PHANOTRONS
HALF WAVE MERCURY VAPOR RECTIFIER TUBES
KI-626
WL-866
WL-866A
WL-869A
WL-871
WL-872
WL-872A

WESTINGHOUSE LAMP DIVISION

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

SPECIAL PRODUCTS SALES DEPARTMENT
BLOOMFIELD, N. J.

DISTRICT OFFICES

426 MARIETTA STREET  ATLANTA, GA.
20 NORTH WACKER DRIVE  CHICAGO, ILL.
411 NORTH 7TH. STREET  ST. LOUIS, MO.
150 BROADWAY  NEW YORK, N.Y.
1735 GULF BUILDING  PITTSBURGH, PA.
1 MONTGOMERY STREET  SAN FRANCISCO, CAL.

DECEMBER 21 1936  BULLETIN TD-54
### CHARACTERISTICS AND RATINGS

<table>
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<tr>
<th>Tube Type</th>
<th>KI-626</th>
<th>WL-666</th>
<th>WL-659A</th>
<th>WL-659A</th>
<th>WL-671</th>
<th>WL-672</th>
<th>WL-672A</th>
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<tr>
<td>10000 (Ambient Temperature)</td>
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<td>1.0*</td>
<td>1.0*</td>
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<td>15.</td>
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<td>2-7/16</td>
<td>2-7/16</td>
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<td>2-7/16</td>
<td>2-7/16</td>
<td>2-7/16</td>
</tr>
</tbody>
</table>
| **A 15-minute pre-heating time is always required if the tube is used in the region of 0-150°F.**

In none of these tube types is the base shell connected to a filament lead within the base.

Additional data and information on these and other Westinghouse electronic tubes may be obtained by request to the Westinghouse Lamp Division, Westinghouse Electric & Manufacturing Company, Special Products Sales Department, Bloomfield, New Jersey.

### GENERAL INFORMATION

The Westinghouse hot-cathode mercury-vapor rectifier tubes, KI-626, WL-666, WL-659A, WL-671, WL-672A and WL-659A, are designed for use in suitable rectifying devices to supply d.c. power from a.c. supply lines. Full wave rectification is accomplished by using two or more of these tubes in suitable rectifier circuits. The directly heated cathodes are made in the form of ribbon filaments of the coated types.

The types KI-626, WL-671, WL-666 and WL-672 are most suitable for use in telegraph or other similar applications where they are not in the proximity of radio-frequency fields, or in locations subject to effects which would interfere with their normal operation. The tube types WL-659A, WL-672A.

<table>
<thead>
<tr>
<th>Type of Tube</th>
<th>Net Wt.</th>
<th>Gross Wt., Øz.</th>
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<tbody>
<tr>
<td>KI-626</td>
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<td>12</td>
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<tr>
<td>WL-659A</td>
<td>0.12</td>
<td>12</td>
</tr>
<tr>
<td>WL-666</td>
<td>0.12</td>
<td>12</td>
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<tr>
<td>WL-659A</td>
<td>0.12</td>
<td>12</td>
</tr>
<tr>
<td>WL-671</td>
<td>0.12</td>
<td>12</td>
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<td>WL-672A</td>
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<tr>
<td>WL-659A</td>
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<tr>
<td>WL-672A</td>
<td>0.12</td>
<td>12</td>
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</tbody>
</table>
INSTALLATION

The Westinghouse hot-cathode mercury-vapor rectifier tubes are designed to fit standard sockets and mounting equipments which have been especially designed for the various types. Suitable mountings for these types of tubes are tabulated below:

<table>
<thead>
<tr>
<th>Type of Tube</th>
<th>Filament or Plate Contact</th>
<th>Cathode Mounting</th>
<th>Anode Contact</th>
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<td>KI-626</td>
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<td>UX Socket</td>
<td>S#82933</td>
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<td>WL-571</td>
<td>S#64394</td>
<td>UX Socket</td>
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<td>WL-566A</td>
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<td>S#64394</td>
</tr>
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<td>UX Socket</td>
<td>S#64394</td>
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<td>WL-572A</td>
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<td>S#531780</td>
<td>UX Socket</td>
<td>S#761288</td>
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<td>WL-566A</td>
<td>S#531780</td>
<td>UX Socket</td>
<td>S#761288</td>
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</tbody>
</table>

All connections in the socket and filament circuit should be of low resistance and of adequate current carrying capacity. The mountings should be located so as to hold the tube in a vertical position with the filament end down. There should be no excess of vibration, and the tube should be handled carefully when placed into its socket. The bulb becomes very hot during operation, and free circulation of air should be provided. Anywhere that hot objects or drops of liquid should be prevented from coming in contact with the bulb.

