. Thermistor 7 has a

negative temperature co-efficient, whilst thermistor 2 has a positive temperature co-efficient. The thermistors are thermally coupled because they are in intimate contact with one another which is indicated in Figure 1 by means of a double arrow. The parallel circuit constituted by components 1, 2, 7 and 8 can be connected through a switch 6 to the terminals 3 and 4 of an a.c. voltage source 5, for example the electric power supply mains.

Rectifier circuit 8 is diagrammatically shown in Figure 1 as the series arrangement of a rectifier 9 and the parallel arrangement of a supply capacitor 10 of high capacitance and a load 11. In operation the rectifier 9, which may consist in known manner of one or more diodes, rectifies the mains voltage from source 5 so that a d.c. voltage is available across capacitor 10 for feeding to further parts of the receiver so that a direct current flows through these parts. Load 11 therefore represents a resistance whose value is equal to the ratio of said d.c. voltage to this direct current. Of course the receiver may comprise further supply circuits, not shown, for example for generating d.c. voltages of different values as well as one or more mains transformers.

In the cold condition thermistor 2 has a comparatively low resistance value (of approximately 24 Ohm), whilst thermistor 7 has a comparatively high value (of approximately 70 Ohm). Immediately after closing the mains switch 6 a large current flows through the thermistor 2 and coil 1 of approximately 5A (peak value) or more. Because the series arrangement of the thermistor 7 and rectifier circuit 8 is in parallel with the source 5 the current therethrough is at the start independent of the degaussing current which flows through the branch 1, 2. The currents through both thermistors are able to heat them in a rather short time (approximately 10s).

Figure 2 shows on a logarithmic scale the resistance value R of thermistor 2 plotted as a function of the temperature T . Above the Curie-temperature T_c (approximately 75°C) the specific resistance of the material of which the thermistor 2 consists and consequently also its resistance value increases very steeply. In the absence of thermistor 7 thermistor 2 would attain, owing to self-heating, a temperature T_1 (approximately 130°C) with a corresponding resistance value R_1 of approximately 20 kOhm, the amplitude of the degaussing current would then be reduced to a value of approximately 20 mA.

When the temperature increases the resistance value of thermistor 7 decreases. The current through this thermistor is mainly determined by the values of the voltage across and of the current through load 11, which values, in the warm condition, are

substantially independent of the temperature of thermistors 2 and 7 and of the degaussing circuit for, these values only depend on the operating conditions of the various parts of the receiver which are provided with supply voltage by circuit 8. This current cannot, for example owing to the action of a safety circuit, exceed a given maximum.

The final value of thermistor 7 is low, for example, approximately 1 Ohm and conveys a current of 1.5 A (r.m.s. value) and runs at a temperature of 175°C. Thermistor 7 is chosen such that even for the smallest possible current through it, depending on load 11, it attains a final temperature which is higher than T_1 . Consequently, thermistor 7 conveys heat to thermistor 2. As a portion of the heat from thermistor 7 is radiated to the air the final temperature of thermistor 2 will be lower than that of thermistor 7. Owing to the heat transfer thermistor 7 attains a final temperature T_2 which is approximately 20 to 30°C higher than T_1 . An equilibrium condition occurs when the final temperature of thermistor 7 is lower than the final temperature without thermal coupling to thermistor 2 and wherein both thermistors are approximately kept at their final temperatures by their final currents. This situation is stable and, consequently, safe; for an increase in temperature T_1 causes a decrease in the current through thermistor 2 which opposes the increase in the temperature. It also prevents the temperature from rising too high which might cause the resistance value R to decrease. The final value R_2 of thermistor 2 is higher than R_1 , namely approximately 60 kOhm and the final amplitude of the current through coil 1 is reduced to the desired value, i.e. less than 5 mA.

In the above operation the dissipation in coil 1 in the final condition is assumed to be negligibly small with respect to that in thermistor 2. This is justified by the fact that the ohmic resistance value (approximately 20 Ohm) of coil 1 is much lower than value R_2 so that the voltage drop across coil 1 is negligibly small.

Thermistor 7 is a safety resistor for rectifier circuit 8. Because, prior to closing mains switch 6 capacitor 10 is still uncharged a very large current would flow through rectifier 9 and capacitor 10 immediately after switch-on if thermistor 7 were absent. This might cause damage to these components and also to switch 6. It would also be possible that a fuse 12 which in Figure 1 is included between switch 6 and the junction of thermistors 2 and 7 would melt. The starting current is limited by thermistor 7 which thermistor produces substantially no voltage drop in the hot condition.

