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(54) Improvements in electric irons.

(57) The present invention discloses a clothes ironing system comprising a cordless electrically heated iron (6,16,26) and an ironing board (1) incorporating an R.F. energised coil (2) which inductively heats the iron.

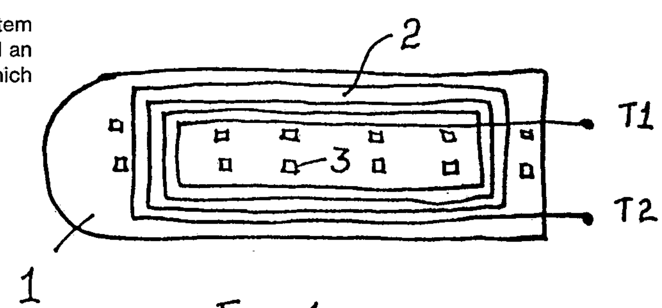

FIG. 1

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Description

Improvements in electric irons

The present invention relates to cordless irons and to a clothes ironing board incorporating a cordless electrically heated iron.

A conventional clothes iron consists of a soleplate and a handle with the soleplace incorporating a resistive electrical heater. Accordingly, the iron is connected to an electric power supply by means of a cord. Clothes are ironed by means of an ironing board against which the clothes are pressed by the iron.

A particular problem which arises with the conventional clothes ironing system is that the hot iron is normally left on the board in an upright, rather than a horizontal, position while clothes are not being ironed and the lengthy cord hangs down below the board. In this position, the cord is able to be pulled by small children who may well succeed in pulling the hot iron on top of themselves.

In order to overcome this difficulty it is known to have a cordless electric iron which incorporates a remote heating unit into which the iron is plugged for resistive heating and reheating. A disadvantage of this known system is that prolonged ironing cannot be undertaken without reheating the iron on many successive ocassions. This necessitates constant replugging of the iron into the remote heating unit. A further problem associated with such known types of cordless irons is that if the iron is provided with a steam generator, steaming causes more rapid loss of stored heat from the soleplate, and therefore exacerbates the replugging problem. In addition, water can also be emitted in drops from the soleplate rather than as steam because the soleplace is not hot enough.

It is the object of the present invention to overcome the abovementioned difficulties of the prior art by the provision of a clothes ironing system incorporating a cordless electrically heated iron in which the iron is inductively heated.

In accordance with one aspect of the present invention there is disclosed a clothes ironing system comprising a substantially flat surface, a coil located adjacent said surface, an R.F. power supply connected to said coil to supply radio frequency electric current thereto, and an iron comprising a soleplate and a handle wherein said soleplate is thermally conductive and includes at least one portion which is electrically conductive whereby said radio frequency current supplied to said coil generates an RF electromagnet field which impinges upon said electrically conductive soleplate portion and inductively heats same.

According to a second aspect of the present invention there is disclosed an ironing board for use with a cordless electric iron, said board comprising a substantially flat surface, a coil located adjacent said surface, and and RF power supply connected to said coil to supply radio frequency electric current thereto.

According to a third aspect of the present invention there is disclosed a cordless electrically heated iron for use with the above described clothes ironing system, said cordless electric iron comprising a handle and a thermally conductive soleplate at least one portion of which is electrically conductive.

Embodiments of the present invention will now be described with reference to the drawings in which:

Fig. 1 is an inverted plan view of the preferred ironing board in accordance with the present invention,

Fig. 2 is a longitudinal cross-section through the ironing board of Fig. 1,

Fig. 3 is a side elevation of a cordless electrically heated iron in accordance with a first embodiment, when placed in the ironing position,

Fig. 4 is an end elevation of the iron of Fig. 3 when placed in the standby position,

Fig. 5 is a side elevational view of the ironing board of Figs. 1 and 2 together with the iron of Figs. 3 and 4 illustrated in two positions,

Fig. 6 is a circuit diagram of the radio frequency power supply to the ironing board.

