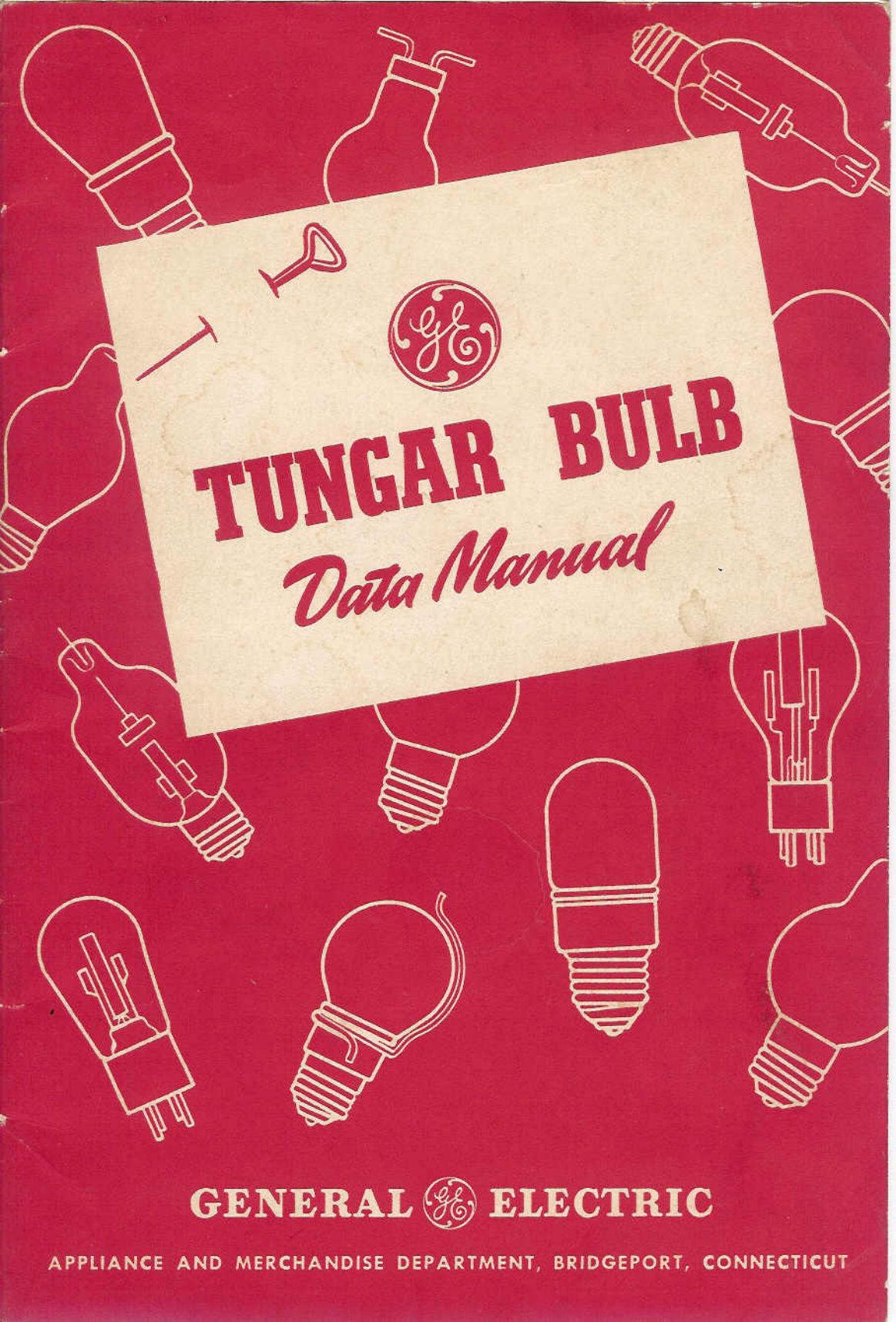


TUNGAR BULB

Data Manual

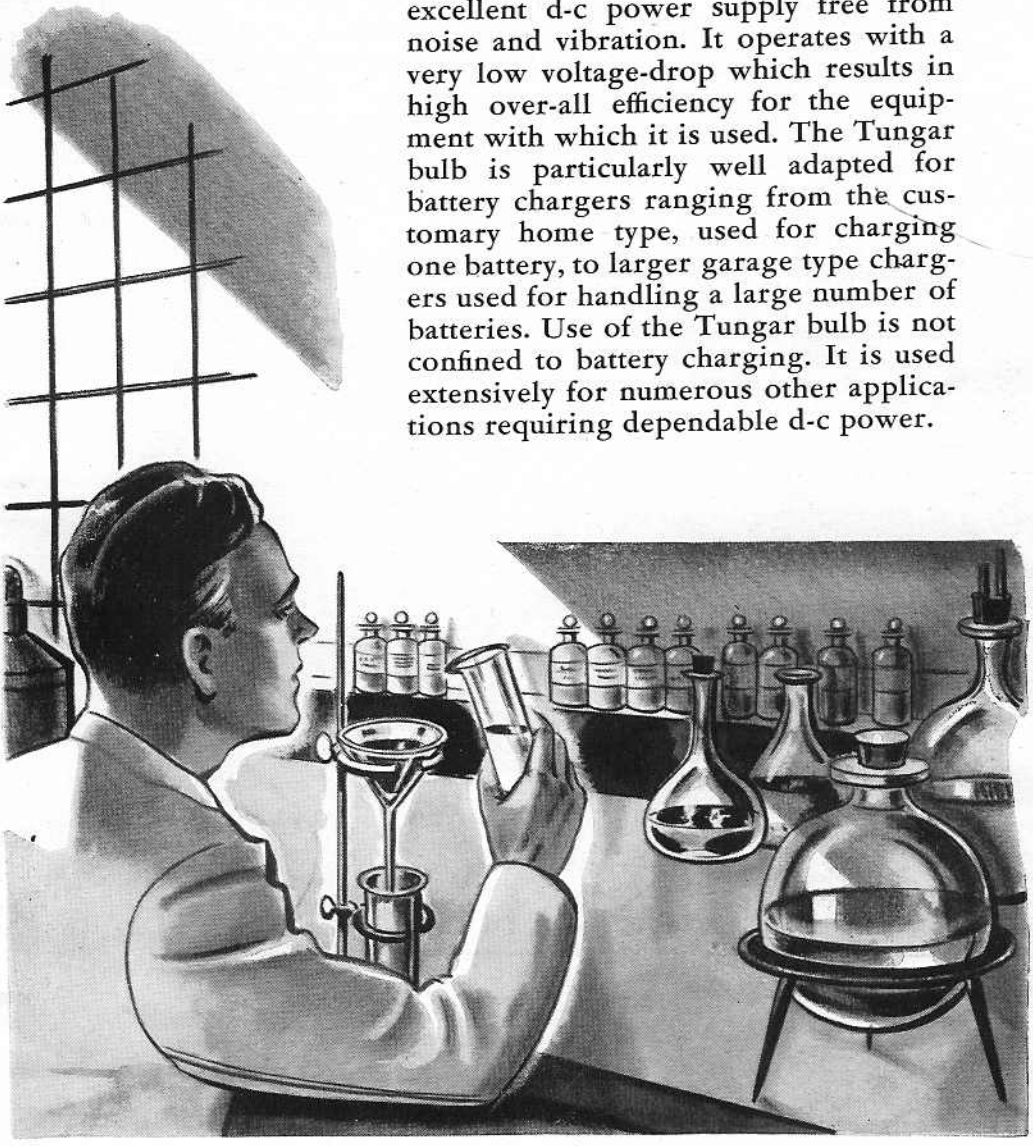
GENERAL ELECTRIC

APPLIANCE AND MERCHANDISE DEPARTMENT, BRIDGEPORT, CONNECTICUT

TUNGAR BULBS

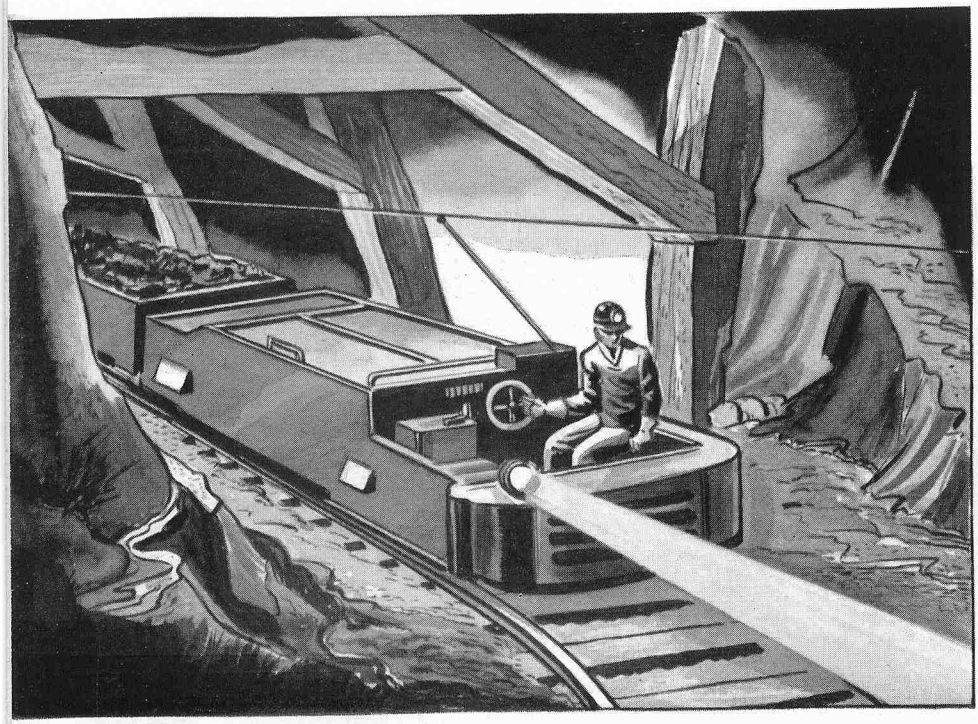
The Tungar bulb developed by General Electric in 1916—and used for rectification of a-c to d-c is well known wherever battery charging or similar applications require d-c power. Since 1916 constant research has improved the characteristics of the Tungar bulb, increased the efficiency, and trebled the operating life.

The Tungar bulb makes possible an excellent d-c power supply free from noise and vibration. It operates with a very low voltage-drop which results in high over-all efficiency for the equipment with which it is used. The Tungar bulb is particularly well adapted for battery chargers ranging from the customary home type, used for charging one battery, to larger garage type chargers used for handling a large number of batteries. Use of the Tungar bulb is not confined to battery charging. It is used extensively for numerous other applications requiring dependable d-c power.



GENERAL DESCRIPTION

The Tungar bulb is made of the finest materials. It is a gas-filled type of electronic tube making use of argon, mercury or a combination of the two gases. The bulb consists of a cathode and an anode enclosed in a glass envelope. The cathode is either a thoriated tungsten filament or a barium-oxide coated nickel filament. The anode is made of high-purity graphite attached to a nickel stem. The connection is made through the bulb's hard glass envelope by a tungsten lead. The glass envelope is designed so that it matches the expansion characteristics of the tungsten. After the bulb has been exhausted to a high vacuum, a specified amount of argon gas, a small



The tungsten and other raw materials used in the manufacture of Tungar bulbs are the finest available, and all materials are laboratory tested before being used.

ELECTRICAL DESCRIPTION

A Tungar bulb in an electrical a-c circuit acts as a valve. When the anode is positive, the cathode emits sufficient electrons to maintain a flow of electrons from the cathode to the anode. During the reverse half cycle, when the cathode is positive, there is an insufficient supply of electrons available to support an electron flow. For this reason the bulb acts as a one-way valve and with current flow normally described as flowing from positive to negative, the current flow through a Tungar bulb would be from anode to cathode. In order to force the flow of electrons across the gap between the cathode and anode, it is necessary to maintain a certain potential. This is known as the "voltage-drop" or "arc-drop" of the bulb.

It is necessary that a sufficient voltage be impressed across the cathode and the anode before current will flow. This required voltage is normally referred to as the "pick-up" or "starting voltage."

