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Mead

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[45] Oct. 22, 1974

[54] TELEVISION PREAMPLIFIER POWER SOURCE

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[73] Assignee: Q-Bit Corporation, Melbourne, Fla.

[22] Filed: July 5, 1972

[21] Appl. No.: 269,207

[52] U.S. Cl. 323/8, 321/14, 323/9

[51] Int. Cl. G05f 1/58

[58] Field of Search ..... 179/170 J; 321/14; 323/1, 323/4, 8, 9, 16, 19, 40; 325/373, 374; 340/210; 317/33 SC

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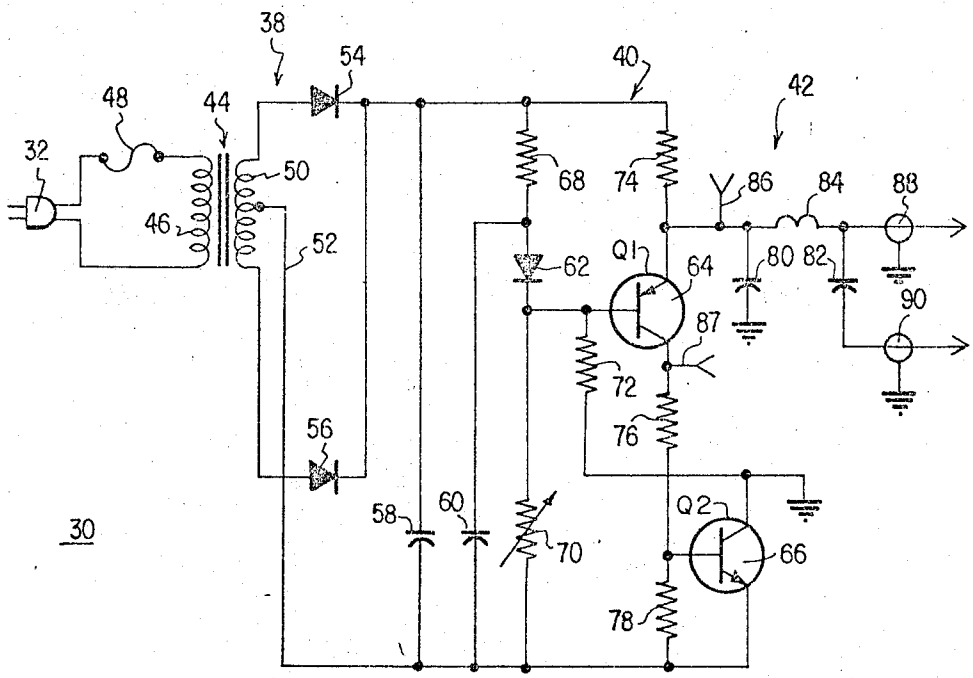
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Attorney, Agent, or Firm—LeBlanc & Shur

[57] ABSTRACT

A remote regulated power supply or source for use with VHF and UHF preamplifier assemblies. It comprises a simple two transistor load regulator displaying current foldback limiting and has a built in DC block to apply power to a preamplifier by way of a coaxial cable.

