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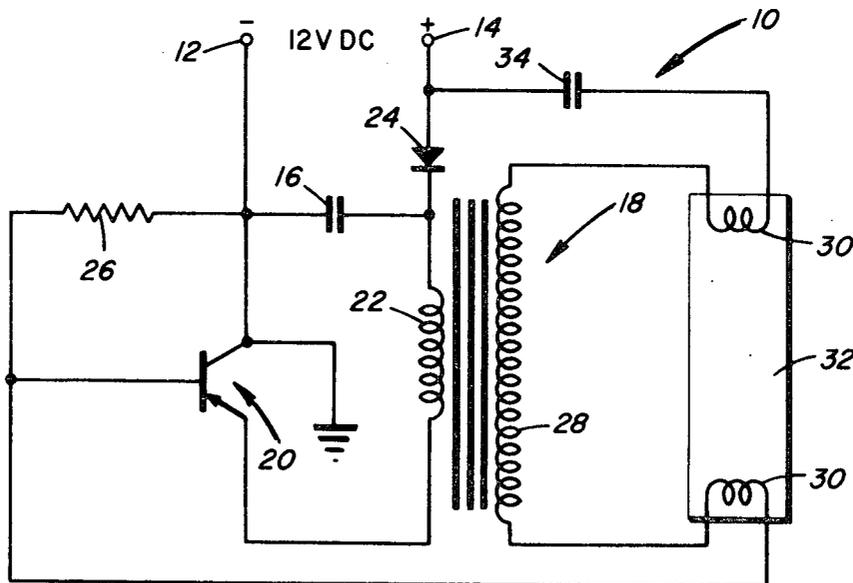
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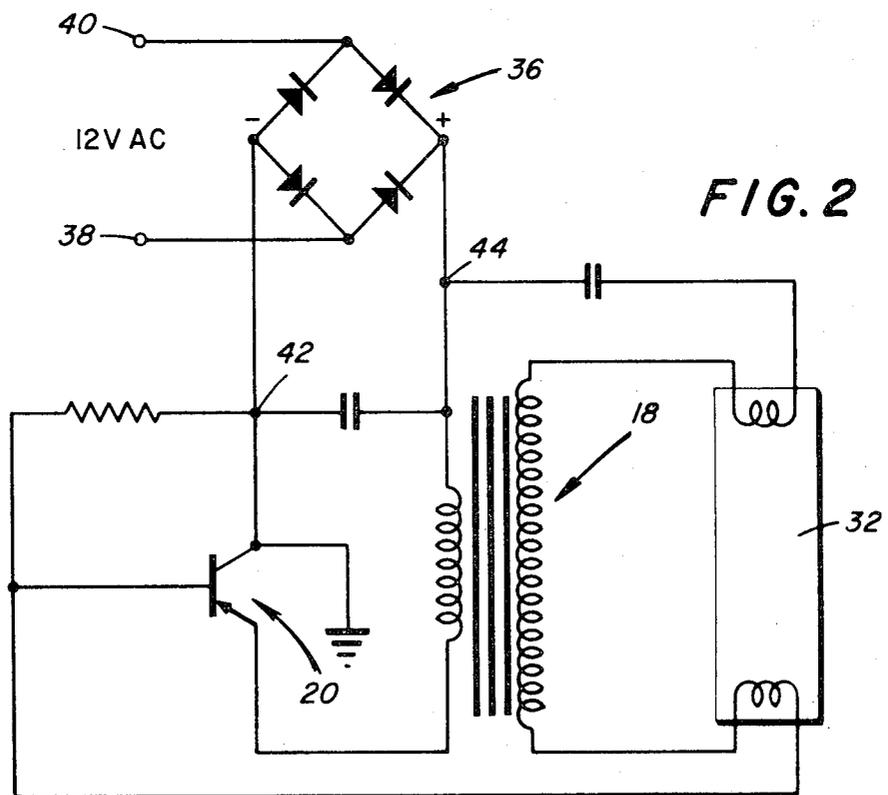
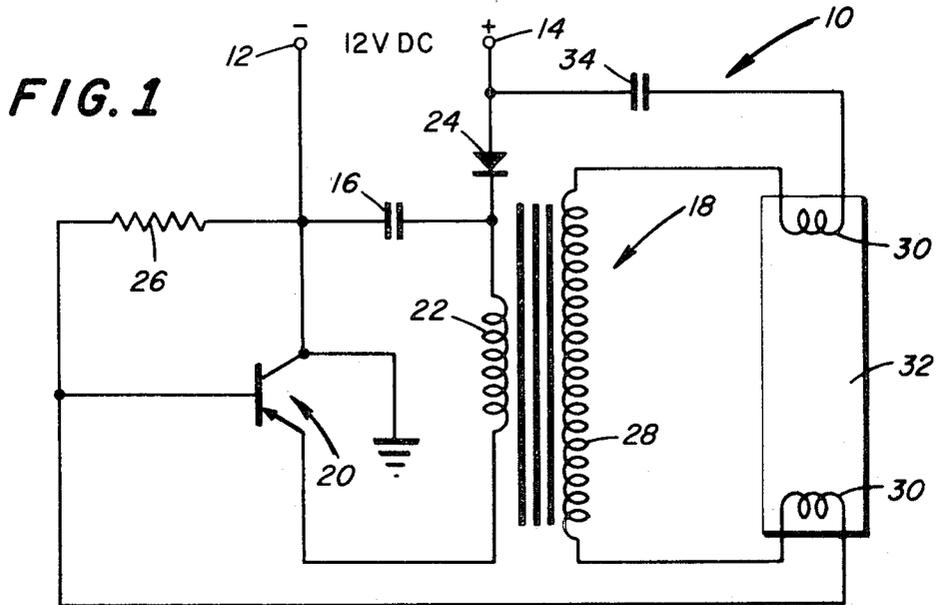
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[54] **TRANSISTORIZED FLUORESCENT TUBE OPERATING CIRCUIT**  
 9 Claims, 4 Drawing Figs.

