FORM 1

REGULATION 9

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952 595420

APPLICATION FOR A STANDARD PATENT

We, BRITISH TELECOMMUNICATIONS public limited company, a British Company, of 81 Newgate Street, London EC1A 7AJ, England, hereby apply for the grant of a Standard Patent for an invention entitled:-

"POWER SUPPLY"

which is described in the accompanying Complete Specification.

Details of basic application:-

Number: 8702299

Country: United Kingdom

Date: 2nd February, 1987

Our address for service is: SHELSTON WATERS
55 Clarence Street
SYDNEY, N.S.W. 2000.

DATED this 2nd day of February, 1988

BRITISH TELECOMMUNICATIONS public limited company

by W Alleyn

Fellow Institute of Patent Attorneys of Australia
of SHELSTON WATERS

LODGED AT SUB-OFFICE
- 2 FEB 1988
Sydney

FEE STAMP TO VALUE OF $155.00 ATTACHED
MAIL OFFICER

To: The Commissioner of Patents
WODEN A.C.T. 2606

File: D.B.147D

Fee: $155.00

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 19-1-90

PATENT OFFICE ONE HUNDRED DOLLARS
PATENT OFFICE FIFTY DOLLARS
PATENT OFFICE FIVE DOLLARS

A 23575/AU

CONVENTION APPLICATION BY A COMPANY

FORM 8 – REGULATION 12 (2)

AUSTRALIA
PATENTS ACT 1952

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made by

(a) Here Insert (in full) Name of Company.

(a) BRITISH TELECOMMUNICATIONS public limited company

81 NEWGATE STREET, LONDON, EC1A 7AJ, ENGLAND.

(hereinafter referred to as "Applicant") for a patent for an invention entitled:

(b) Here Insert Title of Invention.

(b) POWER SUPPLY

(c) and (d) Here Insert Full Name and Address of Company Official authorised to make declaration.

I, (c) VINCENT JOSEPH SKINNER, A person authorised by

of (d) BRITISH TELECOMMUNICATIONS public limited company

of 81 NEWGATE STREET, LONDON, EC1A 7AJ, ENGLAND

do solemnly and sincerely declare as follows:

1. I am authorised by Applicant to make this declaration on its behalf.

(e) Here Insert Basic Country followed by date of Basic Application.

(f) Here Insert Full Name(s) of Applicant(s) in Basic Country.

2. The basic Application(s) as defined by section 141 of the Act was / were made

in (e) GREAT BRITAIN on the 2 day of FEBRUARY 1987

by (f) BRITISH TELECOMMUNICATIONS public limited company

in ..... on the ..... day of 19

by .....

in ..... on the ..... day of 19

by .....

in ..... on the ..... day of 19

by .....

(g) Here Insert (in full) Name and Address of actual Inventor or Inventors.

3. (g) GRAHAM ANTHONY LAIDLER

of THE FORGE HOUSE, SPROUGHTON

IPSWICH, SUFFOLK, IP8 3BN

ENGLAND.

.....

.....

.....is/are

the actual Inventor(s) of the invention and the facts upon which Applicant is entitled to make the Application are as follows:

See reverse side of this form for guidance in completing this part.

Applicant is the Assignee of the said Inventor.

4. The basic Application(s) referred to in paragraph 2 of this Declaration was/were the first Application(s) made in a Convention country in respect of the invention, the subject of the Application.

DECLARED at London, England.

this 26 day of January 19 88

(h) Personal Signature of Declarant (c) (no seal, witness or legalisation).

(12) PATENT ABRIDGMENT (11) Document No. AU-B-11181/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 595420

(54) Title
POWER SUPPLY

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(71) Applicant(s)
BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY

(72) Inventor(s)
GRAHAM ANTHONY LAIDLER

(74) Attorney or Agent
SHELSTON WATERS

(56) Prior Art Documents
GB 2131209
FR 2088070

(57) Claim

1. A power supply system including:

first and second series connected switching means, connected to receive a d.c. voltage;

variable frequency generator means for determining the switching rate of the switching means;

transformer means having a first winding connected on one side to the node of the series connected switching means and having a second winding configured to provide a power supply output at a desired voltage;

first rectification means for converting this voltage into a substantially d.c. voltage; sensing means for detecting the output voltage errors; and

optical feedback means for providing a control path from said sensing means to said switching means to control the

output frequency of the generator means to modify the switching frequency of the switching means to compensate for detected output errors.