Compared with the case where thermistor 7 is replaced by a resistor the circuit

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according to the invention can provide a considerable saving in energy for the final value of thermistor 7 is lower than the value of the linear resistance i.e. the above-mentioned starting value (approximately 70 Ohm) of thermistor 7 whereas the value of the rectified voltage across capacitor 10 is only decreased during the warming-up time of thermistor 7.

There is an additional advantage, namely the fact that after closing mains switch 6 the current derived by circuit 8 from source 5 grows gradually and not suddenly which would attenuate the jump produced by circuit 1, 2 at switch-on with the large current initially through thermistor 2.

Figure 3 shows a second embodiment of a circuit according to the invention, with the same reference numerals as those in Figure 1 wherein the rectifier circuit 8 is in parallel with the series arrangement of coil 1 and thermistor 2, whilst thermistor 7 is included between mains switch 6 and the junction of thermistor 2 and circuit 8. In this embodiment thermistor 7 also limits on switch-on the degaussing current so that both thermistors types must be chosen which each have a lower starting value than in the case of Figure 1. In the final state there is substantially no difference between the two constructions.

It will be noted that in the two described embodiments of the circuit thermistor 7 has a dual function, namely protecting the rectifier circuit 8 and increasing the final value of thermistor 2 and, consequently, reducing the final degaussing current, which means a saving compared with the case where the degaussing circuit is constructed in a known manner, for example with two thermally inter-coupled thermistors with positive temperature co-efficients, whilst thermistor 7 (or a linear resistor if it were in the same position) is not coupled therewith.

In Figure 4 thermistor 7 is in parallel with the series arrangement of degaussing coil 1 and thermistor 2. The circuit constituted by components 1, 2 and 7 can be connected through fuse 12 and switch 6 to terminal 3 of a.c. voltage source 5. In this example rectifier 9 is of the full wave type: four diodes 9a, 9b, 9c and 9d form a bridge across one diagonal of which components 10 and 11 are connected, whilst a point of the other diagonal is connected to that junction of series arrangement 1, 2 and thermistor 7 which is not connected to mains switch 6. The other point of this latter diagonal is connectible through switch 6 to the other terminal 4 of source 5.

In the cold state thermistor 2 has a comparatively low resistance value (of approximately 4 Ohm), whereas thermistor 7 has a comparatively high value (of approximately 150 Ohm). Capacitor 10 has as yet no

charge. In this circuit coil 1 has an ohmic resistance value of approximately 100 Ohm. Immediately after closing mains switch 6, the voltage of the source 5 is substantially completely across the parallel circuit constituted by components 1, 2, 7. If this voltage has an effective value of 220 V then a current of approximately 3.1A (peak value) flows through thermistor 2 and coil 1, whilst a current of approximately 2.1A flows through thermistor 7 which in the beginning is independent of the degaussing current flowing through branch 1, 2.

Figure 5a represents one cycle of the current which flows through rectifier 9 at the start of operation. Herein it is assumed that the frequency of the mains voltage is 50 Hz which corresponds to a period of 20 ms. When capacitor 10 is discharged diodes 9a and 9d or 9b and 9c respectively conduct during the entire half cycle, that is to say the opening angle thereof is equal to 10 ms.

After switch-on the degaussing current through coil 1 gradually decreases, because the resistance value of thermistor 2 becomes higher when the thermistor becomes warmer and on the other hand because capacitor 10 is being charged. In addition, when the temperature increases the resistance value of thermistor 7 decreases. The final value thereof is low, for example approximately 2 Ohm. As in Figures 1 and 3, thermistor 2 attains a final temperature T_2 which exceeds the final temperature T_1 which would be attained by self-heating in the absence of thermistor 7, which causes the final value of thermistor 2 to become higher. The final amplitude of the degaussing current is consequently reduced to the desired value. This final state is stable and, consequently, safe.

Figure 5b represents one cycle of the current flowing through rectifier 9 after warm up. The value thereof depends on the value of load 11; in a given receiver a peak value of approximately 4A was measured at an opening angle for the rectifying diodes of approximately 3 ms. It will be noted that the degaussing current through coil 1 is substantially of the same form as the currents in Figure 5a and 5b as the reactance of the coil at low frequencies may be neglected relative to the ohmic resistance value thereof. Figures 5a and 5b show that the shape of the current is substantially symmetrical about the zero value. A condition for this is that the decrease in the amplitude of the degaussing current does not take place too rapidly, which decrease is determined by the product of the resistance value of the circuit 1, 2, 7 and the capacitance of capacitor 10. Because the capacitance is determined by the permissible amplitude of the ripple voltage across load 11 this condition implies a minimum value for this resistance and, consequently, of the initial resistance value of

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thermistor 7 and of the ohmic resistance value of the degaussing coil, whilst maintaining the magnetic properties thereof. In the example of Figure 4 capacitor 1u has a capacitance of 200 μ F whilst the resistance value is approximately 60 Ohm in the cold state so that the product is approximately equal to 12 ms, that is to say in the order of magnitude of 50 to 60% of the duration of the cycle.