Fig. 7 is a longitudinal cross-sectional view through an iron in accordance with the second embodiment of the present invention being provided with a substantially conventional steam generator, and

Fig. 8 is a view similar to Fig. 7 but of a third embodiment of an iron incorporating an inductively heated steam generator.

As seen in Figs. 1 and 2, the preferred ironing board 1 of the present invention is of a substantially conventional configuration but is preferably made from a thermally insulating material such as fibreglass. On the underside of the ironing board 1 is located a coil 2 which preferably has 25 turns of copper wire having a cross-sectional area of 2.5 sq millimetres. The board 1 is also provided with a number of ventilation holes 3 and a thermal sensor 4 in the form of a thermistor or like known component.

Figs. 3 and 4 illustrate the simplest embodiment of a cordless electrically heated iron 6 in accordance with the present invention. The iron is formed from a cast iron soleplace 7 and a plastics handle 8 the preferred approximate dimensions for the soleplate 7 are 10cm x 20cm. The thickness of the soleplate 7 is from 1mm to 3mm, preferably 1.5mm. Thus there is a substantial weight saving compared with conventional irons which have soleplates approximately 5mm thick.

Turning now to Fig. 5, if the coil 2 is energized with alternating current at a radio frequency in the range of 30kHz-100kHz then an alternating magnetic field is setup about the coil 2 as schematically illustrated in Fig. 5. It will be apparent that this magnetic field passes through the soleplate 7 of an iron 6 located on the board 1 and therefore inductively heats the soleplate 7 by the generation of eddy currents. In this way the electrical energy supplied to the coil 2 is effectively transferred to the soleplate 7 via the magnetic field.

However, if an iron 60 is located with its soleplate 70 substantially vertical as illustrated in Fig. 5, then the plane of the soleplate 70 is substantially parallel to the lines of magnetic flux passing through the ironing board 1. As a consequence, the degree of heating of the soleplate 70 is substantially reduced when the iron 60 is located in the standby position as illustrated in Fig. 5. It will therefore be appreciated that this automatically provides for a reduction in the heating of the iron in the standby position which therefore is a substantial safety feature.

The electrical circuit used to supply power to the coil 2 is illustrated in Fig. 6. A transformer T has its primary winding connected to a conventional low frequency mains supply. The output of one secondary winding is passed through a diode bridge and a substantially conventional rectifier circuit comprising intergrated circuit type LM304, a transistor T6, a resistor R7 and two smoothing capacitors C3 and C4. The output of this power supply is 9 volts at a current capacity of approximately 20amps and is connected to one terminal T1 of the coil 2.

The other secondary winding of the transformer T is centre tapped and connected to a second diode bridge in order to supply a positive and negative 15 volt supply by means of a capacitors C5 and C6 and intergrated circuits types 7815 and 7915.

The positive output of this power supply is connected via normally closed relay 10 to a type 555 timer 11 connected as an RF oscillator. The frequency determing components are resistors R1 and R2 and capacitors C1 and C2 which are selected to provide a square wave output having a frequency of approximately 50kHz.

This output is connected to the light emitting diode D4 of an opto-transistor T5 which is accordingly switched on and off at the rate determined by the timer/oscillator 11. The switching of transistor T5 is transferred via transistors T4 and T3 to a Darlington connection of transistors T1 and T2 which are connected between earth and terminal T2 of the coil 2. As a consequence, the 20 amp current through the coil 2 is switched at the RF rate determined by the timer/oscillator 11.

It will be apparent from a consideration of Figs. 6 and 2 that the thermal sensor 4 can be used to switch into the open state the normally closed relay 10 in response to heat detected by the sensor 4 originating from the iron 6. In this way, the power supplied to the ironing board 1 and its coil 2 can be controlled. The thermal sensor 4 is preferably provided with both a thermistor, and a conventional variable resistance in known fashion in order that the power supplied to the coil 2 can be adjusted in accordance with the intended fabrics to be ironed on the ironing board 1.