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FORM 10

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COMPLETE SPECIFICATION

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Class Int.Class

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Related Art:

Name of Applicant: BRITISH TELECOMMUNICATIONS public limited company

Address of Applicant: 81 NEWGATE STREET, LONDON EC1A 7AJ, ENGLAND

Actual Inventor: GRAHAM ANTHONY LAIDLER

Address for Service: SHELSTON WATERS, 55 Clarence Street, Sydney

Complete Specification for the Invention entitled:

"POWER SUPPLY"

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

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- 2 FEB 1988
Sydney

POWER SUPPLY

The invention relates to a power supply system.

Traditionally power supplies for powering electronic circuits consisted of a mains transformer with a step-down secondary winding and a rectifier followed by capacitor smoothing to provide the low voltage d.c. supply. As a need for more precise regulation arose, such as required for transistor or logic chip circuits, semiconductor regulators were also employed.

An alternative form of power supply is the 'switch mode' system which employs a fixed frequency oscillator control running at several kHz, and controlled by varying the mark : space ratio of this frequency.

With such known arrangements the operating efficiency is not very high and may be subject to substantial heat generation and subsequent dissipation problems.

The present invention is directed to improving on such known power supplies.

According to the invention there is provided a power supply system including:

first and second series connected switching means, connected to receive a d.c. voltage;

transformer means having a first winding connected to the switching means and having a second winding configured to provide a power supply output at a desired voltage;

first rectification means for converting this voltage into a substantially d.c. voltage;

regulation means for controlling the output within desired limits; and

optical-feedback means for providing a control path from said regulation means to said switching means to modify the switching frequency of the switching means to compensate for detected output errors.

The invention will now be described by way of examples with reference to the accompanying drawing which shows an embodiment of the power supply.

A mains voltage bridge rectifier is connected to the mains supply inputs 10,11 and its d.c. output is connected across a capacitor C1. One side of the capacitor C1 is connected to the ground rail 12, and its other side is connected to relay contact RL1 switchable between positions A or B. The A position connects the capacitor C1 via a resistor R2 and diode D7 to a first positive rail 13 and in the B position to a second positive rail 14. The connection node of diode D7 is also connected to diode D6 which is series connected with a secondary winding T5 of the supply transformer T. In parallel there is the relay coil RL1 with capacitor C2 connected across it. Diode D5 connects between the capacitor C5 and the capacitor C1. Between rails 12 and 13 there is connected a timer integrated circuit IC3. In this example, a type 555 is employed which is an 8 pin device. Pin 1 is connected to ground 12 and to capacitor C6 which has its other lead connected to rail 13. Trigger pin 2 is directly connected to pin 6 and is connected to capacitor C4 which is then connected to rail 12. Pin 6 is also connected to rail 13 via resistors R3, R1 and R4. Pin 4 is the reset input connected to zener diode ZD1 and to rail 13, (the other end of ZD1 being connected to rail 12). Pin 5 is the control pin connected to capacitor C3 which is then connected to rail 12. Discharge pin 7 is connected to resistor R4 which is then connected to rail 13. In this configuration the timer operates as an

oscillator. The oscillator output from pin 3 is connected to the interconnection point of the light-emitting-diodes (LEDs) within IC2 (eg type ILD74). The diode portions of IC2a,b are associated with photo-transistor portions IC2a,b. One photo-transistor IC2a is connected to rails 12 and 13 (via resistor R6) and the other IC2b is connected to rails 14 and 15 (via resistor R9). The series connected LEDs of IC2 are connected across the rails 12 and 13 via current limiting resistors R7 and R8.