The terms "pick-up" and "arc-drop" voltage are illustrated in Figure 1. The portion of the curve filled in by dotted lines and the full line is the standard a-c sine wave which would be impressed across the bulb if the filament was not heated and the bulb was not conducting.

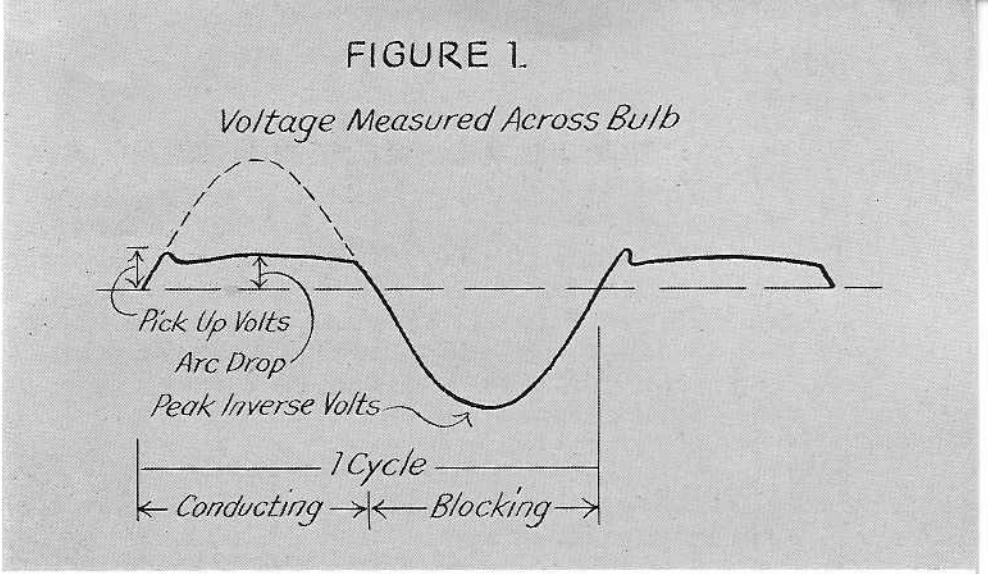
PICK-UP VOLTAGE

Low "pick-up" voltage provides a long conduction cycle limiting the peak current and insuring long life for the bulb. "Pick-up" voltage may vary slightly with different bulbs and throughout the life of a bulb. It is not usually desirable to connect two bulbs in parallel without a separate power supply for each. The bulb with the lower "pick-up" will begin to conduct current and the other bulb or bulbs in parallel will not obtain sufficient voltage to start.

ARC-DROP VOLTAGE

Low "arc-drop" voltage provides long life and high efficiency because it prevents overheating of the cathode. The "arc-drop" voltage is usually slightly less than the "pick-up" voltage and remains practically constant

FIGURE 1.



throughout the conduction period. (See Figure 1.) The "arc-drop" voltage multiplied by the current passing through the bulb gives the instantaneous power loss in the arc stream. This, however, represents only the watts loss in the bulb as a result of passing current and to this value, the filament watts should be added in order to obtain the total losses in the bulb itself. This value of power loss in the bulb remains practically constant for all applied voltages and for that reason the bulb operates much more efficiently as far as the over-all equipment is concerned when operated near its maximum ratings.

TUNGAR ARGON BULBS

The fundamental operating characteristics of a Tungar bulb with argon gas are independent of ambient temperatures because the quantity of gas remains constant at all times. The thoriated tungsten filament in the argon type bulb reaches operating temperature within one to fifteen seconds depending on the bulb size. The bulb will then deliver full output. The 6-ampere and smaller argon bulbs can be used in circuits where the filament and load power are turned on at the same time. Maximum operating life will be obtained if there is a delay of two to three seconds between applying the filament power and the anode power. Due to the greater size of the cathode, the fifteen ampere bulb requires a longer pre-heating period. Peak inverse rating is based on the recommended time delay.

TUNGAR MERCURY-ARGON BULBS

The mercury-argon type bulb has characteristics well adapted for low-voltage applications where quick starting and low operating characteristics are desired. The argon helps to carry the current until the mercury comes up to operating temperature. Some time delay between applying filament power and load voltage is recommended for mercury-argon bulbs with higher current output as stated under argon type bulbs.