Turning now to Fig. 7, it is desirable to provide a steam facility with irons and this is provided in accordance with the iron 16 of Fig. 7. Here the soleplate 17 is provided with a plurality of apertures 19 through which it is intended that steam should issue. Within the handle 18 of the iron 16 is located a water reservoir 15 which is connected to a steam chamber 14 via a conduit 13 including a valve 12. The valve 12 is operable by means of a push button switch 20.

It will be apparent that as the soleplate 17 is heated inductively as described above, so that push button switch 20 can be momentarily operated so as to release some drops of water from the reservoir 15 through the valve 12 and conduit 13. These drops as then immediately evaporated to cause steam to be produced within the chamber 14 and thus issue from the apertures 19.

Whilst the iron 16 of Fig. 7 includes a substantially conventional steam generating mechanism, the iron 26 of Fig. 8 includes an inductively heated steam generator. The iron 26 is provided with a soleplate 27 having apertures 29 leading from a steam chamber 24. The iron 26 has a handle 28 provided with a refillable water reservoir 25 formed from material such as plastic which is permeable to magnetic fields. A stream conduit 23 connects the reservoir 25 with the stream chamber 24. It will be apparent that the conduit 23 exits from the side of the reservoir 25 furthest from the heel 30 of the iron 26 so that when the iron 26 is placed in the standby position (as illustrated by iron 60 of Fig. 5) then water does not run from the reservoir 25 to the steam chamber 24 via the conduit 23.

Located within the reservoir 25 is a coil 32 which is connected in series with a capacitor 33 via a switch 34. The inductance of the coil 32 and the capacitance of the capacitor 33 are selected so as to form a resonant circuit at the RF frequency at which the coil 2 is supplied with energy.

It will be apparent that when the iron 26 is in the position of iron 6 as illustrated in Fig. 5, and the switch 34 is closed, then the coil 32 has a resonant current flowing therein which heats the water within the reservoir 25. As a consequence, the water is brought rapidly to boiling point and steam issues from the reservoir 25 via the conduit 23 into the steam chamber 24 and out the apertures 29.

Detailed Example

For induction heating the depth of penetration of the electric field is

$$d = \sqrt{\frac{2r}{uw}} \qquad (1)$$

where d = depth of penetration in meters
r = resistivity of the material in ohm meters
u = the absolute permeability of the material
w = 2 π f where f is the frequency.
The power dissipated per square meter of surface area is

$$P = \frac{rH^2}{d} \qquad (2)$$

where P = Power dissipated
r = resistivity
H = magnetic field strength, and
d = depth of penetration.

Thus for the coil 2 which is assumed to give a uniform field, and also assuming that there was no reactive losses due to flux leakage, that the flux of the coil is perpendicular to the surface of the soleplate, and that the soleplate is close to the iron; then the magnetic field strength is

$$H = \frac{I\ N}{l} \qquad (3)$$

where I = coil current of 20 A
N = number of turns = 25, and
l = mean length ofthe magnetic path = 0.8m.
Thus

$$H = \frac{20 \times 25}{0.8} = 625 \text{ A/M}$$

For a cast iron soleplate the permeability u is about $170 \times 4 \times 10^{-7}$ when H is approximately 625 A/m. Thus equation (1) above gives d = 0.077 mm.

Hence from equation (2) the power dissapated in the soleplate is P = 0.1 W/sq.cm approximately. Since the area of the soleplate is approximately 10cm x 20cm the total power is 0.1 x 10 x 20 = 20 watts.

For the coil 2, the current at RF frequencies flows in an outer tubular portion of the wire enabling a tube rather than solid wire to be used if desired. At a mains frequency of 50Hz the resistance of the wire of the coil 2 is

$$R50 = \frac{r\ l}{A} \qquad (4)$$

where R50 = the 50Hz resistance
r = resistivity of copper
l = length of wire = 60m, and
A = cross-sectional area of wire = 2.5 sq mm.
thus R50 = 0.413 ohm.