An opto-coupled FET (eg type H11F1) device IC1 has its transistor portion connected in parallel to R1. The LED portion of IC1 is connected in series with a resistor R10 across the power unit outputs 16,17 via collector/emitter electrodes of transistor Q3. In parallel with these is a capacitor C9 and these are connected to receive the output of centre tapped secondary windings T2 and T3 of transformer T via rectifier diodes D9 and D10. A zener diode ZD3 is series connected with a resistor R11 to rail 17. The junction of ZD3 and R11 is connected to the base of the transistor Q3. Further windings T6 and T7 of the transformer provide rectified outputs to terminals 18-20 via diodes D11 and D12. Smoothing is provided by capacitors C10, C11. No other regulation is provided for these outputs. The primary winding T1 of the transformer is connected via capacitor C8 across the source and drain of a power FET (eg VMOS type 2SK310), Q2 its gate being connected to the collector of IC2a. In series with this FET there is a second FET Q1 (eg VMOS type 25J117) which series devices are connected between rails 12 and 14. The gate of Q1 is connected to the common connection of a zener diode ZD2, the emitter of opto-transistor IC2b, and resistor R9. A capacitor C7 is connected between rails 14 and 15 and a diode D8 is series connected from rail 15 to the rail 14 via a secondary

winding T4 of transformer T. A resistor R5 from the rail 15 is connected in series with capacitor C5 to the rail 13.

The system operates as follows.

On connection of the 240 a.c. supply to terminals 10 and 11, the rectified output from D1-D4 charges C1 up to approximately 339 volts d.c. The relay contact RL1, at switch on, will be in position A as shown in the Figure and this will allow the d.c. voltage from the bridge to charge up C6 (via R2 and D7) and charge up C2 (via R2) until the potential is sufficient to energise relay coil RL1 (eg 12V).

Until RL1 is energised, C6 will provide power to IC2 and 3, this being regulated by zener ZD1. The oscillator output from IC3 (at pin 3) will alternately switch on LEDs IC2a,b at a rate determined by the oscillator frequency. The switching action will actuate the photo-transistor portions of IC2a,b in sympathy. This will alternately gate the FETs Q1 and Q2. Power to the photo-transistor portion of IC2a is available via limiting resistor R6 (to prevent excess currents when IC2a is switched on). Once RL1 is energised the contact of RL1 will move to position B and so apply the 339V between rails 14 and 12. C5 will begin to charge, initially providing a 15 volt supply to photo-transistor IC2b, as regulated by ZD2, via limiting resistor R9.

The oscillator action will alternately switch Q1 and Q2 (via the opto-isolators IC2a,b) so that when Q1 is conducting, the 339V will be applied to the winding T1 connected to the common connection of Q1 and Q2, and when Q2 is alternatively conducting, OV will be applied to T1. This alternating action will cause an alternating current to flow in T1 and charge C8 to an average voltage of half supply, and induce a stepped down voltage in the secondary

windings T2-T5. Once this transformer action has started, winding T5 can now provide the source of power via rectifier D6 to rail 13. Similarly, winding T4 will provide power via D8 to photo-transistor IC2b. The capacitor C5 will now be able to become fully charged.

The centre tapped secondaries T2,T3 provide the power supply output via rectifiers D9,10 and smoothed by reservoir capacitor C9 to terminals 16 and 17. A similar rectification and smoothing system is provided by the additional outputs to terminals 18, 19 and 20.

Regulation of the supply output at terminals 16 and 17 is however additionally provided and is achieved by a rising output voltage being detected by zener ZD3 which will cause increased conduction of the LED portion of IC1 driven via transistor Q3. This causes the opto-coupled FET portion to decrease its resistance, thereby modifying the resistance relationship between R3, R1 and R4 (as the FET is parallel with R1). This relationship change affects the CR ratio between pins 6 and 7 of IC3 and so raises the frequency of oscillation of this device. This increase in frequency causes an increase in the switching rate of IC2a,b and Q1 and 2 and hence a reduction in output voltage from the transformer secondaries so adjusting automatically the power supply output. The detection by ZD3 and the driving of IC1 via transistor Q3 ensures regulation over a wide range of output currents, due to the high gain of the feedback circuit.

The provision of capacitor C8 in the primary winding allows charging and discharging through the transformer to provide the source of alternating current for use by this transformer and is more cost effective than providing four transistor switches in combination to drive the transformer circuit. In addition C8 (eg 2.2 μF) will provide some overload protection to the circuit.

When the power supply is no longer required and is switched off, the relay contact will return to position A and C5 can be discharged through D7 and R2 via D5.