17 Claims, 3 Drawing Figures



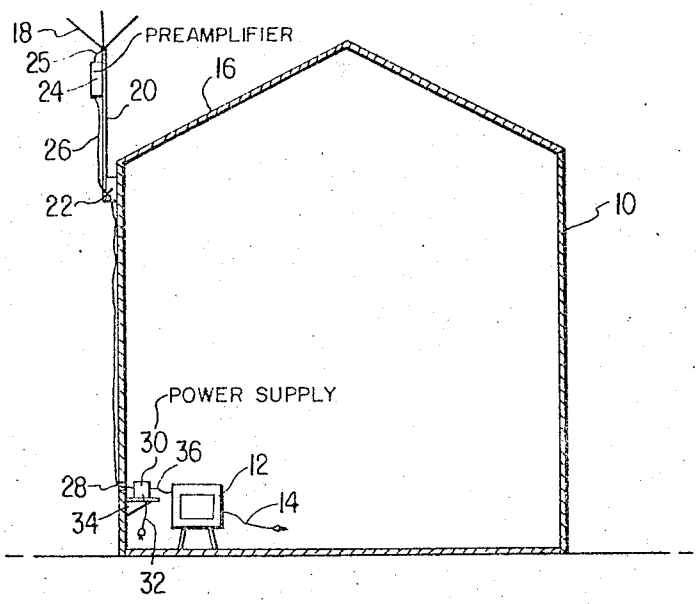

18
PREAMPLIFIER
25
24
20
16
26
22
10
POWER SUPPLY
30
36
12
28
14
34
32

FIG. 1

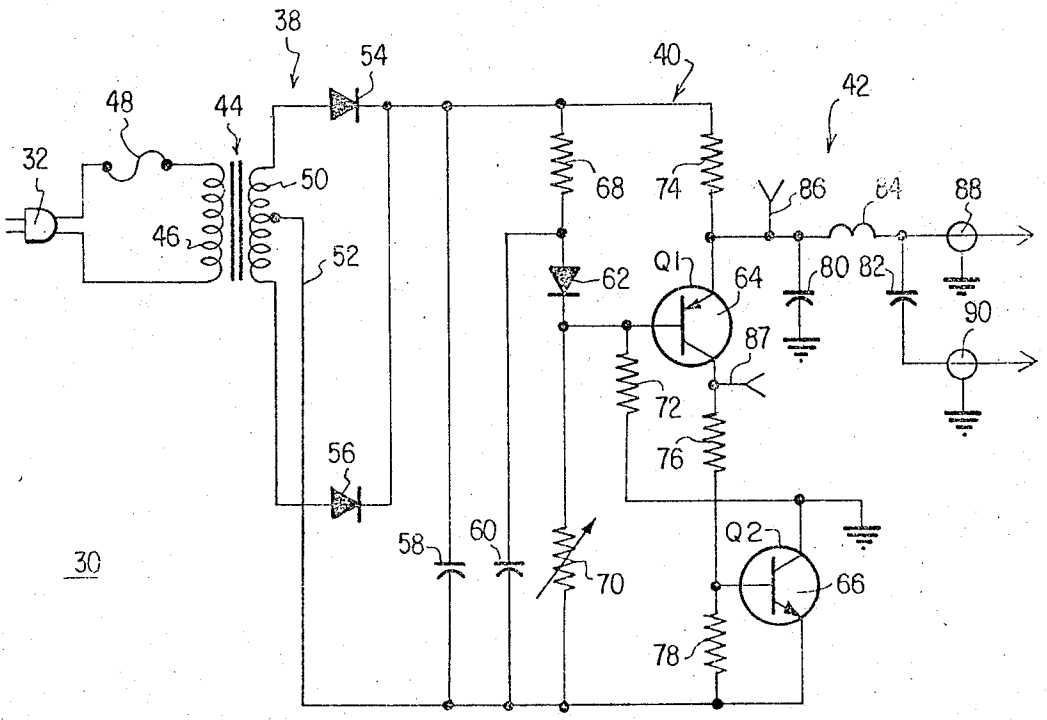

38
54
40
42
48
44
32
50
68
74
86
84
88
46
52
62
Q1
64
80
82
90
87
72
76
56
58
60
70
Q2
66
78
30

FIG. 2

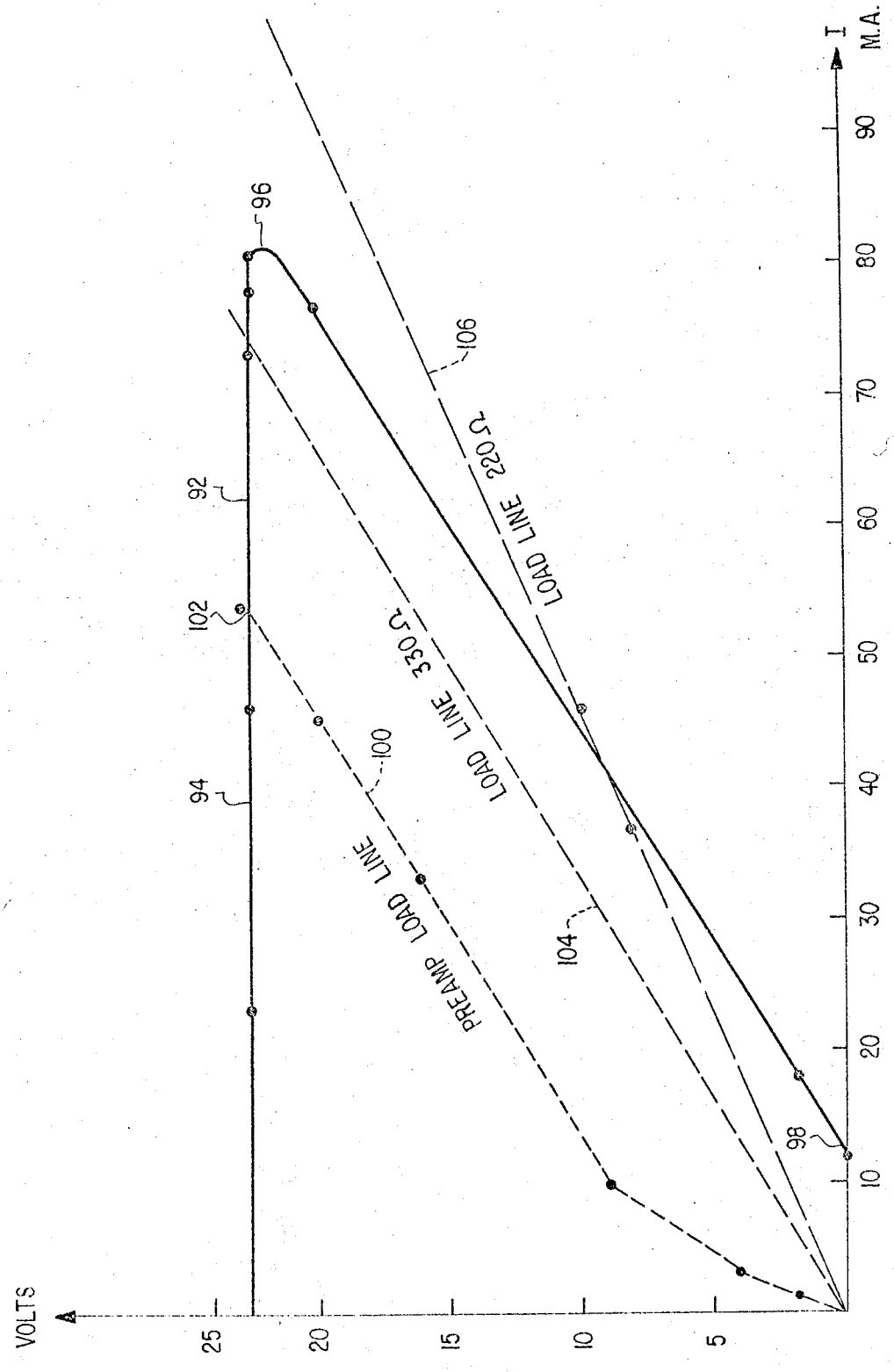

VOLTS
25
20
15
10
5
I
M.A.
10
20
30
40
50
60
70
80
90
92
94
96
98
100
102
104
106
LOAD LINE 220Ω
LOAD LINE 330Ω
PREAMP LOAD LINE

FIG. 3

TELEVISION PREAMPLIFIER POWER SOURCE

This invention relates to a remote supply and more particularly to a unit power source designed primarily as a DC power supply for powering a television signal preamplifier by way of the RF coaxial output cable of the preamplifier. It provides a simple two transistor load regulator displaying current foldback limiting with short circuit protection so that continuous short circuit will not over dissipate components or damage the unit.