Since the skin depth is inversely proportional to the square root of the frequency and the skin depth of copper at 50Hz is 10mm, it follows that the skin depth of copper at 50kHz is 0.32mm. Thus the effective cross-section of the wire of the coil is an annulus having an external diameter of the wire diameter and an internal diameter of the wire diameter less 0.32mm. From this information the effective cross-sectional area of the wire can be calculated at 1.028 sq mm. Hence from equation 4 the resistance of the coil at 50kHz is R50k = 1 ohm approximately.

The inductance of the coil 2 is

$$L = \frac{u\ \ a\ \ N^2}{l} \qquad (5)$$

where L is the inductance
u is the permeability
a is the cross-sectional area of the coil wire
N is the number of turns, and
l is the mean length of the magnetic path.
Hence L = 236 uH which in practice is considerably increased due to the reactance of flux leakage.

Thus the impedance Z of the coil 2 is R + jwL giving Z = l + j 74.14 (i.e. 74.15 with a lagging phase angle of 89.2°.

For the 555 timer/oscillator 11,

$$f = \frac{1.44}{(R1 + 2R2)C1}$$

if R1 = 500 ohms, R2 = 1000 ohms and Cl =0.01uF then F = 57.6kHz.

It will be apparent to those skilled in the art that the above arrangement enables approximately 20W at 50kHz to be transferred to the iron soleplate. This is approximately the same order of magnitude as the power dissapated in a conventional iron with an electric heating element and so continuous ironing with a cordless electrically heated iron is achieved.

The foregoing describes only some embodiments of the present invention and modifications, obvious to those skilled in the art, be made thereto without departing from the scope of the present invention.

Claims

1. A clothes ironing system comprising a substantially flat surface (1), a coil (2) located adjacent said surface, an RF power supply (11,T1) connected to said coil (2) to supply radio frequency electric current thereto, and an iron (6,16,26) comprising a soleplate (7,17,27) and a handle (8,18,28) wherein said soleplate is thermally conductive and includes at least one portion which is electrically conductive whereby said radio frequency current supplied to said coil generates an RF electromagnetic field which impinges upon said electrically conductive soleplate portion and inductively heat same.

2. A system as claimed in claim 1 wherein said coil (2) lies in a plane substantially parallel to said flat surface (1), said coil and surface are separated by thermally insulating material, said soleplate is substantially planar and said soleplate is movable between an ironing position parallel to said surface and a rest position in which said soleplate is substantially perpendicular to said surface.

3. A system as claimed in claim 1 or 2 wherein said RF supply includes means (4,10) to control the power supplied to said coil.

4. An ironing board for use with a cordless electric iron, said board comprising a substantially flat surface (1), a coil (2) located adjacent said surface, and an RF power supply (11,T1) connected to said coil (2) to supply radio frequency electric current thereto.

5. An ironing boad as claimed in claim 4 wherein said coil (2) lies in a plane substantially parallel to said falt surface (1) and said surface and coil are separated by thermally insulating material.

6. An ironing board as claimed in claim 4 or 5 including ventilation holes (3) in said surface.

7. A cordless electrically heated iron for use with the clothes ironing system of claim 1, said cordless electric iron comprising a handle (8,18,28) and a thermally conductive soleplate (7,17,27) at least one portion of which is electrically conductive.

8. An iron as claimed in claim 7 wherein said soleplate (7,17,27) is formed from iron and has a thickness between 1mm and 3mm, preferably approximately 1.5mm.

9. An iron as claimed in claim 7 or 8 including boiler means (14,15,24,25) to generate steam and discharge same through openings (19,29) in said soleplate.

10. An iron as claimed in claim 9 wherein said boiler means comprises a water reservoir (15) and a conduit (13) leading therefrom via valve means (12), into an evaporation chamber (14) including said soleplate, and control means (20) connected to said valve means (12) to drip small quantitites of water onto said soleplate for evaporation within said evaporation chamber.

11. An iron as claimed in claim 9 wherein said boiler means comprises a sealable water reservoir (25) permeable to electromagnetic radiation, a coil (32) located in said reservoir and forming part of a resonant circuit (32,33) tuned to the frequency of the RF power supply (11,T1), and a steam supply conduit (23) leading between said reservoir and said soleplate whereby said coil is inductively heated by the RF electromagnetic field to boil the water within said reservoir.