Although transformer T may be toroidal, in the present configuration the transformer can be of minimal size compared to normal power supply transformers. Thus a Mullard CX3920 ferroxcube based transformer for example with 150 turn primary and 12 turn secondaries will be capable of handling at least 30W. This is for a dimension of only 24mm square (and containing all the secondary windings T2-T6). The configuration shown with optical control with only a single transformer and dual power transistor switching provision can be accommodated on board size of only 65 x 75 mm, so being only about one third size of typical commercially available units.

Tests on the power supply based on this configuration have shown that this can easily provide an output of 30W. IC3 can typically run at 12 kHz with a regulation band of 5-30 KHz dependent on output power. As the regulating frequency increases the impedence in t1 also increases which makes the current therethrough decrease. This in turn causes a reduced induced voltage in the secondaries and thus will regulate the output by reducing this voltage. As the control frequency goes down the impedence reduces and the induced voltage in T increases.The power supply gives a good degree of regulation eg better than ± 2 percent and the efficiency is of the order of 85 percent. This gives a supply suitable for many applications with electronic circuits and without excessive heat generation problems. The transistors run almost cold at this rating so eliminating the need for forced draught cooling or large heatsinks. With a larger transformer and uprated transistors Q1 and Q2 larger power requirements could easily be handled.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A power supply system including:

first and second series connected switching means, connected to receive a d.c. voltage;

variable frequency generator means for determining the switching rate of the switching means;

transformer means having a first winding connected on one side to the node of the series connected switching means and having a second winding configured to provide a power supply output at a desired voltage;

first rectification means for converting this voltage into a substantially d.c. voltage; sensing means for detecting the output voltage errors; and

optical feedback means for providing a control path from said sensing means to said switching means to control the output frequency of the generator means to modify the switching frequency of the switching means to compensate for detected output errors.

2. A system as claimed in claim 1, wherein the first and second switching means each comprise at least one solid state switch, said generator means comprises an oscillator and said optical feedback means includes a first opto-emitting device having a variable output dependent on output variations detected by said sensing means and includes a first opto-receiving FET device associated with the oscillator for providing a variable frequency therefrom so as to adjust the switching rate of said solid

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state switches.

3. A system as claimed in claim 2, including a second opto-emitting and receiving device, said second opto-emitting device receiving the oscillator output and said second opto-receiving device being associated with the solid state switches to provide optical control of the switching thereof.

4. A system as claimed in claim 3, wherein the second opto-device includes at least two transmitters and receivers each associated with a respective solid state switch.

5. A system as claimed in claim 2, 3 or 4, wherein second rectification means are provided to rectify an a.c. voltage for use by the first and second switching means.

6. A system as claimed in any one of claims 2 to 5, wherein each solid state switch comprises a power FET.

7. A system as claimed in any one of claims 2 to 6, wherein the sensing means includes a zener diode connected to a control transistor for driving the first opto-emitting device.

8. A system as claimed in any one of claims 1 to 7, wherein the first and second series connected switching means are connected at their node to one side of the first winding of said transformer means and the second side of this transformer winding is connected in series with a capacitor to allow charging and discharging thereof through the transformer to provide the source of alternating current therefore.

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9. A system as claimed in any one of claims 1 to 8, wherein the transformer means includes a plurality of windings for providing both output power and internal power requirements.

10. A system as claimed in any one of claims 1 to 9, wherein the transformer means consists of a single transformer configuration constructed from a ferrite based material with windings associated therewith.

11. A system as claimed in claim 9 or 10, wherein diverting means are included to provide an alternative power source for internal power requirements when unavailable from said transformer means.

12. A system as claimed in claim 11 wherein the diverting means are connected so as to be powered by an output derived from the d.c. voltage intended for the switching means.

13. A system as claimed in claim 11 or 12, wherein the diverting means includes a relay and the alternative power source includes a capacitor chargeable or dischargable through the path provided by the diverting means.