The reason why the shape of the current must be substantially symmetrical relative to the zero value, the negative and the positive peak values being consequently substantially equal to one another, is that the degaussing current should preferably not contain a direct current component, which component would generate an unwanted magnetic field. When using a full wave rectifier as is the case in Figure 4, the degaussing current reverses its direction at each half cycle as this current alternatingly flows either through diodes 9b or 9c or through diodes 9d and 9a. A single-phase rectifier in which the current does not reverse may not be used with the embodiment of Figure 4. Figure 6 employs a rectifier of the voltage doubler type, rectifier circuit 8 comprising two diodes 9a and 9b and two capacitors 10a and 10b. It is obvious that the degaussing current which also flows through capacitor 10b does not comprise a direct current component. It is also obvious that the circuit 1, 2, 7 may be included in the supply lead to terminal 4 which, of course, also applies to the embodiment in Figure 4. It should be noted that the half-wave rectifier, shown in Figure 3, produces a d.c. voltage drop across thermistor 7. Consequently, also in this construction preference should be given to using a full wave rectifier.

In Figures 4 and 6 the initial current is limited by components 1, 2 and, especially, 7. It will be noted that thermistor 2 always has a rather low voltage drop across it, both in Figure 4 and in Figure 6 for, at the beginning of the process the voltage of source 5 is found substantially fully across coil 1, which has a much higher ohmic resistance value, whilst the voltage across the series circuit 1, 2 at the end of the process is low, as thermistor 7 which is now low-ohmic substantially short-circuits the series arrangement. The advantage thereof is that thermistor 2 may be of a much thinner type than thermistor 2 in Figures 1 and 3, that is to say 0.5 to 0.7 mm instead of approximately 2 mm, which means a considerable saving in material and may be consequently cheaper. In addition, the dissipation is much lower and the loss of heat to air much lower. The preceding also applies with respect of thermistors which in known circuits are in series with the degaussing coil and which, at

least in the beginning of degaussing must be able to withstand a high voltage.

WHAT WE CLAIM IS:—

1. A degaussing circuit for demagnetizing ferro-magnetic components in a colour television receiver, comprising the series arrangement of a degaussing coil and a first thermistor having a positive temperature co-efficient, means for connecting said series arrangement to a terminal of an a.c. voltage source, said circuit further comprising a thermistor, the resistance element being a second thermistor having a negative temperature co-efficient, means for connecting said second thermistor to a or the same terminal of the a.c. voltage source, said first and second thermistors being thermally coupled with each other, said second thermistor additionally serving as a protection resistance for a rectifier circuit in the receiver.

2. A circuit as claimed in Claim 1, in which the current which in operation flows through a rectifier of the rectifier circuit also flows through the second thermistor, the temperature of the second thermistor in the final operating state exceeding the temperature of the first thermistor.

3. A circuit as claimed in Claim 2, in which the second thermistor is in series with the rectifier circuit, the series arrangement thus formed being in parallel with the series arrangement of the degaussing coil and the first thermistor and means for connecting both series arrangements to the terminals of the a.c. voltage source.

4. A circuit as claimed in Claim 2, in which the series arrangement of the degaussing coil and the first thermistor is in parallel with the rectifier circuit, means for connecting one of the junctions thus formed to a first terminal of the a.c. voltage source whilst the other junction is connected to the second thermistor, and means for connecting said second thermistor to the second terminal of the a.c. voltage source.

5. A circuit as claimed in Claim 2, in which the second thermistor is in parallel with the series arrangement of the degaussing coil and the first thermistor, the parallel circuit thus formed being included in a supply lead to the rectifier which is a full-wave rectifier of such a type that in operation substantially no direct current component can flow through said supply lead.

6. A circuit as claimed in Claim 5, in which the resistance value of the first thermistor in the cold state is less than one-twentieth of the ohmic resistance value of the degaussing coil.

7. A circuit as claimed in Claim 4, in which the rectifier circuit is of the full-wave



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thermistor 7 and of the ohmic resistance value of the degaussing coil, whilst maintaining the magnetic properties thereof. In the example of Figure 4 capacitor 10 has a capacitance of 200 μ F whilst the resistance value is approximately 60 Ohm in the cold state so that the product is approximately equal to 12 ms, that is to say in the order of magnitude of 50 to 60% of the duration of the cycle.

