

"PICTURE DISPLAY DEVICE HEATER CIRCUIT"

The invention relates to a picture display device comprising a picture display tube and a circuit for feeding the heater thereof having a first and a second terminal for connection to an alternating voltage source, and means whereby the voltage across
5 the heater assumes at switch-on of the picture display device a value which is higher than the nominal value and assumes substantially the nominal value after a predetermined warm-up period, said means comprising a positive temperature coefficient thermistor.

Such a circuit with which warming up of the cathode(s) of a
10 picture display tube is accelerated is disclosed in United States Patent Specification 3,886,401. In this prior art circuit the heater receives after a few seconds the nominal voltage, i.e. the voltage specified by the tube manufacturer as being the average heater voltage in normal operation. For this the voltage of the
15 alternating voltage source is applied to the heater via a resistor. In parallel with the resistor there is a positive temperature coefficient thermistor which is kept warm and, consequently, highly resistive by means of a second positive temperature coefficient thermistor connected between the terminals.

20 When the picture display device is switched on the two thermistors are of low resistance so that the voltage across the heater is higher than in the steady state. In practice, the circuit does not operate satisfactorily when the second thermistor is omitted. In the cold state the first thermistor must have a very low resistance and,
25 consequently, requires a high current to warm it. As the heater also behaves as a positive temperature coefficient thermistor, the resistance variation of which is, in addition, much faster than that of the first thermistor, the final temperature of this heater must be rather high. This is achieved by means of the second thermistor.
30 This results in that much power is dissipated, particularly by the

second thermistor which is connected directly to the voltage from the source. In addition, such a double thermistor is an expensive component.

The invention has for its object to provide a picture display device having a supply circuit by means of which the heater voltage can initially be temporarily increased, which can be cheaper than the prior art circuit and which can dissipate less power. According to the invention, the picture display device described in the opening paragraph is characterised in that one terminal of the heater is connected to one end of the secondary winding of a transformer one end of the primary winding of which is connected to the said first terminal, the other ends of the primary and the secondary windings being interconnected and connected to one terminal of the thermistor, the other terminals of the heater and the thermistor being connected to the said second terminal and the secondary winding of the transformer having a greater number of turns than the primary winding.

The picture display device of the invention may be further characterised in that the transformer is an auto-transformer having a tapped winding, the entire winding forming the secondary winding while a portion of the winding between one end thereof and its tap forms the primary winding, this end being connected to the thermistor while the tap is connected to the first terminal.

Preferably the picture display device of the invention is characterised in that the magnetic coupling between the primary and the secondary winding is such that the polarity of the voltage across the heater is the same during the warming up period as well as thereafter, and is also further characterised in that the alternating voltage source consists of a winding provided on a line output transformer.

The invention will now be further described by way of example, with reference to the accompanying drawing, in which:-

Figure 1 shows a supply circuit for feeding the heater of a picture display tube in a picture display device of the invention,

Figure 2 shows the variation of the heater voltage as a function of the time in the circuit of Figure 1, and

Figure 3 shows a variant of the circuit of Figure 1.

Referring to Figure 1, there is shown of a picture display device, for example a television receiver, only the supply circuit for the heater F of a picture display tube. In some types of picture tubes the cathode is heated directly so that the cathode is usually brought rather quickly up to its operating temperature. Colour television tubes include three heaters which, when heated indirectly, are internally connected in parallel or in series, the combination thus formed substituting heater F in Figure 1. In the event the heaters are separated the circuit of the type shown in Figure 1 can be used threefold.

The circuit of Figure 1 comprises a coil having a tap which forms two magnetically coupled inductances L1 and L2. Inductance L1 is arranged in series with a resistor R while inductance L2 is arranged in series with heater F. The tap forms a terminal A. That terminal of resistor R which is not connected to inductance L1 and that terminal of heater F which is not connected to inductance L2 are interconnected, forming a terminal B. Terminals A and B are connected to an alternating (a.c.) voltage source E. Source E may be a secondary winding of a transformer which is connectable to electric mains. In the present example source E consists of a secondary winding provided on a line output transformer, line flyback pulses being present across this winding during operation. Feeding the circuit with pulses of the line frequency has the advantage that the inductances have low values owing to the comparatively high frequency, while another advantage is the fact that in most cases line flyback pulses have a substantially constant amplitude.

Resistor R is a positive temperature coefficient thermistor. When the receiver is switched on thermistor R is cold and has consequently a low resistance value. After some tenths of a second the line deflection circuit is operative and line flyback pulses are present between terminals A and B. Inductances L1 and L2 form an auto-transformer whereby the pulses of source E are stepped up. In response thereto the rms heater voltage V_f increases gradually which is a positive effect in the prevention of damage to the heater. The circuit is rated so that voltage V_f becomes higher after some tenths of a second,

for example approximately 10 V rms, than the nominal value which is, for example, 6.3 V rms. This reduces the warming up period of the cathode(s) which are heated by heater F. During this time period the several circuits of the receiver can stabilise. When the warming
5 up time is not shortened, a picture of a normal brightness appears on the picture screen of the picture tube 8 to 9 seconds after turn-on of the receiver. The circuit of Figure 1 accomplishes this already after 4 seconds.