As is well known, television receivers which are normally located indoors such as in a house or an apartment building are frequently connected to an outdoor antenna to improve television reception. Very often the television antenna is mounted on the building roof or at some other elevated outdoor location so that it may more readily receive television signals from local broadcast stations.

In broadcast fringe areas where television reception is marginal it has been found desirable to mount a television receiver preamplifier adjacent the television antenna in order to boost the received signal for adequate viewing. While a portable power supply including batteries can be provided for such a preamplifier these power supplies have a very limited life and need frequent replacement. Because of the relative inaccessability of the preamplifier which is normally mounted on the T.V. antenna mast adjacent the antenna, present day portable battery powered preamplifier supplies are not satisfactory.

Instead, it has been found desirable to power the preamplifier from a remote indoor power supply located convenient to a conventional 117 volt 60 Hz AC power outlet available in almost all homes. However, because of the possibility of short circuits and shock dangers it has been found undesirable to supply 117 volt AC power directly to an antenna mounted preamplifier.

In order to overcome these and other difficulties the present invention provides a simple and inexpensive power supply or power converter for converting the conventional AC power at a household outlet into low voltage DC electrical energy for powering the mast mounted preamplifier. This low power electrical energy is supplied to the preamplifier by way of the RF coaxial drop cable supplying the received television signal from the antenna by way of the preamplifier to the T.V. receiver.

Since the coaxial interface may be subject to shorts or open circuit conditions the power source of the present invention is constructed to operate undamaged by such occurrences. In addition, convenient test points are provided and made available to sense failure conditions of this type. The power source is a simple and relatively inexpensive two transistor load regulator and comprises three basic components namely an AC to DC converter, a voltage/current regulator, and an RF/DC block.

The AC to DC conversion portion of the circuit converts the AC energy from the conventional household power outlet into DC. The RF/DC block applies DC to the coaxial connector by way of an RF choke which offers a low impedance to DC and a high reactance to the RF signal. Likewise a capacitor is incorporated which offers an infinite impedance to DC but a low reactance to the RF signal. Thus the DC is isolated from the RF utilization output while the RF is steered between coaxial outputs.

The regulator is constructed to be as simple as possible while meeting the requirements of load regulation and short circuit protection. In the normal operation mode of constant voltage output the regulator operates as a shunt regulator. Thus it draws a constant current from the AC/DC converter. Under conditions of excess current demand beyond its maximum limits the regulator enters a current fold-back mode. While the regulator can supply 75 milliamperes of current at 24 volts it will only supply 12 milliamperes of current into a short circuit. With this cutback in current the circuit will not overheat. Also if the power source is accidentally connected to a piece of test equipment it will not damage its 75 ohm termination.

While described in conjunction with supplying power to a remote television preamplifier it is apparent that the power supply of the present invention is adapted for use in a variety of applications where it is desirable to supply low power electrical energy to remote electrical equipment in a relatively simplified and inexpensive manner.

It is therefore one object of the present invention to provide an improved regulated power supply.

Another object of the present invention is to provide an improved remote power supply particularly adapted for powering a television preamplifier.

Another object of the present invention is to provide a DC regulated power supply of relatively simplified and inexpensive construction.

Another object of the present invention is to provide a simplified two-transistor load regulator adapted to act as a power source for numerous electronic devices.

Another object of the present invention is to provide a simplified two transistor regulated DC power source incorporating current foldback limiting.

Another object of the present invention is to provide a simplified two transistor regulated DC power source for powering RF preamplifiers by way of an RF coaxial cable.

Another object of the present invention is to provide an improved combination mast-mounted T.V. preamplifier and indoor power supply particularly adapted for use with television receivers in fringe reception areas.