TUNGAR MERCURY BULBS

The Tungar mercury bulb is designed for higher voltage applications. The cathode of barium-coated nickel reaches operating temperature more slowly than the cathode in the argon or mercury-argon type. Tungar mercury bulbs are identified by catalog numbers 16X897 and 45X674. For best results it is desirable to allow the filament from five to ten minutes to come up to operating temperature before applying the load. It is necessary that the condensed mercury temperature be held within the limits specified. If mercury bulbs operate at low temperatures or exceptionally high temperatures, bulb life will be seriously impaired and early failure may result. Normal ambient temperatures and reasonably free access to circulating air will maintain the proper operating temperature.

OPERATION

A few simple precautions in the design of equipment in which Tungar bulbs are to be used will be of help in obtaining long bulb life. In the most desirable type of operation the bulb is turned ON and operated continuously for a long period of time. Under this condition maximum life is obtained.

In intermittent service, where the load is turned ON and OFF frequently, it is sometimes desirable to operate the filament under continuous excitation and control the rectifier in the load circuit.

The filament voltage should be maintained to within plus or minus 5 per cent of the recommended value Under no circumstances should the filament power be turned OFF after the bulb has started to conduct, even

though it is possible to operate Tungar bulbs with the filament supply removed. This does not add to the overall efficiency of the circuit since it is necessary that the "arc-drop" increase to supply the power normally obtained from the filament excitation. The higher "arc-drop" value means more severe bombardment of the cathode and results in short operating life. Low filament voltage also contributes to arc-backs and bulb damage.

The rated values shown in the tabulation for each bulb should not be exceeded. Severe damage can result if rated values are not respected. If over-voltage is applied and the bulb breaks down and conducts in the reverse direction, a short circuit across the transformer will result and the entire transformer capacity can be dissipated into the bulb resulting in its destruction. A fuse in the anode circuit will sometimes interrupt the flow of current in time to prevent serious damage.

Clean contact surfaces are necessary both to conduct the electric current and also to reduce the heat generated at the contacts. This is true of both the contacts in the base and of those of the anode. The tension on anode clips should be maintained to assure good contact.

When a mercury bulb is first installed, the filament should be operated for ten or fifteen minutes without any voltage applied to the anode to obtain redistribution of the mercury within the bulb.

Three Tungar bulbs are of twin-anode full-wave construction. When it is desirable to operate any one of these bulbs in a half-wave circuit (with the anodes connected together) the load current should be limited to half the rated output to avoid the danger of exceeding the peak current rating of the cathodes.

Tungar bulbs are frequently employed in applications requiring momentary overloads. Supplying current to motion picture arc lamps is a typical example. In this application bulbs operate at greatly increased load at the instant when the arc lamp electrodes come together to start the arc. The bulb filament must attain operating temperature before it is subjected to such an overload. In other words, the recommended bulb pre-heating time must be observed. Care should be taken to separate the lamp electrodes quickly to prevent bulb damage due to prolonged overload.

RECTIFIER BULB CIRCUITS

There are various circuits which can be used with Tungar bulbs and the particular selection depends a great deal on the application.

A simple circuit used in many Tungar battery charging applications is illustrated in Figure 2. A common variation in this circuit is a provision of taps on the secondary to adjust the output. Primary taps for adjusting the output should not be used unless there is a separate filament transformer. The constants covering this circuit are given in the Rectifier Circuit Constants tabulation shown on page 10. The theoretical maximum voltage output is equal to 45 per cent of the a-c input voltage to the bulb circuit. These constants are theoretical and do not take into consideration the "arc-drop" or other circuit characteristics. The conduction period is only for one-half cycle which gives a very pronounced ripple. One important point in the application of bulb circuits of this type is the heating current or rms appearing in the d-c circuit. This represents a value of approximately 1.57 times the d-c current and when fusing the circuit or figuring current-carrying capacities in a circuit of this type, it is necessary to figure the heating value of the current (1.57 times the d-c current reading). The peak inverse volts which the bulb must hold off during the inverse cycle is 1.414 times the a-c applied voltage. All of these values are based on a sine wave a-c power supply.

Another circuit very widely used with Tungar bulbs is the full-wave mid-tap circuit shown in Figure 3. The filament excitation can be supplied as an extra winding

FIGURE 2.

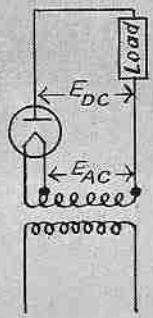


FIGURE 3.

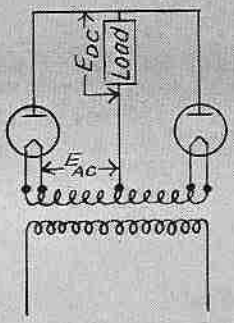
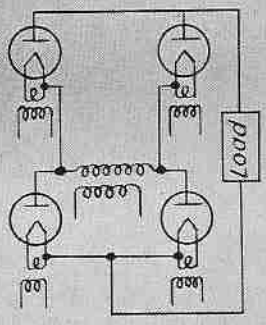


FIGURE 4.



on the main transformer or a separate transformer can be used. Characteristics of this circuit are also given in the Rectifier Circuit Constants tabulation. The ripple is limited to 48 per cent with this circuit.

A third single-phase circuit is illustrated in Figure 4. This is essentially two full-wave mid-tap circuits connected in series to obtain higher d-c voltage output, using a bulb which has limited voltage characteristics.

When it is desired to operate a rectifier from a three-phase supply using only four bulbs, the arrangement shown in Figure 5 may be employed. The Scott-connected transformers provide the equivalent of two-phase operation and the theoretical ripple is 11 per cent.

There are several three-phase circuits which can be used. The circuit illustrated in Figure 6 is one of these selections. With a three-phase circuit the theoretical ripple is limited to about 4 per cent which is usually satisfactory for the majority of applications. In designing three-phase circuits care should be taken not to exceed the peak current ratings of the bulbs.

The minimum anode voltage for use with a Tungar bulb may be calculated from information on the bulb data sheets which follow. "Pick-up" voltages listed are measured with d-c voltage applied to the anode and a-c voltage on the filament. The true starting voltage for rectification is obtained by adding the peak value of the filament voltage (1.414 times listed filament voltage) to the maximum "pick-up" voltage. In battery charging circuits sufficient voltage over and above the starting voltage must be allowed to give the required charging current without exceeding instantaneous peak current rating.

FIGURE 5.

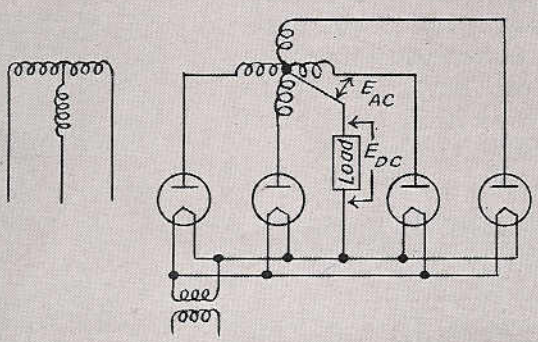
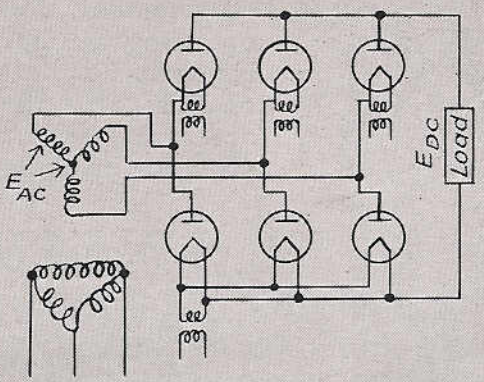


FIGURE 6.



