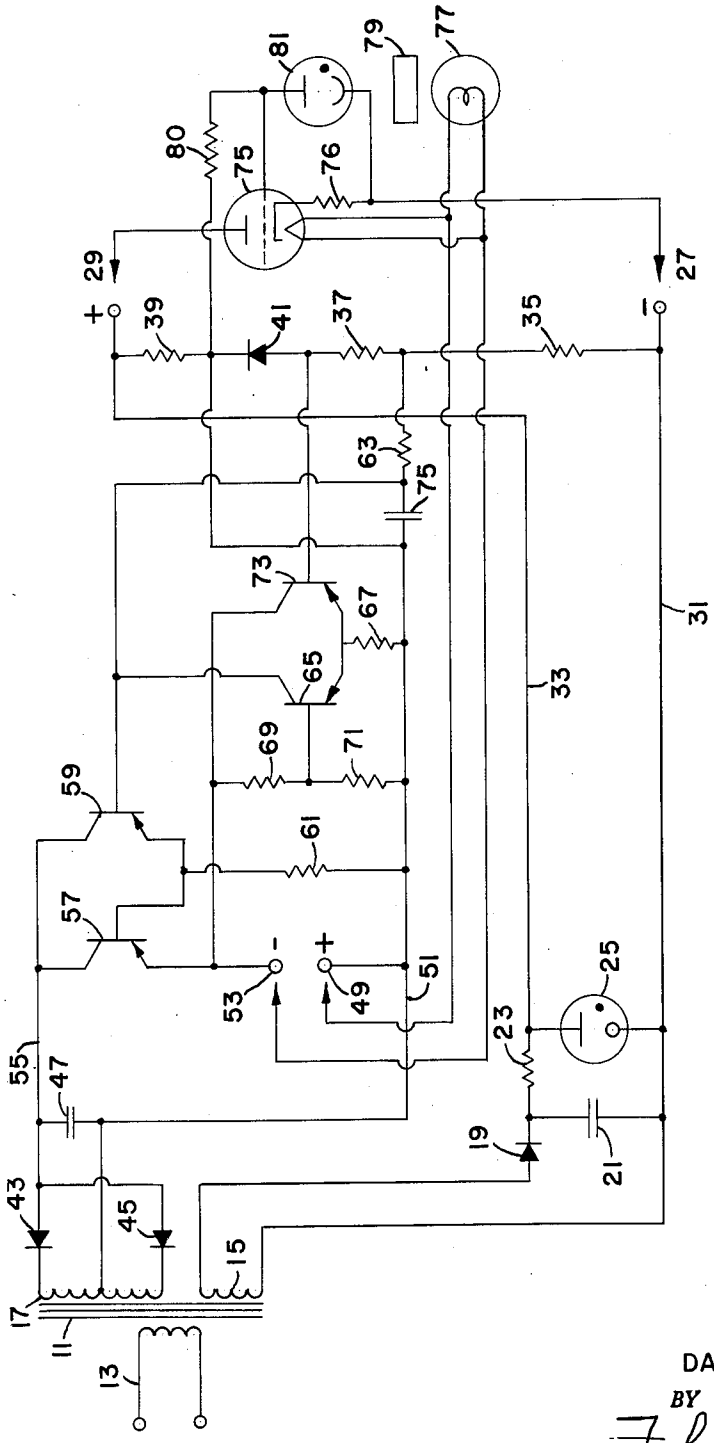
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REGULATED POWER SUPPLY

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REGULATED POWER SUPPLY

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This invention relates generally to a regulated power supply and more particularly to a regulated power supply for use with apparatus requiring both a high and a low regulated voltage.

In many applications, it is desirable to have a source of relatively constant low voltage high current power and at the same time a regulated high voltage low current power. For example, in colorimetry it is desirable to provide a constant low voltage high current power to the light source. It is equally desirable to provide high voltage low current power either to a vacuum tube voltmeter or to an amplifier serving to amplify the output of a photoelectric cell. Additionally, a low voltage high current regulated supply may be desirable to provide relatively constant current to either of the associated tubes in electrical equipment.

It is a general object of the present invention to provide an improved regulated power supply having a low voltage high current output and a high voltage low current output.

It is a general object of this invention to provide an improved regulated low voltage high current power supply.

It is a further object of this invention to provide a power supply having the above characteristics employing a voltage regulator tube and a Zener diode complementing each other.

These and other objects of the invention will become more clearly apparent upon reading the following description in conjunction with the accompanying drawing in which the single FIGURE is a schematic diagram of one embodiment of the invention.