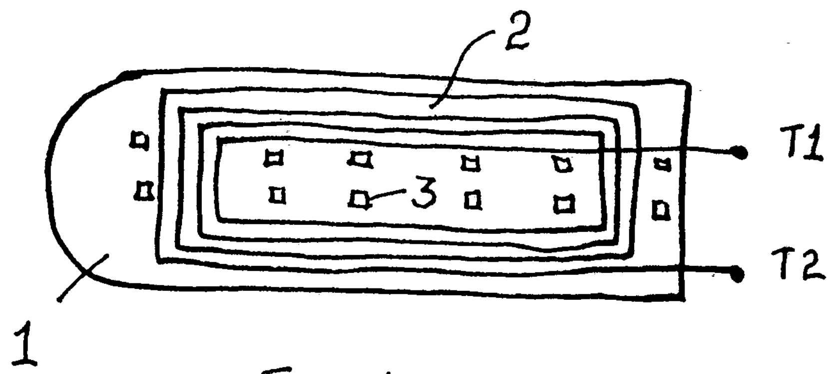

Fig. 1

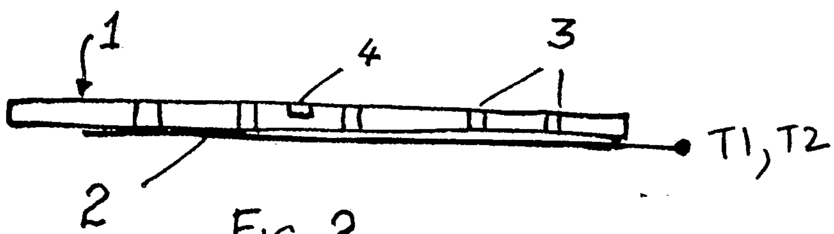

Fig. 2

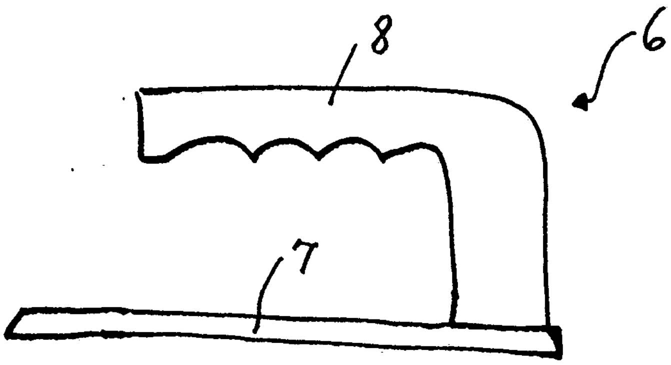

Fig. 3

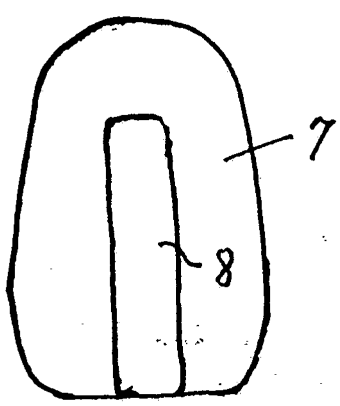

Fig. 4

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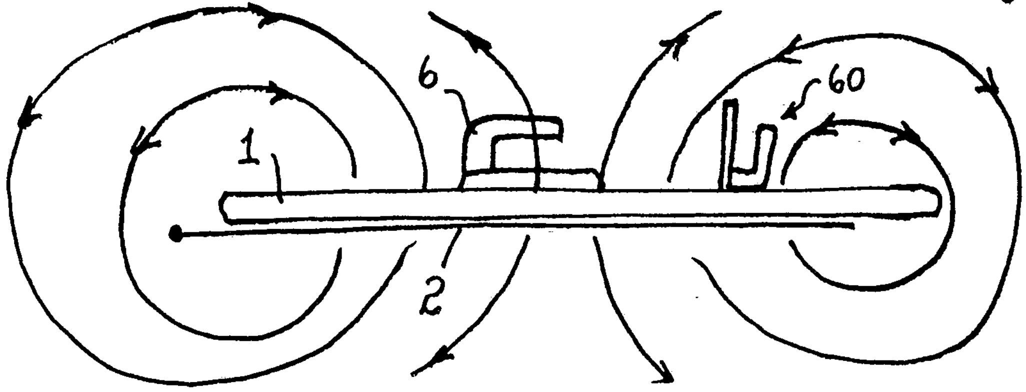