When first received, the new hot-cathode mercury-vapor rectifier tube should be tested in the equipment in which it will later be used, and the procedure which is described below should be followed each time the tube is turned upside down or whenever mercury has come in contact with either the filament or plate electrodes. A deposit of mercury on the filament or plate reduces the arc-back voltage considerably, and a proper treatment schedule should be carried out to prevent permanently ruining the tube. After the mercury has been redeposited by this pre-treatment process, the tube should be mounted in a socket or other equipment so that the tube is held in its operating position with the filament end down. Care should be taken not to lay the tube on its side even while changing tubes in the rectifier unit. If a new tube is found to be in a broken or inoperative condition, a new tube should immediately be filled and filled with the transportation company.

As a class, these tubes are designed to operate within the specified ambient temperature and condenser mercury temperature ranges corresponding with the maximum plate potential ratings. Operation at ambient temperatures below the recommended limit may have a considerable adverse effect on tube life.

The ambient temperature is the temperature of the air which encompasses the bulb. This temperature should be measured by means of several thermometers placed at different points around and opposite the filament base at a distance of a few inches. If the tube is used in a location where the circulation of air is restricted, the temperature should be taken adjacent to the filament base and with the thermometer embedded in the cooling air stream before the air reaches the tube. Forced ventilation may be used if necessary from the standpoint of tube safety and life.

In service, the bulb will eventually darken, which effect represents a normal condition. The mercury-vapor produces a characteristic glow when operated under load. External shields or radio-frequency filters should be provided wherever the tube may be subjected to extraneous high voltage or high frequency fields when used. Such fields may produce a continuous glow inside the tube and thus tend to produce breakdown effects in the mercury vapor which will adversely affect the tube performance. Radio frequency filters will tend to prevent damage from radio frequency current which might otherwise be fed back into the rectifier tube.

The transformer secondary winding should be provided with a provisory relay, tap or center tap resistor, and should supply the particular filament potential at each individual socket under operating conditions. As measured at the tube terminals, the filament voltage should not fluctuate more than plus or minus 5% from the rated value. This variation should include the effects of plate power and other operating conditions when measured at the filament properly calibrated should be provided and installed so that the rated filament potential can be maintained. The filament circuit is at high potential, and precaution should be observed when the filament potential is checked by means of a voltmeter connected directly to the filament terminals.

The plate supply of the circuit should be provided with a time delay relay having an obtainable delay of a few seconds. This delay will allow the filaments to come up to normal temperature before plate potential is applied. Since various installations will have filament supply transformers of widely different characteristics, it is recommended that the relays be adjusted to give the maximum permissible delay. The necessary delay period will vary with the particular type of tube, but in any case, the filament must reach the normal operating temperature before plate voltage is applied.

If it should become necessary to decrease the filament heating time, the following procedure is recommended: in testing for the proper time delay, the tests should be made in the actual circuit under consideration if possible, and if not, the characteristics of the filament circuit should be duplicated. Approximately 115 volts d.c. should be applied to the plate of one tube through a resistance of sufficient value to limit the current through the tube to 20% of its rated average value. A voltmeter should be placed between the plate and filament electrodes.

The filament supply voltage should be the maximum encountered in service, and the filament rheostat should be set for rated voltage. With the d.c. plate voltage on, the filament supply voltage should be closed with the tube cold and the time necessary to bring the d.c. plate voltage reaches a constant value. The decrease in this voltage will be very rapid until this value is reached. The time noted should be increased by 50%, which will give the shortest allowable delay period for the particular installation tested. The filament and plate voltages may be applied simultaneously when the KI-626, WL-566A and WL-566A types are used at peak inverse potentials not exceeding 2200 volts.
In the case of type WL-859A, an arc-drop indicator, which in a series relay is recommended for use with each tube in the rectifier, and should be connected in series with the anode. In all cases, regardless of the size to which the tubes are put, a careful handling and conservative operation will be amply rescind by the longer and more uniform tube life which will be obtained.