These and other objects and advantages of the invention will be more apparent upon reference to the following specification, claims and apended drawings WHEREIN:

FIG. 1 is a simplified schematic diagram of a fringe reception television receiving system incorporation a mast-mounted preamplifier and remote power supply constructed in accordance with the present invention;

FIG. 2 is a detailed circuit diagram of the remote power supply of FIG. 1; and

FIG. 3 is a plot of the transfer characteristic for the power supply of FIG. 2 illustrating current foldback limiting.

Referring to the drawings FIG. 1 is a simplified diagram of the system of the present invention illustrating at 10 a building which may for example, be a conventional house or an apartment building in which are located one or more conventional television receivers of the type illustrated at 12. Television receiver 12 is illustrated as provided with a conventional cord and plug 14 for the application of power from a standard 117 volt 60 Hz power outlet.

Located externally of building 10 near roof 16 is a conventional television receiving antenna 18. Antenna 18 is supported by mast 20 which by way of example only may be mounted on the building 10 by way of a suitable mounting bracket assembly generally indicated at 22.

In order to improve television reception from the more remote broadcast stations antenna 18 is electrically connected to a television preamplifier 24 by a short lead 25. For improved reception preamplifier 24 is mounted as close as possible to antenna 18 and may be connected to mast 20 by any suitable means such as by U-bolts or the like to receive mechanical support from the antenna mast. The RF output from preamplifier 24 is by way of coaxial drop cable 26 which conveniently may follow mast 20 and the side of building 10 where it enters into the building as at 28 for application of the RF T.V. signals to television receiver 12 located inside building 10.

Application of the RF signals from cable 26 to television receiver 12 is by way of preamplifier power supply 30 illustrated as provided with a conventional cord and plug 32 for receiving power from a conventional household 117 volt 60Hz outlet. Power supply 30 may be mounted inside building 10 in any conventional manner such as by a shelf generally indicated at 34 but in any event is preferably located near television receiver 12 where a second AC outlet is most likely to be readily available. Power supply 30 is connected to the RF input of television receiver 12 by way of a short length of coaxial cable 36.

FIG. 2 is a detailed circuit diagram of the simple power supply or converter 30 of FIG. 1. As previously indicated the power supply comprises three principle components namely an AC to DC conversion portion generally indicated at 38, a voltage/current regulator portion 40, and an RF/DC blocking portion 42. The AC/DC converter portion of the circuit comprises a transformer 44 having its primary 46 connected to plug 32 by way of a fuse 48. Secondary 50 of transformer 44 is provided with a center tap as indicated at 52 and the two ends of the secondary feed a pair of rectifier diodes 54 and 56. The transformer 44 and rectifier diodes 54 and 56 in combination with a filter capacitor 58 form the AC/DC converter 38.

The voltage/current regulator 40 is formed by a second capacitor 60, a third rectifier diode 62, transistors 64 and 66 labelled Q1 and Q2 respectively, and six resistors, namely resistors 68, 70, 72, 74, 76 and 78. The RF/DC block 42 is formed by capacitors 80 and 82 in combination with the RF choke coil 84. Test point taps are illustrated at 86 and 87 and the power supply is provided with a pair of coaxial cable connectors at 88 and 90. Connector 88 supplies plus 24 volts DC electrical energy to preamplifier 24 of FIG. 1 by way of coaxial cable 26 while at the same time receiving the T.V. RF over the cables and connector 90 of FIG. 2 transmits the T.V. RF signal by way of coaxial cable 36 in FIG. 1 to the television receiver 12.

The RF/DC block 42 applies DC to coaxial connector 88 through the RF choke 84 which choke offers a low impedance to DC and a high reactance to the RF signal from cable 26. Capacitor 82 offers an infinite impedance to DC but a low reactance to the RF signal. Thus the DC is isolated from the RF utilization output connector 90 while the RF is steered through capacitor 82 from coaxial connector 88 to coaxial connector 90.