RECTIFIER CIRCUITS CONSTANTS

(THEORETICAL VALUES)

Circuit Reference	E_{dc} Output, Theoretical Maximum	*D-c Ripple %	I_{dc} Bulb / I_{dc} Load	I_{ac} in Bulb Circuit	Peak Inverse Volts
2	0.45 E_{ac}	121	1.00	1.57 I_{dc}	1.414 E_{ac}
3	0.90 E_{ac}	48	0.50	0.786 I_{dc}	2.828 E_{ac}
4	0.90 E_{ac}	48	0.50	0.786 I_{dc}	1.414 E_{ac}
5	1.27 E_{ac}	11	0.25	0.502 I_{dc}	2.828 E_{ac}
6	2.34 E_{ac}	4	0.33	0.579 I_{dc}	2.450 E_{ac}

Assume sine wave. E_{ac} = A-c volts rms. E_{dc} = Volts output across d-c load. I_{dc} = Load current d-c (Total for circuit). I_{ac} = A-c volts rms. *Effective ripple as a % of d-c voltage.

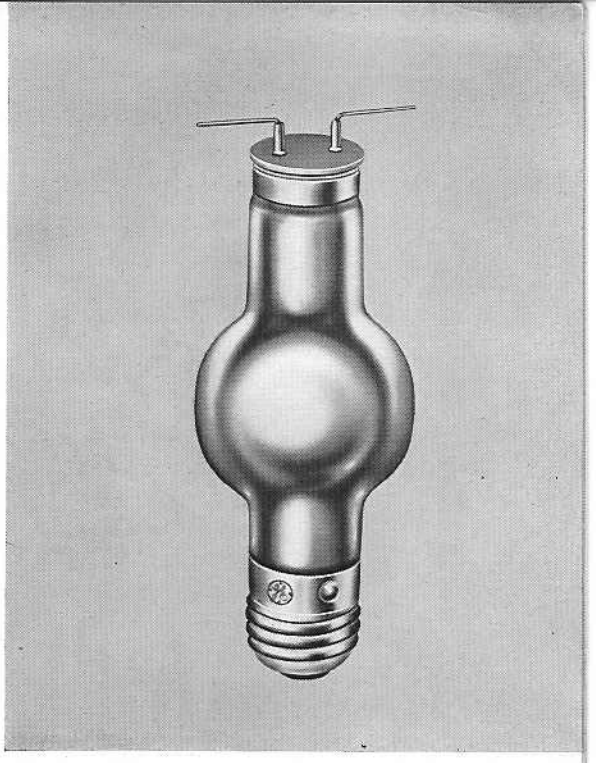
TUNGAR BULB CHARACTERISTICS

The following pages contain complete technical information about each Tungar bulb. Equipment using these bulbs should be designed so that any bulb within the limits specified will operate satisfactorily. For an argon type bulb the voltage-drop or arc-drop across the bulb and the pick-up or starting voltage will be the same whether the bulb is hot or cold providing, of course, the filament is operating at the specified voltage. In mercury-vapor and mercury-argon bulbs, these values are given for cold operation which is the characteristic after the filament has been operating for the recommended pre-heating time. The hot characteristics are those obtained after the bulb has come up to operating temperature within the limits given for maximum base temperature.

G-E TUNGAR BULB

Cat. No. 199698

Tungar bulb, Catalog 199698 is a quick-starting twin-anode rectifier for use in low-voltage full-wave circuits. It is recommended for full-wave applications where only a single bulb is desired to deliver low-voltage and low-current output. This bulb is frequently used to supply power to d-c relays. The discharge medium is argon gas.



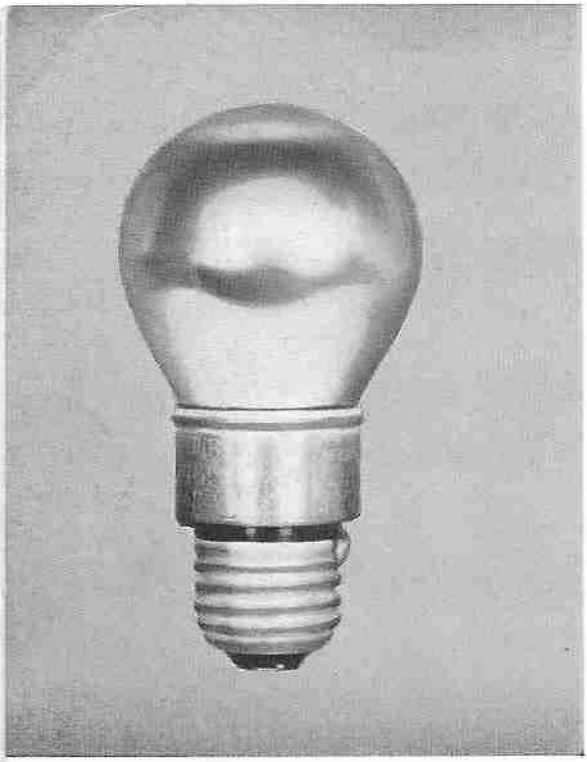
GENERAL DESIGN

Number of electrodes	3
Socket required	Standard Edison
Cathode—thoriated tungsten filament:	
Voltage	1.8 ± 5%
Current, amperes, approx.	12
Pre-heating time, typical seconds	0*
Tube voltage drop, volts d-c:	
Maximum	10.0
Minimum	5.5
Average during life	8.0
Starting (pick-up) voltage, volts d-c:	
Maximum	14.0
Minimum	10.0
Average during life	12.0
Net weight, ounces, approx.	2
Shipping weight, ounces, approx.	6
Length, inches, approx.	5⅝
Diameter, inches, approx.	2

RATINGS

Maximum peak voltage between anodes	105	120
Maximum current:		
Average per anode, amperes	1.0	0.25
Average full-wave output per tube, amperes	2.0	0.5
Instantaneous (peak) amperes, recurrent	6.0	1.5
Maximum d-c output, average volts	25	30

*Under normal ambient temperature conditions, this tube will deliver 90% of full output within three seconds after the simultaneous application of anode and filament voltage. Longer tube life may be obtained by applying the anode voltage one to three seconds later than the filament voltage.



G-E TUNGAR BULB

Cat. No. 12X825

(RMA TYPE 4B35)

Tungar bulb, Catalog 12X825, is a half-wave argon type bulb, particularly well adapted for charging batteries used in telephone, telegraph, clock and alarm systems. Catalog 206501 is identical except that it is fitted with an adapter to take a clip anode lead. The discharge medium is argon gas.

GENERAL DESIGN

Number of electrodes	2
Cat. No. of Socket required:	
Cat. No. 12X825 tube	GE-278768
Cat. No. 206501 tube	Standard Edison
Cathode—thoriated tungsten filament:	
Voltage	2.0 ± 5%
Current, amperes, approx.	13.5
Pre-heating time, typical seconds	0*
Tube voltage drop, volts d-c:	
Maximum	9.5
Minimum	5.0
Average during life	7.5
Starting (pick-up) voltage, volts d-c:	
Maximum	15
Minimum	9.5
Average during life	12.0
Net weight, ounces, approx.	2
Shipping weight, ounces, approx.	6
Length, inches, approx.	4 1/4
Diameter, inches, approx.	2 1/8

RATINGS

Maximum peak inverse voltage (half-wave circuit), volts	275
Maximum anode current:	
Average amperes	2.0
Instantaneous (peak) amperes, recurrent	12.0
Maximum d-c output, average volts	75

*Under normal ambient temperature conditions, this tube will deliver 90% of full output within three seconds after the simultaneous application of anode and filament voltages. Longer tube life may be obtained by applying the anode voltage one to three seconds later than the filament voltage.

G-E TUNGAR BULB

Cat. No. 20X672

(RMA TYPE 4B36)

Tungar bulb, Catalog 20X672, is a quick-starting single-ended half-wave rectifier for low-voltage applications. It is particularly well adapted for charging 1 or 2 automobile storage batteries. The discharge medium for this bulb is argon gas and mercury-vapor.