[52] U.S. Cl. .... **315/98,**  
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 315/260, 315/DIG. 7, 331/112  
 [51] Int. Cl. .... **H03k 3/28,**  
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 100 H, 100 T, 94, 98, 99, 101-103, 105, 107, 200,  
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**ABSTRACT:** A circuit for operating fluorescent tubes ranging from 8 to 40 watts, the circuit being supplied by either direct or alternating current. The circuit components are arranged so that input current flows through a series path defined by the primary winding of a transformer and the emitter and collector junctions of a transistor. The secondary winding of the transformer serves to provide energy for lighting the fluorescent tube and further serves to provide a feedback current for biasing the transistor.





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FIG. 3

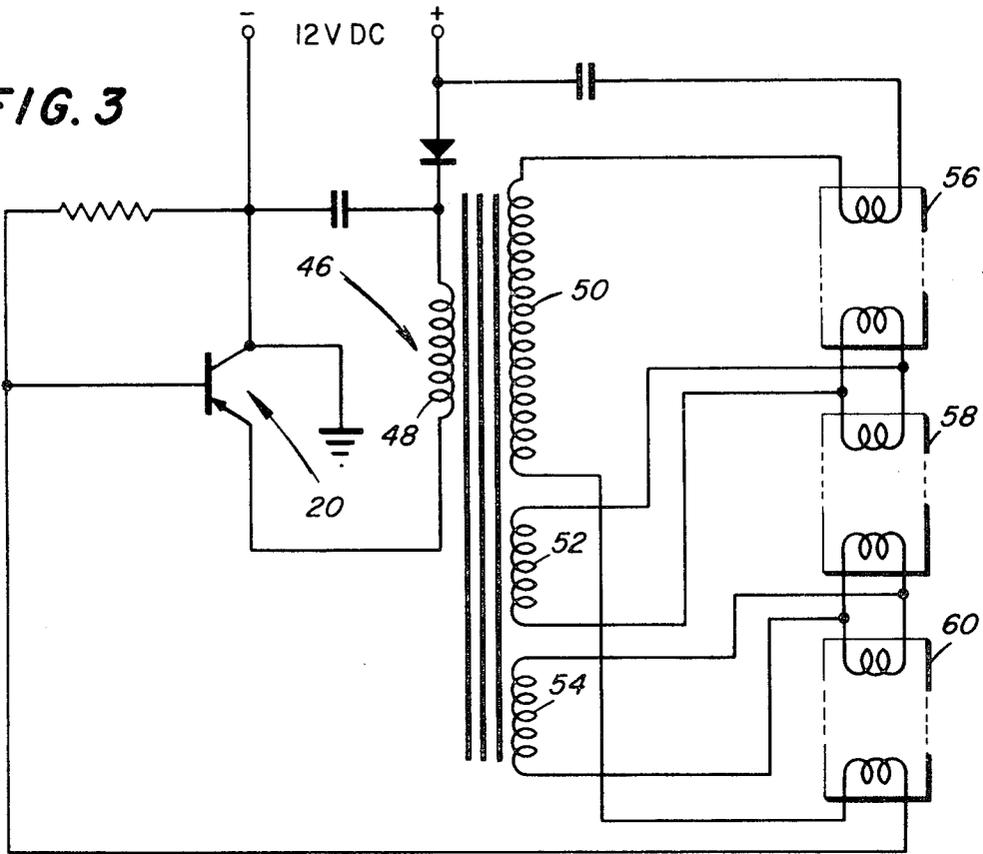
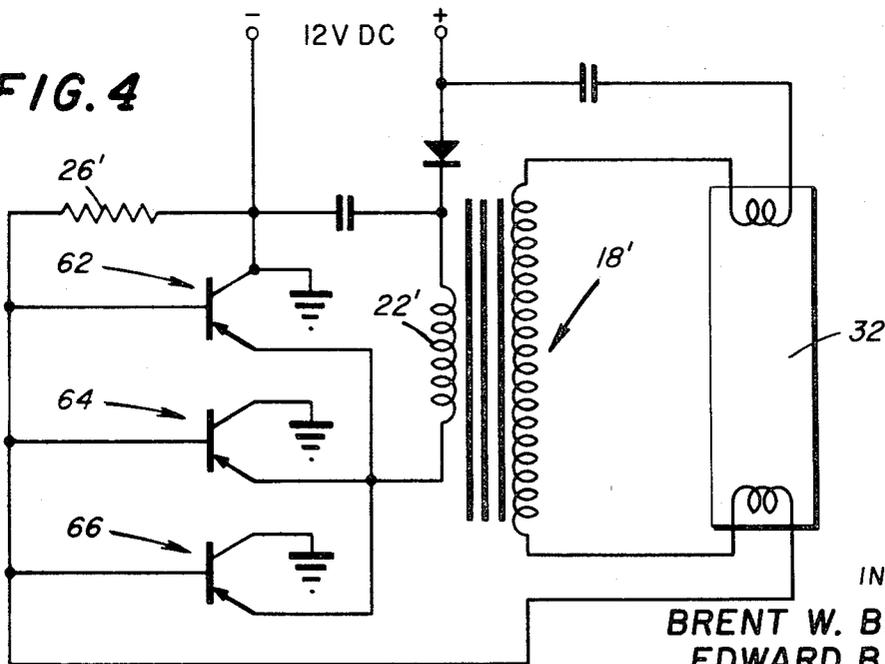


FIG. 4



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## TRANSISTORIZED FLUORESCENT TUBE OPERATING CIRCUIT

### BACKGROUND OF THE INVENTION

The popularity of the fluorescent tube is steadily increasing. This increasing polarity owes to the fact that the fluorescent tube is three or four times more efficient than is the incandescent bulb. Despite the desirability of the fluorescent tube, however, the application of fluorescent lighting in remote or mobile applications is somewhat limited.

The limited use of fluorescent lighting in these mobile applications is due to many factors. First, the customary fluorescent tube requires a relatively high-voltage source of the alternating current variety. Portable sources meeting these criteria tend to be somewhat complex. Second, while there are known circuits for converting low level DC sources to alternating currents of the required voltage level for lighting fluorescent tubes, these circuits tend to be inefficient, somewhat large and relatively expensive. In addition to the above, the known circuits for providing the requisite power for mobile fluorescent lighting assemblies function for only a single type of tube and a single wattage level. As a consequence, these circuits are limited in their application.