In normal operation the device operates as a shunt regulator. It draws a constant current from the AC/DC converter 38 but under conditions of excess demand such as a short circuit the regulator enters a current foldback mode as illustrated in FIG. 3. Referring to FIG. 3 which is a plot of the transfer characteristic in terms of volts as a function of current in milliamperes the transfer characteristic of the power supply 30 is illustrated by the solid line 92. This line contains a substantially flat portion 94 at a value of about plus 24 volts up to about 75 milliamperes where it turns over or "folds back" as at 96 and moves downwardly so that at zero volts (short circuit) it intercepts the X axis at approximately 12 milliamperes as indicated at 98. The load line for preamplifier 24 is illustrated by the dashed line 100 and this intercepts the transfer characteristic 92 at approximately 50 milliamperes as indicated at 102 which represents normal operating conditions. A 330 ohm load line is illustrated by the dashed line 104 and a 220 ohm load line is illustrated by the dashed line 106 in FIG. 3.

In operation, in the normal voltage mode transistor 66 (Q2) if hard switched in the "ON" saturated mode. This connects the transformer center tap 52 to the circuit common or ground. Resistors 68, 70, and 72 along with diode 62 in forward conduction form a resistance divider to reference the base of transistor 64 (Q1). Transistor 64 becomes an emitter follower. Current supplied through resistor 74 is set by reference at base bias voltage. The maximum current is set by this bias point and resistor 74. Capacitor 60 is provided for additional filtering to reduce AC ripple on the output. Diode 62 voltage tracks the base-emitter junction of transistor 64 and supplies protection of the base-emitter from capacitor 60 in event of a short. Excess current not drawn by the load flows through the transistor 64 collector and through resistor 76 and into the base of transistor 66 keeping transistor 66 in the switched "ON" mode.

The emitter-follower transistor 64 draws constant current from the AC/DC converter 38. The output voltage in the voltage mode is proportional to the line voltage input. The emitter-follower allows for good load regulation. This is desirable since different preamplifier assemblies draw different current but require constant voltage.

If excess current is demanded from the regulator, transistor 64 (Q1) is starved of current. This allows little current to flow through the base of transistor 66 (Q2), which in turn causes transistor 66 to come out of saturation allowing the transformer center tap 52 to go negative. This reduces the input voltage between the regulator input and circuit common and the reference at the base of transistor 64 thereby reducing the maximum current that can be supplied. Under a complete short circuit, the regulator output to common is at zero potential. The reference bias is now set by resistors 68 and 70 and resistor 70 is preferably adjustable to set the short circuit current.

This type of foldback regulation is useful in driving all types of resistive loads. The V versus I transfer curve 92 of FIG. 3 shows the behavior of the regulator for various resistive loads. The regulator dissipates maximum power under a no load condition. All current flows through the collector of transistor 64 and resistor

76. Resistor 76 has its value chosen to allow transistor 64 to just go into saturation under no load. Thus resistor 76 dissipates most of the power under these conditions.

Under normal load conditions some of the current is supplied to the load and the voltage across resistor 76 reduces. Under a short condition it goes negative with respect to common. Test points 86 and 87 make convenient test points to observe the amplifier/cable interface during suspected system failure.

It is apparent from the above that the present invention provides an improved power supply or source particularly adapted for use with VHF and UHF preamplifier assemblies. The unit has a built in DC block to apply power by way of the coaxial cable and features a two transistor load regulator with short circuit protection. Continuous short circuit will not over dissipate the components or damage the unit. For safety however, the 117 volt input is fused for protection in event of failure in the power source itself. Externally available test points allow the system (preamplifier and power source) performance to be checked with a volt-meter while the system is operating. Open or shorted cables or preamplifier assemblies can be sensed at these two test points. The input power is approximately 5 watts and the unit operates on 117 volt AC 50/60Hz input. The output is +24 ± 1 volt up to 75 milliampere load. The AC ripple is approximately 25 millivolts peak to peak. The unit is of simplified and relatively inexpensive construction and by way of example only diodes 54, 56 and 62 may be of the type identified as IN4003. Transistor 64 (Q1) may be of the General Electric type D41D1 and transistor 66 (Q2) may be of the type identified as General Electric D40D1.