The reason why the shape of the current must be substantially symmetrical relative to the zero value, the negative and the positive peak values being consequently substantially equal to one another, is that the degaussing current should preferably not contain a direct current component, which component would generate an unwanted magnetic field. When using a full wave rectifier as is the case in Figure 4, the degaussing current reverses its direction at each half cycle as this current alternatingly flows either through diodes 9b or 9c or through diodes 9d and 9a. A single-phase rectifier in which the current does not reverse may not be used with the embodiment of Figure 4. Figure 6 employs a rectifier of the voltage doubler type, rectifier circuit 8 comprising two diodes 9a and 9b and two capacitors 10a and 10b. It is obvious that the degaussing current which also flows through capacitor 10b does not comprise a direct current component. It is also obvious that the circuit 1, 2, 7 may be included in the supply lead to terminal 4 which, of course, also applies to the embodiment in Figure 4. It should be noted that the half-wave rectifier, shown in Figure 3, produces a d.c. voltage drop across thermistor 7. Consequently, also in this construction preference should be given to using a full wave rectifier.

In Figures 4 and 6 the initial current is limited by components 1, 2 and, especially, 7. It will be noted that thermistor 2 always has a rather low voltage drop across it, both in Figure 4 and in Figure 6 for, at the beginning of the process the voltage of source 5 is found substantially fully across coil 1, which has a much higher ohmic resistance value, whilst the voltage across the series circuit 1, 2 at the end of the process is low, as thermistor 7 which is now low-ohmic substantially short-circuits the series arrangement. The advantage thereof is that thermistor 2 may be of a much thinner type than thermistor 2 in Figures 1 and 3, that is to say 0.5 to 0.7 mm instead of approximately 2 mm, which means a considerable saving in material and may be consequently cheaper. In addition, the dissipation is much lower and the loss of heat to air much lower. The preceding also applies with respect of thermistors which in known circuits are in series with the degaussing coil and which, at

least in the beginning of degaussing must be able to withstand a high voltage.

WHAT WE CLAIM IS:—

1. A degaussing circuit for demagnetizing ferro-magnetic components in a colour television receiver, comprising the series arrangement of a degaussing coil and a first thermistor having a positive temperature co-efficient, means for connecting said series arrangement to a terminal of an a.c. voltage source, said circuit further comprising a thermistor, the resistance element being a second thermistor having a negative temperature co-efficient, means for connecting said second thermistor to a or the same terminal of the a.c. voltage source, said first and second thermistors being thermally coupled with each other, said second thermistor additionally serving as a protection resistance for a rectifier circuit in the receiver.

2. A circuit as claimed in Claim 1, in which the current which in operation flows through a rectifier of the rectifier circuit also flows through the second thermistor, the temperature of the second thermistor in the final operating state exceeding the temperature of the first thermistor.

3. A circuit as claimed in Claim 2, in which the second thermistor is in series with the rectifier circuit, the series arrangement thus formed being in parallel with the series arrangement of the degaussing coil and the first thermistor and means for connecting both series arrangements to the terminals of the a.c. voltage source.

4. A circuit as claimed in Claim 2, in which the series arrangement of the degaussing coil and the first thermistor is in parallel with the rectifier circuit, means for connecting one of the junctions thus formed to a first terminal of the a.c. voltage source whilst the other junction is connected to the second thermistor, and means for connecting said second thermistor to the second terminal of the a.c. voltage source.

5. A circuit as claimed in Claim 2, in which the second thermistor is in parallel with the series arrangement of the degaussing coil and the first thermistor, the parallel circuit thus formed being included in a supply lead to the rectifier which is a full-wave rectifier of such a type that in operation substantially no direct current component can flow through said supply lead.

6. A circuit as claimed in Claim 5, in which the resistance value of the first thermistor in the cold state is less than one-twentieth of the ohmic resistance value of the degaussing coil.

7. A circuit as claimed in Claim 4, in which the rectifier circuit is of the full-wave type.

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8. A circuit as claimed in Claim 5 in which the product of the total ohmic resistance value of the said parallel circuit in the cold state with the capacitance of a supply capacitor being part of the rectifier circuit amounts to approximately 50% of the duration of the cycle of the voltage supplied by the a.c. voltage source.
9. A degaussing circuit substantially as herein described with reference to the accompanying drawings.

10. A colour television receiver comprising a picture display tube of the shadow mask type and a degaussing circuit as claimed in any of the preceding Claims.

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