### SUMMARY OF THE INVENTION

The present invention relates to a versatile, inexpensive and efficient circuit for converting the energy from a low-voltage AC or DC power source to an alternating current of a sufficiently high voltage to power fluorescent tubes of wattages ranging from 8 to 40 watts.

When operating from a DC power source, the primary winding of a transformer is in series with the emitter-to-collector path of a transistor. This series circuit is connected directly to the power source. The secondary winding of the transformer is in series with the filaments of a fluorescent tube and serves as a biasing path to the base of the transistor. When operating from an AC power source, the circuit is provided with a full-wave rectifier.

The circuit of the present invention is simple in design. Notwithstanding this, however, the circuit functions efficiently as a converter, fed by either a low-voltage alternating or direct current power source, and converting this energy so as to be suitable for powering a fluorescent tube. In addition to its high efficiency, this circuit is versatile in its operation in that it may be adapted to power several tubes or tubes of different wattage ratings. Still further, the circuit is relatively unaffected by fluctuations in the supply voltage.

Accordingly, it is the main object of the present invention to provide a circuit for powering a fluorescent tube which circuit is simple in design, efficient in operation and versatile in its use.

Another object of the invention is to provide a circuit for powering a fluorescent tube in such a manner that the tube output remains relatively constant, notwithstanding substantial fluctuations in the input voltage.

A further object of the invention is to provide a circuit for powering fluorescent tubes of varying configurations and wattages.

Other objects of the invention are to provide a circuit for powering a fluorescent tube which circuit is cross-polarity protected and which is relatively insensitive to RF interferences.

Still a further object of the invention is to provide a circuit for powering a plurality of fluorescent tubes from but a single ballast.

These and other objects of the invention, as well as many of the attendant advantages thereof, will become more readily apparent when reference is made to the following description taken in conjunction with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1. is a schematic drawing of the fluorescent tube circuit of the present invention;

FIG. 2 is a circuit similar to that shown in FIG. 1, but which is adapted to be powered by an AC source;

FIG. 3 is a schematic similar to that shown in FIG. 1, but illustrating the circuit when adapted to operate a plurality of tubes from a single ballast; and

FIG. 4 is a circuit schematic similar to that shown in FIG. 1, but in which multiple transistors are provided for obtaining higher wattage capabilities.

### DETAILED DESCRIPTION OF THE INVENTION

With reference first to FIG. 1, the circuit of the present invention is shown generally at 10, this circuit being powered by means of a 12-volt DC power source (not shown). The power source is connected into the circuit 10 by means of a pair of input terminals 12 and 14, respectively. Across the terminals 12 and 14 is positioned a capacitor 16.

Also forming part of the circuit 10 is a transformer 18 and a transistor 20. The transformer 18 is of the H-material core or equivalent construction and the transistor 20 is of the PNP-variety. As seen in FIG. 1, a primary series circuit is defined by the power source, the primary winding 22 of transformer 18 and the emitter-to-collector path of the transistor 20. Also forming part of this series circuit is a diode 24.

A secondary series circuit is also provided. This latter circuit is defined by the power source, the secondary winding 28 of transformer 18, the filaments 30 of a fluorescent tube 32 and a feedback path for biasing transistor 20. A capacitor 34 is also provided in the filament and tube circuit.

The circuit 10 is further provided with a resistor 26 positioned between the terminal 12 and the base of transistor 20. Resistor 26 serves to bias the transistor.

The operation of circuit 10 is as follows. Power from a 12-volt DC source is connected across terminals 12 and 14. If the power source is of the correct polarity, current will flow through the diode 24. If, however, the power is incorrectly connected, no circuit current will flow. Thus, the circuit 10 is cross-polarity protected. Naturally, if cross-polarity protection is not necessary, diode 24 may be omitted.

When the power source is correctly connected into the circuit, a direct current flows through the primary winding 22 of transformer 18, from the emitter to the collector of transistor 20 and then to ground. Resistor 26 provides the base of transistor 20 with enough "on" bias to allow this current to flow from the emitter to the collector of the transistor. Resistor 26 also serves to bias the feedback pulse so that the transistor remains in its "on" condition over a larger portion of the cycle.