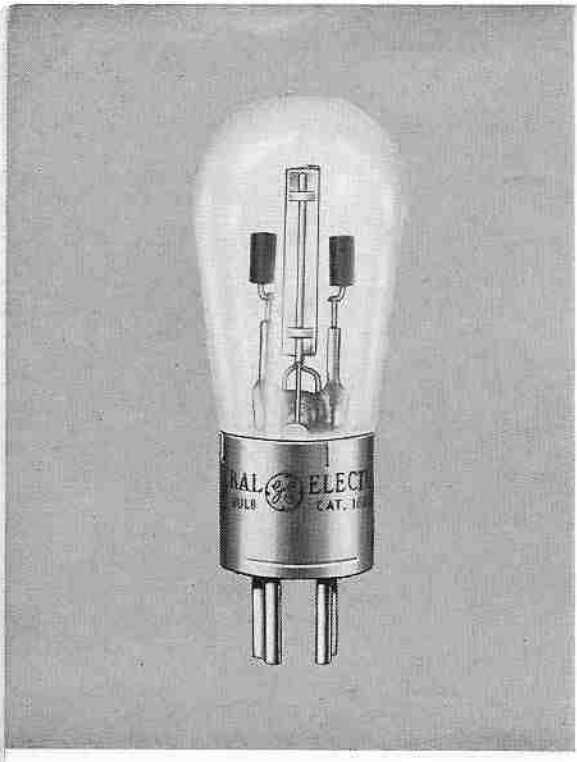
GENERAL DESIGN

Number of electrodes		2
Cat. No. of Socket required		GE-K3778926
Cathode—thoriated tungsten filament:		
Voltage		2.0 ± 5%
Current, amperes, approx.		12.0
Pre-heating time, typical seconds		0*
Tube voltage drop, volts d-c:	*Hot*	*Cold*
Maximum	7.5	9.0
Minimum	4.5	6.0
Average during life	6.0	7.5
Starting (pick-up) voltage, volts d-c:	*Hot*	*Cold*
Maximum	6.0	11.0
Minimum	2.5	8.0
Average during life	4.5	9.5
Net weight, ounces, approx.		3
Shipping weight, ounces, approx.		11
Length, inches, approx.		4 5/8
Diameter, inches, approx.		2 1/8

RATINGS

Maximum peak inverse voltage (half-wave circuit), volts	90
Average amperes	5.0
Instantaneous (peak) amperes, recurrent	30.0
Maximum d-c output, average volts	20.0
Temperature limit, condensed mercury, degrees C.	130

*Under normal ambient temperature conditions, this tube will deliver 80% of full output within three seconds after the simultaneous application of anode and filament voltages. Longer life may be obtained by applying the anode voltage one to three seconds later than the filament voltage.



G-E TUNGAR BULB

Cat. No. 16X897

(RMA Type 4B27)

Tungar bulb, Catalog 16X897, is a twin-anode single ended mercury-vapor rectifier, designed for high-voltage full-wave operation. Its applications are similar to those outlined for Catalog 45X674 which include supplying power to operate magnetic chucks, small motors, etc. This bulb should be mounted in a vertical position.

GENERAL DESIGN

Number of electrodes		3
Cat. No. of Socket required		GE-M-5556072G1
Cathode—coated filament:		
Voltage		2.5 ± 5%
Current, amperes, approx.		10
Pre-heating time recommended, seconds		300
Tube voltage drop, volts d-c:	*Hot*	*Cold**
Maximum	15.0	20.0
Minimum	6.0	7.5
Average during life	9.0	12.5
Starting (pick-up) voltage, volts d-c:	*Hot*	*Cold**
Maximum	20.0	24.0
Minimum	8.0	8.0
Average during life	12.5	14.0
Net weight, ounces, approx.		3
Shipping weight, ounces, approx.		27
Length, inches, approx.		6
Diameter, inches, approx.		2⅛

RATINGS

Maximum peak voltage between anodes	1000
Maximum current:	
Average amperes per anode	1.0
Average amperes, full-wave output per tube	2.0
Instantaneous (peak) amperes, recurrent	6.0
Maximum d-c output, average volts	250
Maximum base temperature, degrees C.	90

*These values are for the end of the 300-second cathode pre-heating time. Tube losses are much greater, resulting in short life, if the pre-heating time is shortened. The pre-heating time listed must be respected and filament excitation must be continuous if guarantees are to apply. When first installed in a new location this tube should be operated 10 minutes with filament voltage only.

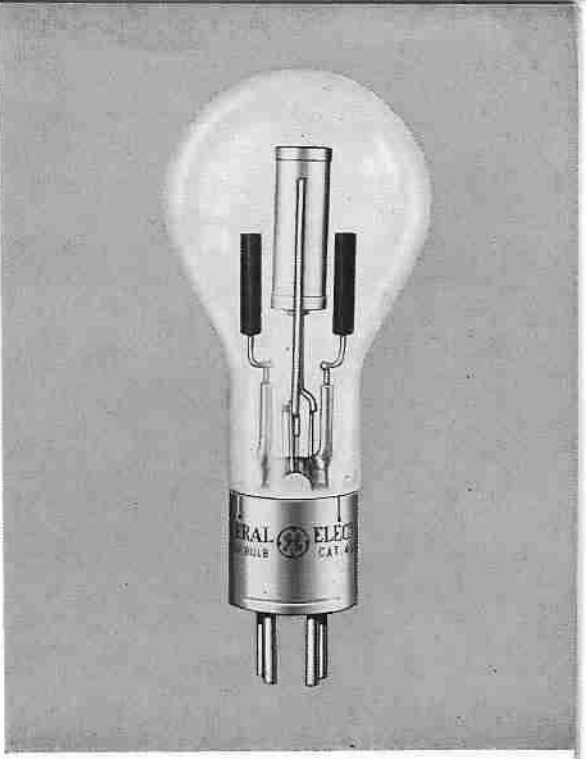
G-E Tungar bulbs pass rigid inspection before shipment.

G-E TUNGAR BULB

Cat. No. 45X674

(RMA TYPE 5B24)

Tungar bulb, Catalog 45X674, also identified as JAN Type 38674 is a twin-anode single-ended mercury-vapor rectifier, for high-voltage full-wave applications. It is used extensively for charging 60-celi batteries, supplying power to operate magnetic chucks, small motors, etc. This bulb should be mounted in a vertical position.



GENERAL DESIGN

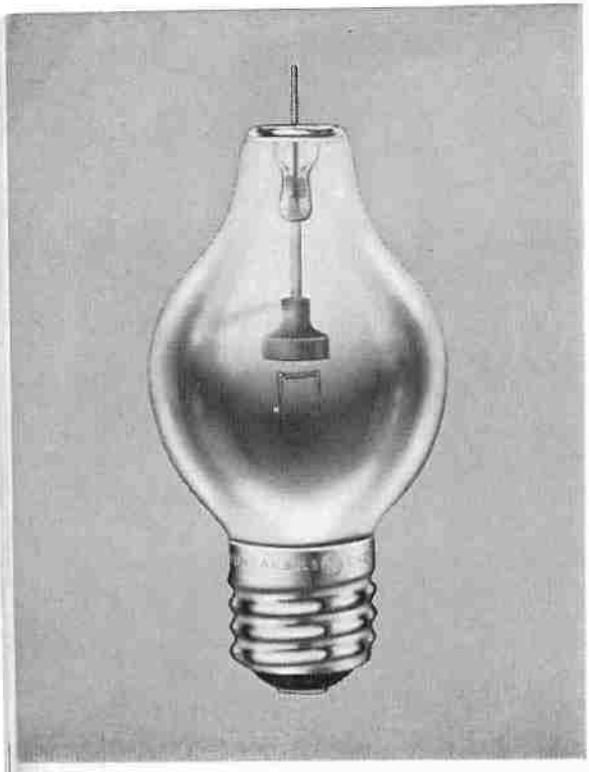
Number of electrodes		3
Cat. No. of Socket required		GE-M-5556072G1
Cathode—coated filament:		
Voltage		2.5 ± 5%
Current, amperes, approx.		24
Pre-heating time recommended, seconds		300
Tube voltage drop, volts d-c:	*Hot*	*Cold**
Maximum	15.0	18
Minimum	7.0	7.5
Average during life	9.0	11.5
Starting (pick-up) voltage, volts d-c:	*Hot*	*Cold**
Maximum	20	20
Minimum	8.5	8.5
Average during life	11.5	13.0
Net weight, ounces, approx.		4½
Shipping weight, ounces, approx.		27
Length, inches, approx.		7⅜
Diameter, inches, approx.		3⅛

RATINGS

Maximum peak voltage between anodes	1000
Maximum current:	
Average amperes per anode	3.0
Average amperes, full-wave output per tube	6.0
Instantaneous (peak) amperes, recurrent	18.0
Maximum d-c output, average volts	250
Maximum base temperature, degrees C	90

*These values are for the end of the 300-second pre-heating time. Tube losses are much greater, resulting in short life, if the pre-heating time is shortened. The pre-heating time listed must be respected and filament excitation must be continuous if guarantees are to apply. When first installed in a new location this tube should be operated for 10 minutes with filament voltage only.