Referring to the drawing: The power supply includes a transformer **11** having a primary winding **13** and secondary windings **15** and **17**. The winding **15** is connected to a half wave rectifier circuit including the diode **19**, filter capacitor **21**, and resistor **23**. The rectifier circuit provides a source of unregulated D.-C. voltage to a voltage regulating device which may be the voltage regulator tube **25**. The electrodes of the voltage regulating tube **25** are connected to the terminals **27** and **29** by the lines **31** and **33**, respectively.

A voltage divider network **34** including resistors **35**, **37** and **39**, and a Zener diode **41** is connected between the terminals **27** and **29**. The properties of the Zener diode **41** are such that when connected in series with an external resistance across a voltage supply, a relatively constant voltage is maintained across the diode regardless of the variations at the voltage terminals provided that the voltage in the terminals exceeds a minimum breakdown voltage of the Zener diode. Characteristic of the Zener diode however is that the constant voltage which is maintained may be made variable by variations in current through the diode. Consequently it is desirable in the use of Zener diodes to provide a relatively constant current source.

In the circuit shown, a relatively constant current is maintained through the diode **41** by the use of the regulator tube **25** in conjunction with the resistors **35**, **37** and **39**. Since the voltage at the terminals **27** and **29** is relatively constant the current through the voltage divider network will likewise be constant. Consequently the voltage across the Zener diode **41** is maintained at a substantially constant value.

The secondary winding **17** is connected to a full wave rectifier circuit including the diodes **43** and **45** and the filter capacitor **47**. The full wave rectifier serves as supply voltage for the regulating and amplifying transistors to be described presently. One side of the full wave rectifier circuit is connected directly to the output terminal **49** of the low voltage regulated supply through the line **51**. The other side of the full wave rectifier circuit is connected to the low voltage regulated output terminal **53** through the line **55** and a variable impedance device such as transistor **57**. A low voltage high current supply is provided therefore at the terminals **49** and **53**. Regulation of the low voltage supply is directly provided by the use of the transistor **57**.

The base of the transistor **57** is connected to the emitter of the transistor **59**. The emitter of the transistor **59** is connected to line **51** through the resistor **61** while the collector of the transistor **59** is connected to the line **55**. The transistor **57**, therefore, operates as an emitter follower of the transistor **59**. The base of the transistor **59** is connected to the terminal **27** through resistors **63** and **35**.

A transistor **65** has its collector connected to the base of the transistor **59** and its emitter connected to the line **51** through the resistor **67**. The base of the transistor **65** is connected to a voltage divider network **68** including the resistors **69** and **71** connected in series across the terminals **53** and **49**. The collector of transistor **73** is connected directly to the terminal **53**. The base of the transistor **73** is connected to one side of the Zener diode **41** while the emitter of the transistor **73** is connected to the other side of the Zener diode through the resistor **67** and the line **51**. A capacitor **74** is connected between the line **51** and the base of transistor **59** to prevent oscillation due to feedback.

In operation, a source of A.-C. potential is applied to the primary winding **13** thereby producing a regulated high voltage at the terminals **27** and **29**. Current will flow through the transistor **57**, dependent upon the voltage from the full wave rectifier and the resistance at the terminals **49** and **53** and the base current applied to the transistor **57**. The collector current of transistor **57** will also be dependent upon the collector current of transistor **73**.

The Zener diode **41** in conjunction with the resistor **67** and the transistor **73** act as a reference to the voltage regulator. The voltage across the diode **41** is applied between the base of transistor **73** and the line **51** to establish the reference voltage.

The transistor **65** has its emitter connected to this reference voltage and its base connected to a fraction of the output voltage determined by the resistors **69** and **71**. Transistor **65** serves to amplify any voltage difference between the reference voltage and this fraction of the output voltage. The amplified difference voltage is applied to the base of transistor **59** which, in turn, controls the series regulating transistor **57**.

Assuming an increase in the line voltage at the winding **13**, emitter current of the transistors **57** and **59** will tend to increase causing a greater voltage at the terminals **49** and **53**. The greater voltage at the terminals **49** and **53**, however, causes an increase of base bias at the transistor **65**. Consequently, the current flow through the transistor will increase thereby deflecting part of the base current from the transistor **59**. With the decreased base current at transistor **59**, its emitter current necessarily decreases, thereby causing the consequent decrease of the emitter current of the transistor **57** and of the voltage at terminals **49** and **53**.