The current rise in the primary winding 22 of transformer 18 induces a current in the secondary winding 28 of this transformer. The secondary winding 28 not only provides the voltage necessary for lighting the fluorescent globe 32, but also provides the current needed to heat the filaments 30 and to bias the transistor 20. When current flows through the circuit of the secondary winding 28, the base of transistor 20 is biased so that transistor 20 turns more "on" and, as a consequence, the current in the primary winding 22 of transformer 18 is forced to a maximum value.

When maximum current in the primary winding 22 is reached, flyback action in the transformer 18 occurs. This flyback action generates, in the secondary winding 28, a voltage of an opposite polarity. Therefore, the transistor 20 is driven "off". The cycle is not able to begin again until the current in the primary winding 22 of the transformer 18 drops to zero.

Capacitor 16 is provided in the circuit 10 in order to prevent high-frequency radio interference from deleteriously affecting the line of the voltage source and further serves to hold back the EMF within limits to prevent damage to the transistor 20. Capacitor 34 provides the ground reference and phase shift necessary for oscillator action of the circuit 10 and further serves to define the alternating current path for heating the filaments 30 of the fluorescent tube 32. Capacitor 34

also prevents transistor damage from line transient voltages originating from other equipment and/or portable generators and converters.

In the operation of the circuit, it should be noted that until the fluorescent tube 32 arcs, the voltage across the secondary winding 28 of transformer 18 overdrives the transistor 20, thereby causing an excess of base current. This excess of base current heats the filaments 30 in the fluorescent tube 32. The tube 32 then arcs through, thereby reducing the drive voltage by shunting the secondary winding 28. Only then does the drive return to normal. It should be appreciated that in this manner no power is wasted on filament current, and that most of the current passes through the tube 32. It will also be noted that when the tube 32 is removed from the circuit, the operation of the circuit 10 ceases.

The circuit described above serves quite efficiently and economically to convert a 12-volt direct current to an alternating current for powering fluorescent tubes. This circuit operates at approximately 36 kHz. and at a voltage sufficient for powering fluorescent tubes. The transformer in the circuit serves to raise the voltage to a level suitable for powering the associated tube. As noted above, the circuit of the present invention is able to provide power for fluorescent tubes ranging from 8 to 40 watts. To adapt the circuit for use with various tubes, all that is required is to vary the transformer ratio of transformer 18. The circuit can be packaged in a unit much smaller than the conventional 60-cycle 110-volt AC ballasts. As a consequence, the present circuit gives more versatility of fixture designed. Further, the circuit shown in FIG. 1 powers a fluorescent tube in such a manner that a substantially constant light output results, notwithstanding fluctuations in the power source.

With reference now to FIG. 2, it will be seen that the circuit of the present invention may be operated with an AC power source. Due to the similarities between the circuits of FIG. 1 and FIG. 2, only the differences therebetween are here discussed. In FIG. 2, the basic circuit is identical with that shown in FIG. 1, but for the removal of the diode 24 and the addition of a full-wave rectifier 36. A 12-volt AC source of power is impressed upon the circuit at terminals 38 and 40. The full-wave rectifier 36 converts the AC signal into a full-wave rectified DC signal. The DC signal from the rectifier 36 is fed to the circuit shown in FIG. 2 by means of terminals 42 and 44. Thereafter, the circuit operation is identical to that of FIG. 1. The diode 24, forming part of the circuit of FIG. 1, is not necessary in the circuit of FIG. 2 as the individual diodes forming part of the rectifier circuit 36 provide inherent cross-polarity protection.

While the circuit shown in FIG. 2 is explained with reference to AC input, it should be evident that this circuit operates equally well whether the input is of the AC or the DC variety. Thus, while the circuit shown in FIG. 1. is suitable only for use with a DC input, the circuit of FIG. 2 is capable of functioning with either AC or DC power.