G-E Tungar bulbs have unusually long life.



G-E TUNGAR BULB

Cat. No. 99X44

Tungar bulb, Catalog 99X44, is a quick-starting half-wave rectifier, designed for use in comparatively low-voltage circuits, principally battery charging. This bulb is also widely used for operating 12-volt relays and as a filament supply for exciter lamps. The discharge medium is mercury-vapor and argon gas. This bulb should be operated in a vertical position.

GENERAL DESIGN

Number of electrodes		2
Cat. No. of Socket required, Mogul		GE-217967
Cathode—thoriated tungsten filament:		
Voltage		2.2 ± 5%
Current, amperes, approx.		17.5
Pre-heating time, typical seconds		0*
Tube voltage drop, volts d-c:	*Hot*	*Cold*
Maximum	9.5	10.5
Minimum	4.5	5.5
Average during life	6.0	7.0
Starting (pick-up) voltage, volts d-c:	*Hot*	*Cold*
Maximum	6.0	11.0
Minimum	2.0	2.5
Average during life	3.5	6.0
Net weight, ounces, approx.		4
Shipping weight, ounces, approx.		11
Length, inches, approx.		7
Diameter, inches, approx.		3

RATINGS

Maximum peak inverse voltage (half-wave circuit), volts	105
Maximum anode current:	
Average amperes	6.0
Instantaneous (peak) amperes, recurrent	36.0
Maximum d-c output, average volts	25.0
Maximum base temperature, degrees C.	160

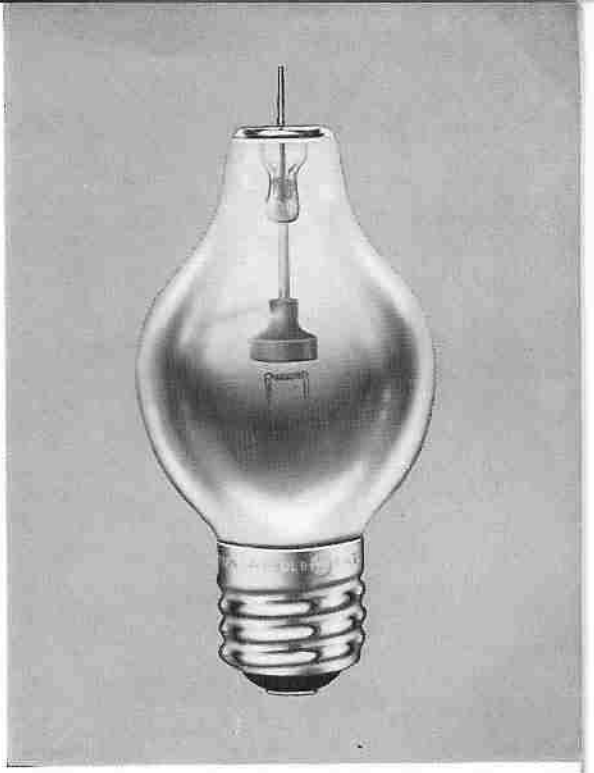
*Under normal ambient temperature conditions, this tube will deliver 80% of full output within three seconds after the simultaneous application of anode and filament voltages. Longer life may be obtained by applying the anode voltage one to three seconds later than the filament voltage.

G-E
TUNGAR BULB

Cat. No. 189048

(RMA Type 4B28)

Tungar bulb, Catalog 189048, is a half-wave rectifier for use in intermediate and low-voltage circuits, for example, the charging of 1 to 6 automobile storage batteries in series. The discharge medium for this bulb is argon gas which allows quick starting.



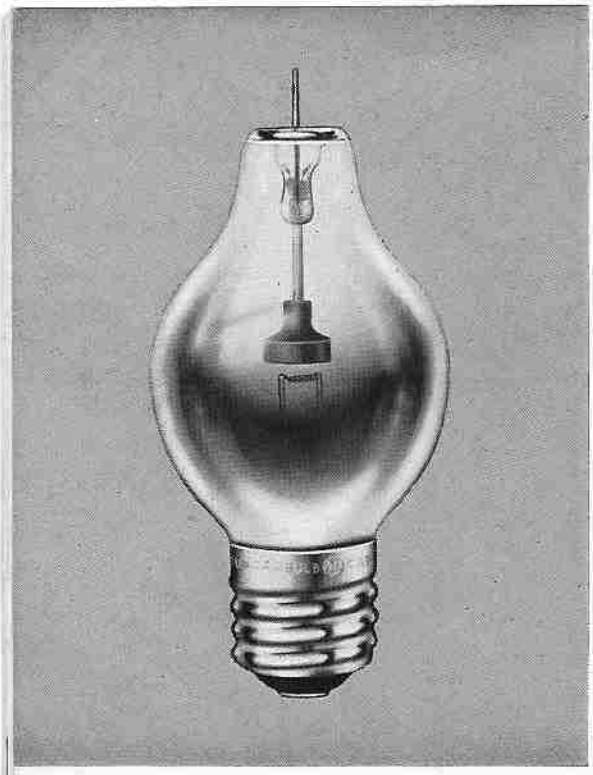
GENERAL DESIGN

Number of electrodes	2
Cat. No. of Socket required, Mogul	GE-217967
Cathode—thoriated tungsten filament:	
Voltage	2.2 ±5%
Current, amperes, approx	17
Pre-heating time, typical seconds	0*
Tube voltage drop, volts d-c:	
Maximum	10.0
Minimum	5.0
Average during life	7.0
Starting (pick-up) voltage, volts d-c:	
Maximum	15.0
Minimum	10.0
Average during life	12.0
Net weight, ounces, approx	4
Shipping weight, ounces, approx	11
Length, inches, approx	7
Diameter, inches, approx	3

RATINGS

Maximum peak inverse voltage (half-wave circuit), volts	300
Maximum anode current:	
Average amperes	6.0
Instantaneous (peak) amperes, recurrent	36.0
Maximum d-c output, average volts	60.0

*Under normal ambient temperature conditions, this tube will deliver 90% of full output within three seconds after the simultaneous application of anode and filament voltages. Longer life may be obtained by applying the anode voltage one to three seconds later than the filament voltage.



G-E
TUNGAR BULB

Cat. No. 189049
(RMA Type 4B26)

Tungar bulb, Catalog 189049, is a half-wave rectifier, similar to Catalog 189048, but suitable for higher-voltage applications, for example, the charging of 1 to 12 automobile storage batteries in series. The discharge medium is argon gas which allows quick starting.

GENERAL DESIGN

Number of electrodes	2
Cat. No. of Socket required, Mogul	GE217967
Cathode—thoriated tungsten filament:	
Voltage	2.2 ± 5%
Current, amperes, approx.	17
Pre-heating time, typical seconds	0*
Tube voltage drop, volts d-c:	
Maximum	11.0
Minimum	6.0
Average during life	7.5
Starting (pick-up) voltage, volts d-c:	
Maximum	16.0
Minimum	10.0
Average during life	12.0
Net weight, ounces, approx.	4
Shipping weight, ounces, approx.	11
Length, inches, approx.	7
Diameter, inches, approx.	3