By way of example only preamplifier 2 may be of the broadband type shown and described in assignees copending application Ser. No. 269,209 Filed July 5, 1972. The amplifier has a passband on the order of from about 54 to about 216 MHz and draws approximately 4 watts power at 117 volts 60Hz from the power outlet. The unit is constructed for use with a conventional 75 ohm coaxial cable connected to each of the cable connectors 88 and 90.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the inventing being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A power supply comprising a source of direct current, first and second D.C. output terminals, a first regular transistor coupled across said source, said first transistor having one side coupled to both said first output terminal and one side of said source whereby said first transistor acts as a shunt regulator, a second current foldback transistor coupling said second output terminal to the other side of said source, and means coupling said transistors together whereby the impedance of said second transistor is controlled by said first transistor.

2. A power supply according to claim 1 wherein said source of direct current comprises an AC to DC converter.

3. A power supply according to claim 1 wherein said source of direct current comprises a transformer and rectifier.

4. A power supply according to claim 1 including an RF block coupling said one side of said first transistor to said first output terminal.

5. A power supply according to claim 4 wherein said RF block comprises a choke coil.

6. A power supply according to claim 5 wherein said RF block further comprises at least one capacitor coupled between said one side of said first transistor and said second output terminal.

7. A power supply according to claim 1 including third and fourth terminals, and means coupled to said terminals for steering an RF signal from said first and second terminals to said third and fourth terminals.

8. A power supply according to claim 7 including a remote amplifier coupled to said first and second terminals and a receiver coupled to said third and fourth terminals.

9. A power supply according to claim 8 including a remote T.V. antenna, said amplifier being mounted adjacent said antenna, said receiver comprising a T.V. receiver.

10. A power supply according to claim 9 wherein said amplifier comprises a broadband VHF T.V. preamplifier and is coupled to said first and second output terminals by a coaxial cable.

11. A power supply comprising a first transistor having an emitter, a collector and a base, an electrical power source having one side coupled to the emitter of said first transistor and the other side coupled to the collector of said first transistor, means coupling the base of said first transistor to said power source, a first output terminal coupled to one of said emitter and collector of said first transistor, a second transistor having an emitter, a collector and a base, means coupling the other of said emitter and collector of said first transistor to the base of said second transistor, and a second output terminal, the emitter-collector circuit of said second transistor coupling said second output terminal to the other side of said power source.

12. A power supply according to claim 11 herein said first output terminal is coupled to the emitter of said first transistor.

13. A power supply according to claim 11 wherein said second output terminal is grounded.

14. A power supply according to claim 11 wherein said power source comprises a transformer having a secondary winding, said emitter-collector circuit of said second transistor coupling said second output terminal to said secondary winding.

15. A power supply according to claim 14 including a rectifier diode coupling one end of said secondary winding to said one of said emitter and collector of said first transistor, said emitter-collector circuit of said second transistor coupling said second output terminal to a point on said secondary winding remote from said one end of said winding.

16. A power supply according to claim 15 wherein said emitter-collector circuit of said second transistor is coupled to a center tap on said winding, and a second rectifier diode coupling the other end of said winding

to said one of said emitter and collector of said first transistor.

17. A power supply according to claim 11 including a first coaxial cable connector forming said first and second output terminals, an RF block coupling said first connector to said transistors, a second coaxial cable connector, and a DC block coupling said connectors to each other.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,843,922 Dated October 22, 1974

Inventor(s) Hansel B. Mead

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5 , line 36, "preamplifier 2" should read -- preamplifier 24 --; line 38, "Ser. No. 269,209" should read -- Ser. No. 269,208 --.

Col. 6, line 47, "herein" should read --wherein--.

Signed and sealed this 4th day of February 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

UNITED STATES PATENT OFFICE
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