14. A power supply system substantially as described herein and with reference to the accompanying drawing.

DATED this 9th Day of January, 1990

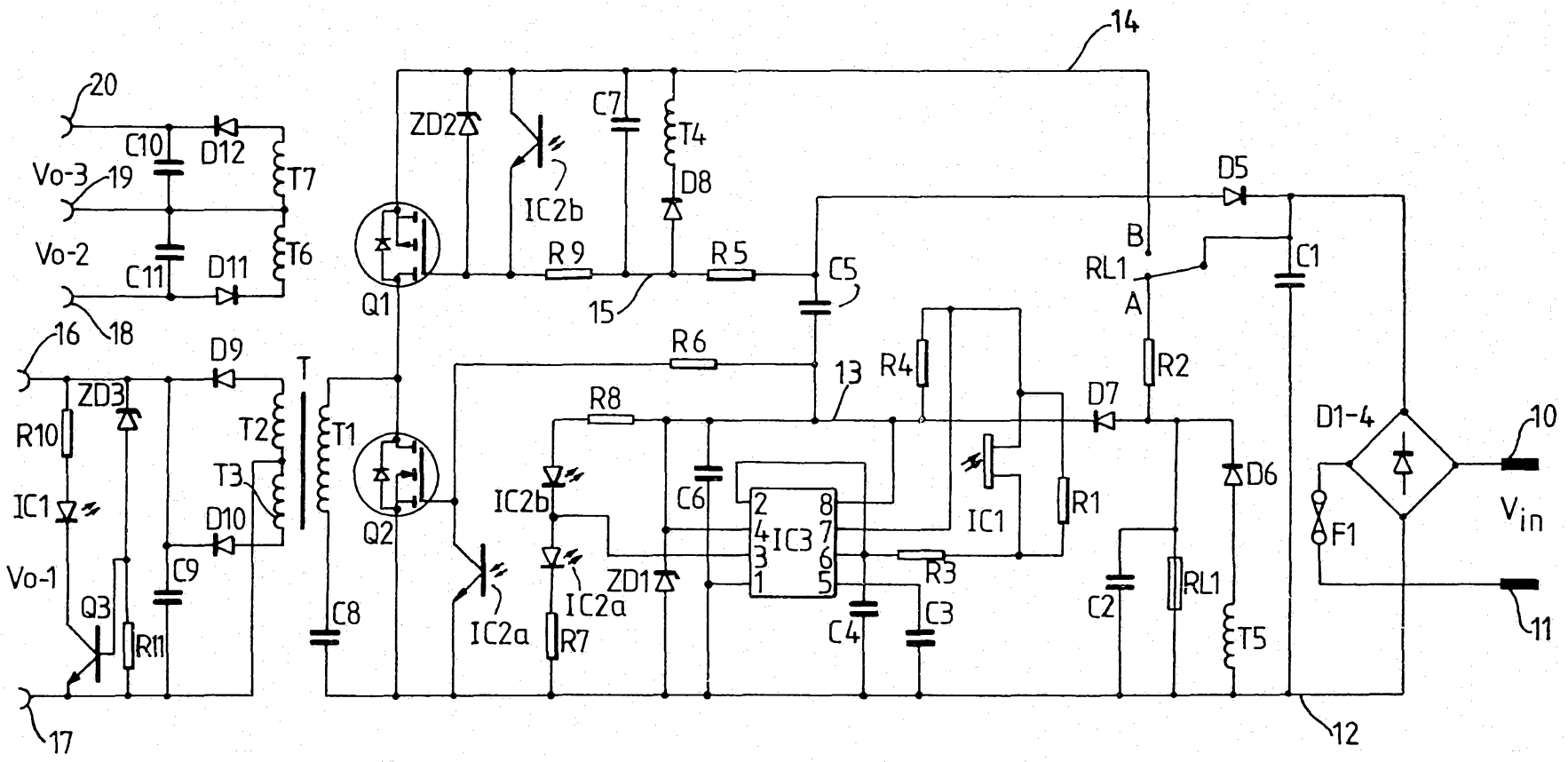
BRITISH TELECOMMUNICATIONS public limited company

Attorney: PETER HEATHCOTE

Fellow Institute of Patent Attorneys of Australia

of SHELSTON WATERS

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20
C10
D12
T7
Vo-3
19
Vo-2
C11
D11
T6
16
18
D9
T
ZD3
R10
T2
T3
IC1
D10
Vo-1
C9
Q3
R11
17
T1
Q1
Q2
C8
ZD2
IC2b
C7
T4
D8
R9
R5
C5
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14
R6
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R8
IC2b
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IC2a
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D1-4
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