RATINGS

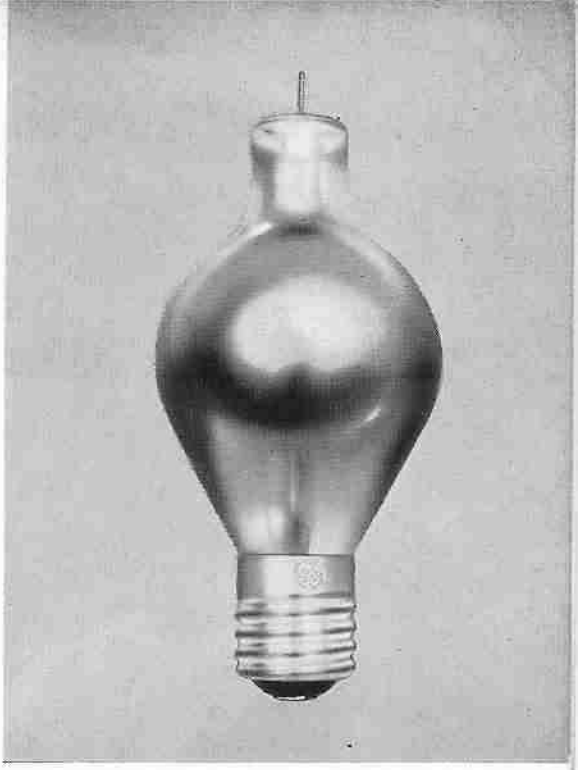
Maximum peak inverse voltage, volts:	
Half-wave circuit	375
Full-wave circuit	250
Maximum anode current:	
Average amperes	6.0
Instantaneous (peak) amperes, recurrent	36.0
Maximum d-c output, average volts	90

*Under normal ambient temperature conditions, this tube will deliver 90% of full output within three seconds after the simultaneous application of anode and filament voltages. Longer life may be obtained by applying the anode voltage one to three seconds later than the filament voltage.

G-E TUNGAR BULB

Cat. No. 217283

Tungar bulb, Catalog 217283, is a half-wave rectifier, suitable for intermediate-voltage application. This bulb is widely used to supply d-c power for the arc in motion picture projectors when two or more bulbs are used. The discharge medium is argon gas.



GENERAL DESIGN

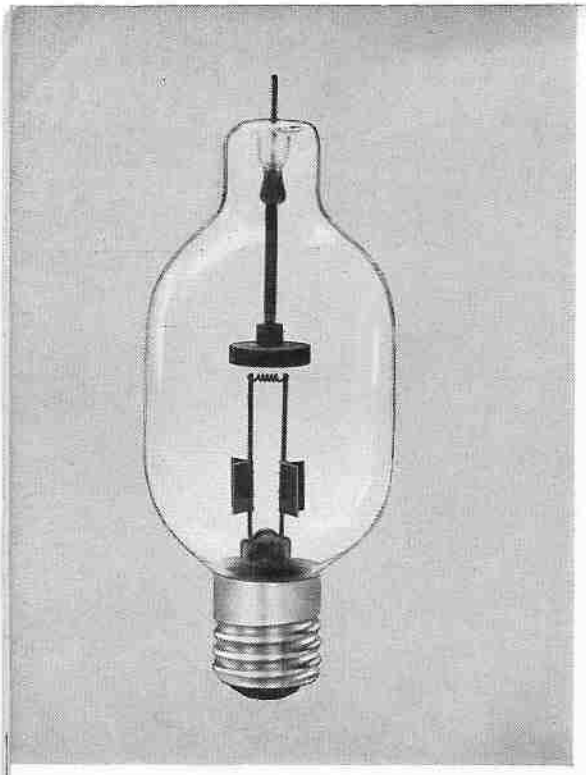
Number of electrodes	2
Cat. No. of Socket required, Mogul	GE-217967
Cathode—thoriated tungsten filament:	
Voltage	2.5 ±5%
Current, amperes, approx.	25
Pre-heating time recommended, seconds	15*
Tube voltage drop, volts d-c:	
Maximum	9.0
Minimum	5.0
Average during life	7.5
Starting (pick-up) voltage, volts d-c:	
Maximum	16.0
Minimum	8.0
Average during life	12.0
Net weight, ounces, approx.	5½
Shipping weight, ounces, approx.	27
Length, inches, approx.	8⅝
Diameter, inches, approx.	3¾

RATINGS

Maximum peak inverse voltage (half-wave circuit), volts	225
Maximum anode current:	
Average amperes	15.0
Instantaneous (peak) amperes, recurrent	90.0
Maximum d-c output, average volts	60.0

*For long tube life a pre-heating time of 15 seconds is recommended. Full output can be obtained as soon as power is applied to the anode after the pre-heating time. The recommended tube pre-heating time must be respected and filament excitation must be continuous if guarantees are to apply.

G-E Tungar bulbs operate with very low voltage drop.



G-E TUNGAR BULB

Cat. No. 76X13

Tungar bulb, Catalog 76X13, is a half-wave high-current rectifier, similar to 99X45, but designed for intermediate voltages. This bulb is extensively used in applications requiring high current. The discharge medium is mercury vapor and argon gas.

GENERAL DESIGN

Number of electrodes		2
Cat. No. of Socket required, Mogul		GE-217967
Cathode—thoriated tungsten filament:		
Voltage		2.6 ± 5%
Current, amperes, approx.		34
Pre-heating time recommended, seconds		180*
Tube voltage drop, volts d-c:	*Hot*	*Cold*
Maximum	11.0	15.0
Minimum	5.0	8.0
Average during life	6.5	12.0
Starting (pick-up) voltage, volts d-c:	*Hot*	*Cold*
Maximum	6.0	12.0
Minimum	2.0	5.0
Average during life	2.6	7.0
Net weight, ounces, approx.		6½
Shipping weight, ounces, approx.		27
Length, inches, approx.		9¼
Diameter, inches, approx.		3½

RATINGS

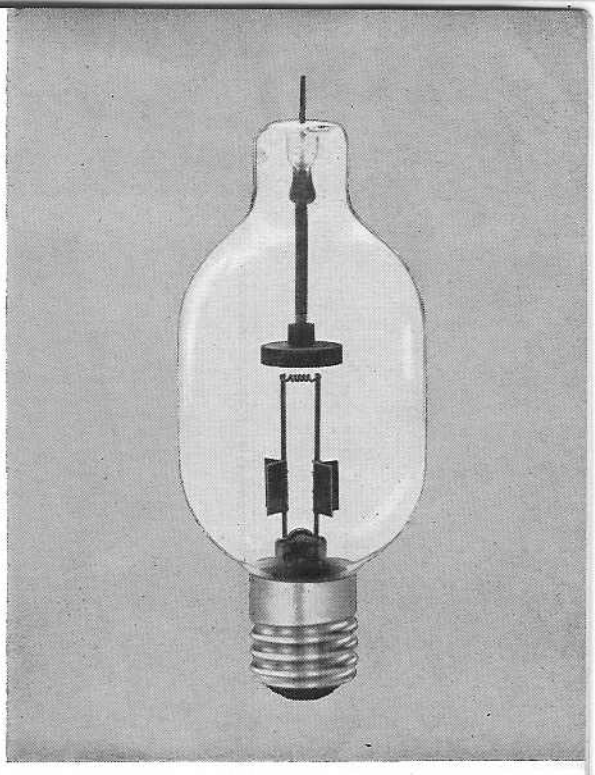
Maximum peak inverse voltage (half-wave circuit), volts	275
Maximum anode current:	
Average amperes	20
Instantaneous (peak) amperes, recurrent	120
Maximum d-c output, average volts	75
Maximum base temperature, degrees C.	160

*The recommended pre-heating time helps to assure long tube life. If guarantees are to apply the recommended pre-heating time must be respected. When first installed this tube should be operated 10 minutes with filament voltage only.

G-E TUNGAR BULB

CAT. NO. 99X45

Tungar bulb, Catalog 99X45, is a half-wave rectifier, designed for high current at low voltages. It is particularly well adapted for use in battery boosters where two bulbs will give a charging rate of 40 amperes. The discharge medium is mercury-vapor and argon gas.



GENERAL DESIGN

Number of electrodes		2
Cat. No. of Socket required, Mogul		GE-217967
Cathode—thoriated tungsten filament:		
Voltage		2.6 ± 5%
Current, amperes, approx		34
Pre-heating time recommended, seconds		15*
Tube voltage drop, volts d-c:	*Hot*	*Cold*
Maximum	9.0	10.0
Minimum	4.5	6.0
Average during life	7.5	8.5
Starting (pick-up) voltage, volts d-c:	*Hot*	*Cold*
Maximum	6.0	12.0
Minimum	2.5	3.0
Average during life	3.2	7.5
Net weight, ounces, approx.		6½
Shipping weight, ounces, approx.		27
Length, inches, approx.		9¼
Diameter, inches, approx.		3½

RATINGS

Maximum peak inverse voltage (half-wave circuit) volts	110
Maximum anode current:	
Average amperes	20
Instantaneous (peak) amperes, recurrent	120
Maximum d-c output, average volts	25
Maximum base temperature, degrees C.	160

*The recommended pre-heating time listed must be respected and filament excitation must be continuous if guarantees are to apply. When installed in a new location this tube should be operated for 10 minutes with filament voltage only.