**OPERATION**

When a new tube, or one in which the mercury has come in contact with the filament or anode, is first placed in operation, the filament only should be operated for 15 minutes. The plate voltage should be reduced so that the tube is not above 20% of the full ratings, and the circuit should be closed. After the rectifier has been operated for a period of 5 minutes, the plate potential should be gradually increased so that it may reach stable operating conditions. Normal load conditions are reached in 15 minutes.

If it is not possible in a particular installation to reduce the peak inverse voltage to 20% of the normal value, practically the same effect can be obtained by applying the lowest available plate voltage for periods of time. For example, apply plate voltage for one second and remove for five seconds. Continue the above procedure with correspondingly longer period until satisfactory operation is obtained at normal reverse voltage. Operation should be continued for 15 minutes during normal conditions. If there is any evidence of sparking in the tube, the time for reaching full voltage should be increased so that the tube can reach stable operating conditions without causing injury to itself. In some cases where a tube is being operated improperly and shows a tendency to flash occasionally, this characteristic can be overcome by following the above procedure.

The filament of these tubes should always be operated at rated voltage. Less than this voltage may result in a high tube drop with consequent bombardment of the cathode and eventual loss of emission. Greater than rated voltage will shorten the life of the filament. If standby operation of the equipment without plate voltage is desired, a normal filament voltage should be maintained. Also, if the time of intervals are less than two hours, the filament voltage should be left on for at least 15 minutes to prevent drop in the tube is approximately constant within the rated current range of the tube.

**Maximum peak inverse voltage** is the highest peak voltage that a rectifier tube can safely stand in the direction opposite to that in which it is designed to pass current. In many cases, this is the safe arc-drop limit with the tube operating within the specified temperature range. The relations between the peak inverse voltage, the d.c. voltage, and the rms value of a.c. voltage depend largely upon the individual characteristics of the rectifier circuit and the power supply. The presence of line surge, keying, siphon, or any other transient or wave form distortion may raise the actual peak voltage to a value which is higher than that calculated from the sine wave voltages in the transformer. It should, therefore, be emphasized that the maximum rating of the tube refers to the actual inverse voltage and not to the calculated value. A cathode ray oscillograph or a spark gap connected across the tube is useful in determining the actual peak inverse voltage.

**Maximum instantaneous or crest plate current** is the highest peak of instantaneous current that a rectifier or other device can be safely called or designed to pass during the time in which it is designed to pass current. If a large condenser is used in the filter circuit next to the rectifier tube, the peak current is often as much as four times the load or average current. In order to determine accurately the instantaneous current in any circuit, the best procedure usually is to use an oscillograph.

**Maximum average or d.c. plate current** is the average output current that can be safely supplied by the tube in the operating direction. This value is dependent upon the average output current that can be obtained from the use of these circuits is also tabulated for the various tubes. These formulas which permit calculating the load current waveform, as well as the shape of the current taken from the tube in the accompanying circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits.

Several circuits particularly suited for use with these tubes are schematically given in the accompanying circuit diagrams. A summary of the approximate conditions and typical results which will usually be obtained from the use of these circuits is also tabulated for the various tubes. This summary shows the main characteristics of the load current waveform, as well as the shape of the current taken from the individual tubes in the accompanying circuits. Formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits. These formulas which permit calculating the load and tube current values for these various circuits are also given for the appropriate circuits.
<table>
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<th>Tube Type</th>
<th>Circuit</th>
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<td>2650 per tube</td>
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<td>2.50</td>
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<td>Three Phase Half Wave</td>
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<td>5300 total</td>
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<td>6</td>
<td>4080</td>
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Definition of terms:

Load  Tube  Transformer

\[ E_{av} \quad I_{max} \quad E_{rms} \quad I_{av} \quad E_{inv} \quad E_{max} \]

\[ E_{av} = \frac{1}{2} E_{max} \quad I_{max} = \frac{1}{2} I_{rms} \quad E_{inv} = -rac{1}{2} E_{av} \quad I_{av} = -rac{1}{2} I_{max} \]

Fig. 1-13 - A two-tube, single-phase, full-wave rectifier

Fig. 1-14 - A four-tube, single-phase, full-wave rectifier

Fig. 1-15 - A three-tube, three-phase, half-wave rectifier

Fig. 1-16 - A six-tube, three-phase, half-wave rectifier, double Y connection

Fig. 1-17 - A six-tube, three-phase, full-wave rectifier