In use of the circuit described with a colorimeter, the high voltage terminals **27** and **29** may be connected across a vacuum tube amplifier such as tube **75**, thereby to establish a constant cathode to plate amplifier voltage. To

further limit variations and amplification of the amplifying tube **75**, the heater of the tube may be connected to the low voltage terminals **49** and **53**. With such a connection, the amplification factor of the tube **75** is extremely constant. By connecting a light source **77** across the low voltage terminals **49** and **53**, an extremely constant value light energy can be obtained. Consequently, when the light from the source **77** is passed through a sample **79** onto a photocell **81**, exact measurements may be obtained as to the amount of source reaching the cell **81** and consequently accurate determination of a sample **79** can be accomplished.

By using the regulated voltage divider network **34** having voltage levels more negative than the consequent output (at terminal **53**), a continuous source of collector current is provided for the transistor **65**. The source is regulated thereby assuring a constant operation level for the transistor **65**.

Apparatus in accordance with the foregoing was constructed. The various components shown in the diagram were as follows.

Transistors:	
57	2N301.
59	2N217.
65	2N217.
73	2N217.
Tubes:	
25	OB2.
75	½ 12AU7.
Photocell **81**	CE34.
Transformer:	
Primary	110/220 volts.
Secondary	15–30 volt center tapped; 550 milliamperes. 17–110 volt, 15 milliamperes.
Rectifiers:	
19	Sarkes Tarzian 40K.
43	Sarkes Tarzian 10K.
45	Sarkes Tarzian 10K.
Capacitors:	
21	12 mf. 250 volts.
47	500 mf. 25 volts.
74	.02 mf. 100 volts.
Zener diode **41**	1N429
Resistors (ohms):	
23	3K.
35	6.8K.
37	2K.
39	10K.
61	2K.
63	6.8K.
67	3.3K.
69	300.
71	510.
76	135K.
80	100 meg.

Thus, it is seen that there is provided a combination high voltage regulating device employing elements such as an inexpensive voltage regulating tube acting as a constant current source for a Zener diode and a constant plate voltage source for an amplifier tube. The Zener diode acts as a reference for low voltage supply terminals which provides a constant voltage for the heater of the amplifier tube and as a constant low voltage load source.

I claim:

1. A power supply for providing a high and a low voltage output comprising a source of regulated high voltage being connected to a pair of high voltage output terminals, a first voltage divider across said high voltage output terminals including a Zener diode and a resistor, a source of low D.-C. voltage, a plurality of variable current devices each having two current carrying electrodes and a control electrode, said source of low voltage and first of said variable current devices being series connected to a pair of low voltage output terminals, second of said variable current devices and a resistor being series connected across said source of low voltage to provide a current path through said resistor, the junction of said resistor with said second variable current device being coupled to the control electrode of said first variable current device, said second variable current device being connected to a source of conducting bias on said first voltage divider, a third of said variable current devices having its current carrying electrodes connected across said source of bias, a second voltage divider being across said low voltage output terminals and having one side connected to control said third variable current device, and a fourth of said variable current devices having one current carrying electrode connected to a current carrying electrode of said third variable current device and having each current carrying electrode connected to one of said low voltage output terminals, said fourth variable current device being connected to said Zener diode to provide a regulated source of conducting bias.

2. A power supply as defined in claim 1 wherein said variable current devices are transistors.

3. A power supply comprising a high voltage and a low voltage regulating device, each adapted to be connected to a source of D.-C. voltage, said high voltage regulating device being connected to control current through the low voltage regulating device, said low voltage regulating device being connected to provide a low voltage reference and means for connecting a load across said voltage reference.

4. A power supply in accordance with claim 3 wherein said low voltage reference device is a Zener diode.

5. A power supply as defined in claim 3 together with means to connect an additional load across said high voltage regulating device.

6. In a colorimeter including a light source, a photocell and a photocell voltage amplifying tube, said amplifying tube having an anode, a cathode, and a grid electrode; a power supply comprising a source of regulated high voltage connected across said anode and said cathode, said photocell being connected to said grid electrode, a voltage divider including a Zener diode and at least one resistor connected across said regulated high voltage, a source of low D.-C. voltage providing an output voltage, a variable current device connected in series between said output voltage and the source of low voltage, and a voltage reference controlled by voltage across said Zener diode connected to said output voltage, said output voltage connected to supply regulated low voltage to said light source.

7. A power supply as defined in claim 6 together with a second variable current device having one current carrying terminal connected to one side of said voltage reference and another current carrying terminal connected to a point on said voltage divider whereby continuous current is produced by said second variable current device.

8. A power supply as defined in claim 6 wherein said amplifying tube includes a heater, said heater being connected to said output voltage to provide a regulated heater voltage.

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