G-E Tungar bulbs have welded base contacts.

G-E TUNGAR BULB FEATURES

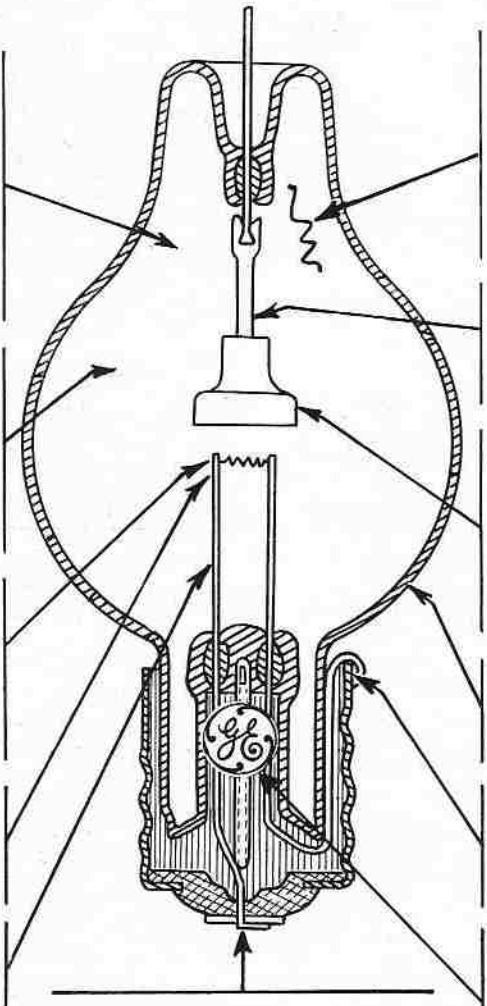
1. Pure Argon Gas—The gas with which Tungar bulbs are filled is over 99.5% pure when purchased. Even this purity cannot insure long life. It is further necessary to subject this argon gas to four different treatments to remove all impurities. The resulting high purity is one of the reasons for the long, efficient life of Tungar bulbs.

2. Gas Remains Pure—The silver-colored magnesium coating on the inside of all Tungar bulbs absorbs any traces of impurities that are given off during the operation of the bulb. This feature also helps to assure long, efficient operation.

3. Long Filament Life—The selected thoriated tungsten wire which forms the filament must pass rigid test specifications. After assembly, the filament is given a special treatment to further assure long, efficient operating life.

4. Strong Filament Construction—Welding the filament to the leads forms a complete union that will withstand high operating temperatures.

5. Rigid Tungsten Leads Are made by our own factory which pioneered the process of making tungsten wire.



12. Welded Base Contact—This provides a more durable and permanent connection than do soldered contacts.

6. Strong Heat-resistant Glass—Only heat-resisting glass is used in Tungar bulb construction. This glass and the tungsten expand and contract at the same rate, thus eliminating in Tungar bulbs the possibilities of breakage due to unequal expansion.

7. Special Threads on Anode and Anode Lead—A uniform low resistance contact is provided by special threads on the anode and anode lead.

8. High-quality Graphite Anode—The graphite used in the anode of Tungar bulbs is selected for its high quality. It is given special high temperature vacuum treatments to enable it to withstand bombardment and be gas-free throughout the life of the bulb.

9. Smooth Bulb Surface—The outside surface of all Tungar bulbs is smooth. Bulbs have no seal-off tip to become broken.

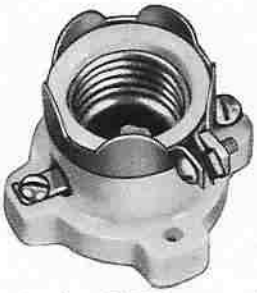
10. Special Basing Compound—The base is held permanently to the bulb by a special basing compound used exclusively by General Electric.

11. The G-E Monogram—Here is assurance that the high quality of Tungar bulbs will be continued and improved as new materials and processes are developed.

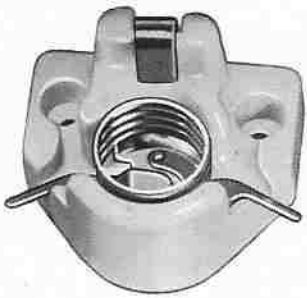
The raw materials used in Tungar bulbs are the finest obtainable and are rigidly laboratory tested before being used. This plus the fact that General Electric has had more than 28 years of bulb engineering and manufacturing experience helps to explain why the Tungar bulbs are superior.

TUNGAR BULB SOCKETS

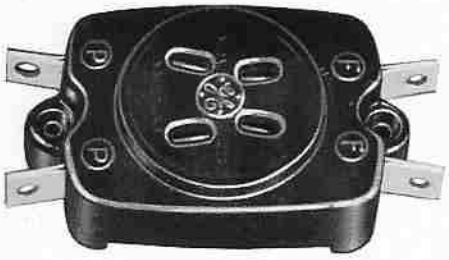
Standard Edison



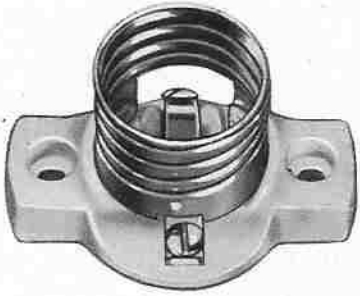
Catalog GE-K-3778926



Catalog GE-278768



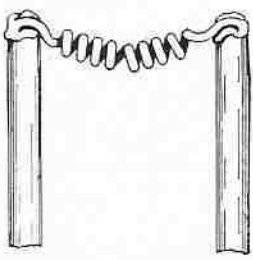
Catalog GE-5556072G1



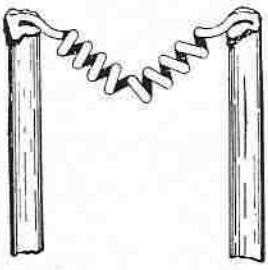
Catalog GE-217967

The correct socket to be used with each type of Tungar bulb is listed on preceding data pages.

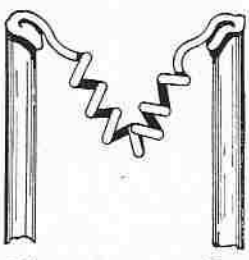
TUNGAR BULB FILAMENTS



Filament sag after 1500 to 2000 hours



Filament sag after 3000 to 4000 hours



Filament sag after 5000 or more hours

The approximate life of a Tungsten filament type Tungar bulb is indicated by filament sag. When such a bulb is overloaded or operated at higher than its rated output, the filament life is shortened considerably.

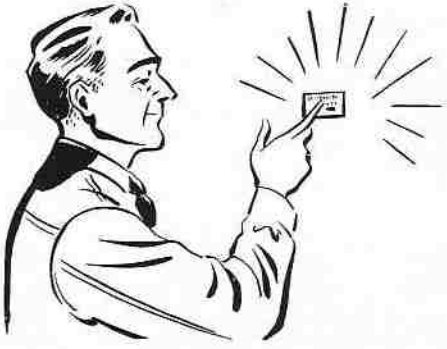
TUNGAR BULB HELPFUL HINTS

A few minutes' attention periodically will help to keep Tungar bulbs operating properly. No technical knowledge is required to make these four important checks.

Check the socket to make certain that it is clean and not corroded or pitted. If cleaning is necessary to get a good contact, use sandpaper to remove the corrosion.

Keep the bulb tightly screwed in the socket. Check frequently to make certain that the bulb has not come loose.

Check the anode clip and connection to make certain of a good contact. If the clip connector has lost its tension, replace it immediately.



Before installing in a new location, check the power input to the rectifier to be sure the a-c supply voltage corresponds to the rating of the transformer.

THE SECRET OF SERVICE IS CARE

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