Fig. 5

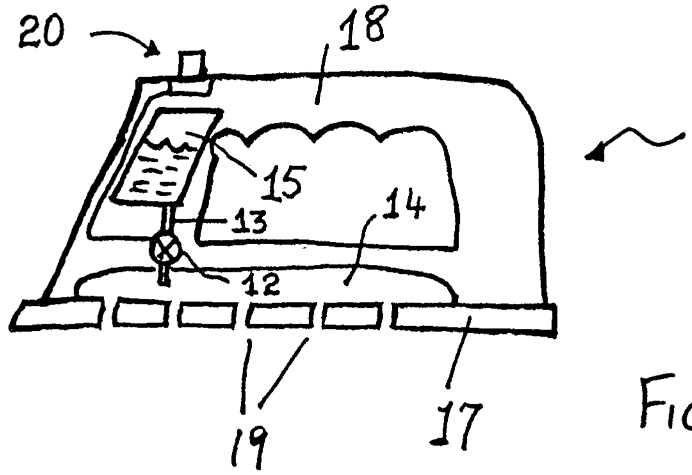

Fig. 7

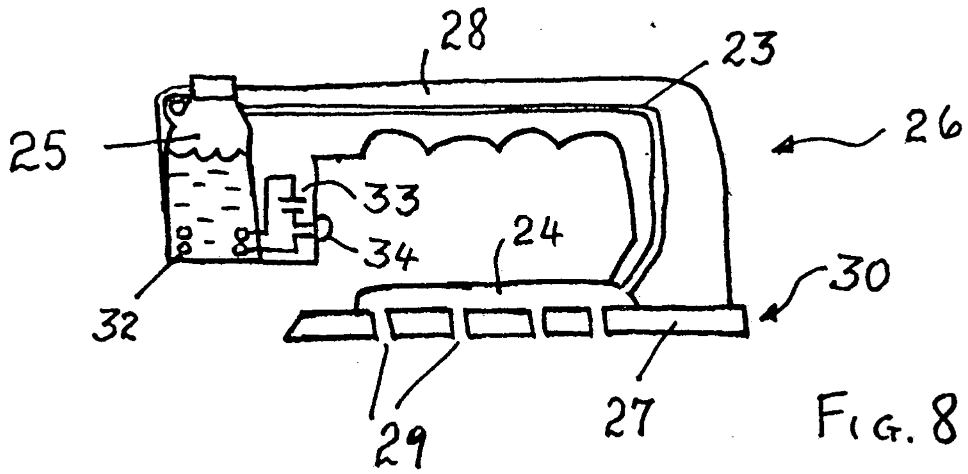

Fig. 8

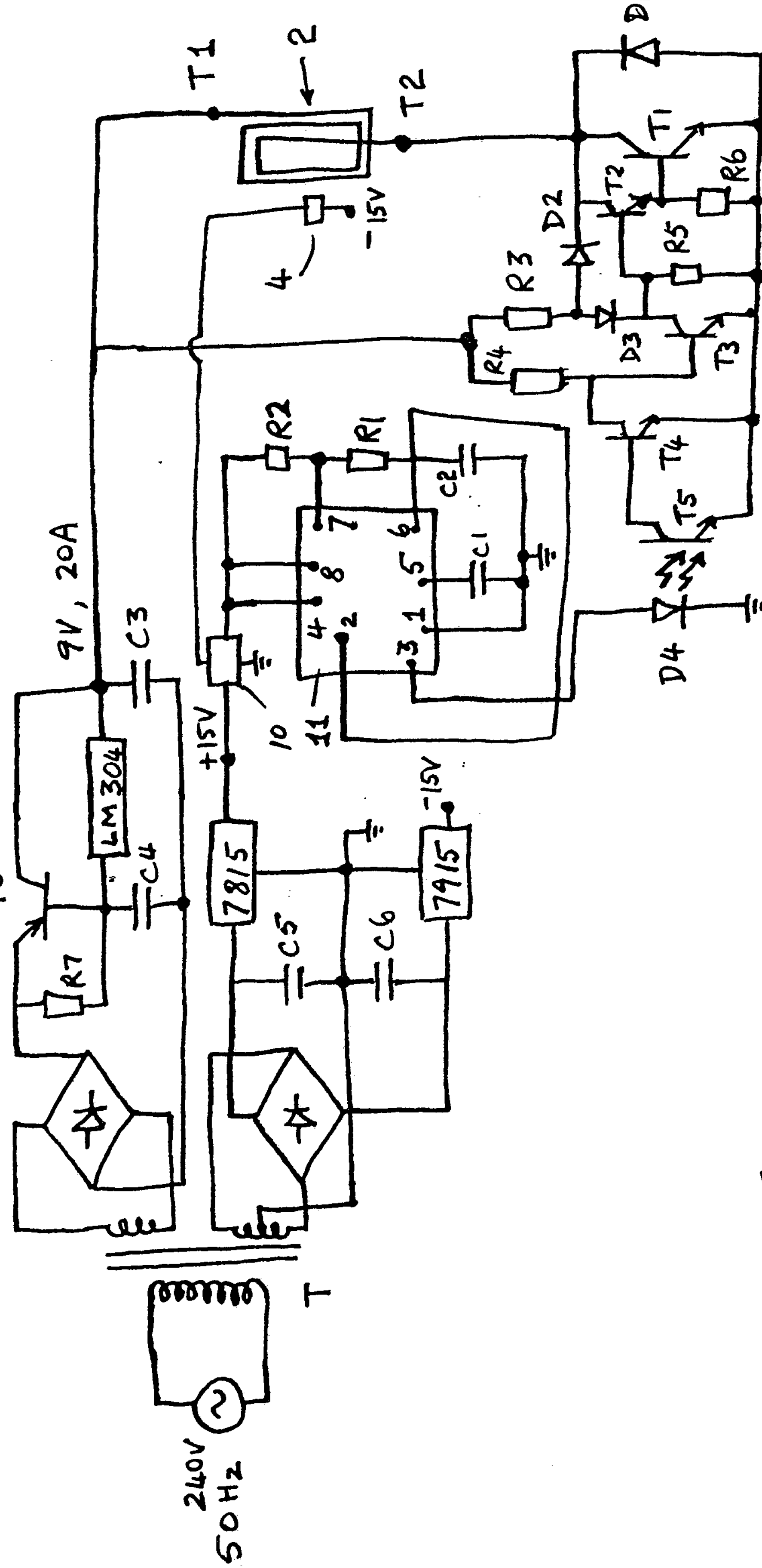
T1
2
T2
-15V
4
D1
D2
R3
R4
D3
T3
R5
R6
T4
T5
D4
R2
R1
C2
C1
9V, 20A
C3
LM304
C4
T6
R7
+15V
7815
7915
-15V
C5
C6
10
11
T
240V
50Hz

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 87 30 4597

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-4 268 737 (PASCHAKARNIS et al.) * Columns 1,2 * ---	1-8	D 06 F 81/08 D 06 F 75/24 H 05 B 6/02
X	US-A-2 133 494 (H.F. WATERS) * Page 1, left-hand column, lines 1-8, right-hand column, lines 9-55; page 2, left-hand column, lines 1-51; page 3, right-hand column, lines 18-75; page 4, left-hand column, lines 1-26 *	1-8	
A	 ---	9-11	
A	US-A-3 742 174 (HARNDEN, Jr.) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)
D 06 F H 05 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19-08-1987	D HULSTER E.W.F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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