With reference now to FIG. 3, it is seen that the circuit of the present invention may be adapted to power a plurality of fluorescent tubes from a single ballast. The main difference between the circuit shown in FIG. 3 and that shown in FIG. 1 is in the transformer. Rather than a transformer having a single primary and a single secondary winding, the circuit of FIG. 3 is provided with a transformer 46 having a primary winding 48, a secondary winding 50 and a pair of filament windings 52 and 54, respectively. A transformer such as transformer 46 is suited for use with three tubes such as those shown at 56, 58 and 60, respectively. Naturally, if more or less tubes were desired, the transformer 46 would be adapted accordingly. As is shown in FIG. 3 the secondary winding 50 of transformer 46 is connected to one filament of the first tube 56 and one filament of the last tube 60. The intermediate filaments are connected, in parallel, to the filament windings 52 and 54.

With reference now to FIG. 4, there is shown another embodiment of the present invention. This embodiment is provided with a plurality of transistors shunted so as to provide

higher wattage capability for the circuit. It will be noted that the circuit of FIG. 4 is like the circuit of FIG. 1 in all respects, but that three transistors 62, 64 and 66 are substituted for the single transistor 20 of FIG. 1. Naturally, more or fewer transistors may be provided depending on the desired wattage capabilities. The respective bases of transistors 62, 64 and 66 are connected together and are biased by means of a resistor 26'. The respective emitters of the three transistors are connected together and receive current from the secondary winding 22' of transformer 18'. In all other respects, the circuit operation is identical with that described with reference to FIG. 1.

The circuits described above may, for example, be constructed according to the following specifications:

C <sub>18</sub>	100 mfd.
C <sub>34</sub>	0.01-0.015 mfd.
Q <sub>20</sub>	Dtg. 600B
T <sub>18</sub>	Core CF-905-H, Cf-906-H, or equivalent.
Ratio:	25-100 or 25-150 depending upon desired wattage.

Above, there have been described particular embodiments of the present invention, circuits for powering one or more fluorescent tubes varying in wattage from 8 to 40 watts and of any shape or configuration. The circuits exhibit a further degree of versatility in that they may be powered by means of direct or alternating current sources of potentials which may range from 8 to 16 volts without appreciably changing the light outputs of the associated tube or tubes. It should be noted that these embodiments are described for exemplary purposes only and that numerous modifications and alterations may be practiced without departing from the spirit and scope of the invention. Accordingly, it is the intent that the invention not be limited to the above, but only as defined in the appended claims.

What is claimed is:

1. A circuit for powering fluorescent tubes, the circuit comprising: first and second input terminals; a transformer having a primary and a secondary winding; a transistor; a primary series circuit defined by the primary winding of the transformer, the transistor, and the first and second input terminals, a secondary series circuit defined by the secondary winding of the transformer, the first and second input terminals, and the first and second filaments of a fluorescent tube; and means connecting said transistor to said secondary series circuit for biasing said transistor; the secondary series circuit being defined in such a manner that the ionization of the fluorescent tube shunts the secondary winding of the transformer and reduces the bias on the transistor.

2. The circuit as described in claim 1 and further comprising resistor means for biasing the base of said transistor from one of the input terminals.

3. The circuit as defined in claim 2 wherein the transistor is a PNP-transistor wherein the resistor means for biasing the transistor is connected between said second terminal and the base of the transistor.

4. The circuit as defined in claim 1 and further comprising a diode connected between the first input terminal and the primary winding of the transformer for cross-polarity protection.

5. The circuit as defined in claim 1 and further comprising a capacitor connected between said input terminal and the first filament of said fluorescent tube.

6. The invention as defined in claim 1 and further comprising a full-wave rectifier associated with said first and second input terminals for providing the circuit with capabilities of operating from either AC or DC powering means.

7. The circuit as defined in claim 1 and further comprising at least one filament winding on the secondary side of said transformer and means for connecting said filament winding to respective filaments of fluorescent tubes in order to power a plurality of tubes from a single ballast.

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8. The invention as defined in claim 7 wherein said secondary winding is connected between one filament of a first fluorescent tube and one filament of a further fluorescent tube and wherein one filament winding is provided for each tube in excess of one, each filament winding connecting, in parallel,

the intermediate filaments of said tubes.

9. The invention as defined in claim 1 and further comprising a plurality of transistors shunted so as to increase the wattage capability of said circuit.

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