As long as the thermistor R is still cold and consequently of
10 a low resistance, stepped up line pulses are applied to heater F and the voltage V_f remains approximately equal to 10 V (see Figure 2). However, the current flowing through inductance L1 and thermistor R warms the thermistor. After a further 3 to 4 seconds the thermistor has reached such a temperature that its resistance value has become
15 comparatively high. A small current now flows through the thermistor so that the thermistor maintains a high temperature. The connection between inductance L1 and terminal B is as it were interrupted. As the amplitude of the pulses from source E for each winding of the line output transformer amounts already to some Volts (rms) and is,
20 consequently, stepped up in steps which are too coarse with respect to the nominal voltage of V_f , the voltage from source E is decreased by means of the series inductance L2. Figure 2 shows that voltage V_f decreases gradually after approximately 3 to 4 seconds and that it reaches the final value of 6.3 V between approximately 7 to 10
25 seconds after the receiver has been turned on.

The supply circuit may alternatively be of the construction shown in Figure 3. Herein T denotes a transformer a primary winding of which is connected between terminal A and thermistor R and which consequently has the same function as inductance L1 in Figure 1.
30 The secondary winding of transformer T is connected between heater F and thermistor R and has therefore the same function as the entire winding L1 + L2 in Figure 1.

The winding sense of the windings is important, both for Figure 1 and Figure 3. The inductances L1 and L2 must preferably be coupled
35 such that the lines of force generated thereby must be of opposite

directions, which is indicated in Figures 1 and 3 by means of polarity dots. The polarity of voltage V_f in the cold state of thermistor R is then equal to the polarity in the warm state. From calculation it appears that for the other case the rating is much more critical.

In practice the magnetic coupling k between inductances L_1 and L_2 and between the similar windings of transformer T, respectively, is so loose that they can be in the form of an air cored coil. The choice of the inductance values of L_1 and L_2 , of coupling k and of the properties at line frequency of thermistor R makes it possible, at a given amplitude of the pulses from source E, to satisfy within certain limits the three requirements imposed, namely the value of the increased heater voltage, the final value thereof and the warming up period of the cathode(s) heated by heater F. Good results were obtained with the circuit of Figure 1 when the following values were opted for:

source E:	amplitude 28.5 V with an inductive internal impedance corresponding to 2 μ H
inductance value of L_1 :	6.6 μ H
inductance value of L_2 :	22 μ H
coupling $k = 0.51$	
thermistor R:	at 25°C, $R \approx 0.5 \Omega$
	at 150°C, $R > 40 \Omega$
	dissipation factor: 27 mW/°C
	heat capacity : 1.2 J/°C

When this circuit is used, thermistor R requires approximately 4 seconds to get warm and the current therethrough has the rms value required therefor of approximately 5.4 A. The initial value of the current through heater F is approximately 2 A rms, which is the maximum permissible value, while the final value thereof is 700 mA. It is obvious that in a direct series arrangement of the thermistor with the heater, that is to say without series inductance, an initial current having a value of 5.4 A cannot be achieved. It has been found that spreads in the values of thermistor R do not have any substantial influence on the heater voltage, neither in

the cold nor in the hot state. This heater voltage is determined almost exclusively by the a.c. voltage source and by the coil L1, L2. It has also been found that the parasitic capacitance of the thermistor, which cannot be ignored at the line frequency, does not negatively affect the operation of the circuit and neither does the fact that the resistance value of the thermistor in the final state varies somewhat in dependence on the instantaneous pulse voltage. So the thermistor is not critical and the circuit is easily reproducible.

In addition, the circuit is reliable. When the thermistor becomes defective it forms an open circuit. It has been found that a complete break-down of the thermistor produces in the final state only a change of 0.2 V in the heater voltage. It is obvious that then no accelerated heating of the heater occurs. In contrast therewith, a mechanical switch, if provided in the position of the thermistor, may go on conducting, thereby considerably shortening the operating life of the picture tube. This also holds for an alternative possibility namely when a rectifier with a time-constant network is used as the switch. Finally, it should be noted that keeping the thermistor warm produces a slight dissipation in the final state. The above-specified values result in a dissipation of $(140 - 20) \times .027 = 3.2 \text{ W}$ at an ambient temperature of 20°C and a final temperature of 140°C .

**CLAIMS:-**

1. A picture display device comprising a picture display tube and a circuit for feeding the heater thereof having a first and a second terminal for connection to an alternating voltage source, and means whereby the voltage across the heater assumes at switch-on of the picture display device a value which is higher than the nominal value and assumes substantially the nominal value after a predetermined warming up period, said means comprising a positive temperature coefficient thermistor, characterised in that one terminal of the heater is connected to one end of the secondary winding of a transformer one end of the primary winding of which is connected to the said first terminal, the other ends of the primary and the second windings being interconnected and connected to one terminal of the thermistor, the other terminals of the heater and the thermistor being connected to the said second terminal and the secondary winding of the transformer having a greater number of turns than the primary winding.

2. A picture display device as claimed in Claim 1, characterised in that the transformer is an auto-transformer having a tapped winding, the entire winding forming the secondary winding while a portion of the winding between one end thereof and its tap forms the primary winding, this end being connected to the thermistor while the tap is connected to the said first terminal.

3. A picture display device as claimed in Claim 1 or 2, characterised in that the magnetic coupling between the primary and the secondary winding is such that the polarity of the voltage across the heater is the same both during the warming up period as well as thereafter.

4. A picture display device as claimed in any of the preceding Claims, characterised in that the alternating voltage source consists

of a winding provided on a line output transformer.

5. A picture display device substantially as herein described with reference to the accompanying drawing.

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