HYTRONIC LABORATORIES

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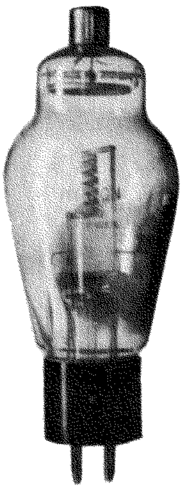
Engineering Bulletin

866 - 1

Type 866



GENERAL CHARACTERISTICS

Filament Voltage (A.C.)	2.5	volts
Filament Current	5.0	amp.
Max. RMS A.C. Volts	2650	volts
Peak Inverse Voltage*	7500 max.	volts
Peak Plate Current	.500 max.	amp.
Average Plate Current	.250 max.	amp.
Tube Voltage Drop*	15	volts
Bulb	ST-19	
Cap	Medium metal	
Base	Med. 4-pin Bayonet	

HALF-WAVE MERCURY VAPOR RECTIFIER

Hytron 866 is a half-wave, mercury-vapor rectifier tube of the hot-cathode type. It is intended for use in high-voltage rectifying devices designed to supply d-c power of uniform voltage. In single-phase circuits, full-wave rectification is accomplished by using two 866's.

INSTALLATION

The base pins of the 866 fit the standard four-contact socket which should be installed to hold the tube in a vertical position with the base down. Only a socket making very good filament contact and capable of carrying 5 amperes continuously should be used with the 866.

The condensed-mercury temperature of the 866 should be maintained between 10°C (50°F.) and 60°C (140°F.). This temperature may be measured with a small thermometer contacting the bulb with a minimum amount of putty at a point near the base end of the bulb. Low condensed-mercury temperature produces conditions which make starting with rated peak plate current difficult. High condensed-mercury temperature decreases the arc drop and is favorable for long filament life, but reduces the maximum value of peak inverse voltage which the tube will stand.

* Approximate for supply frequency up to 150 cycles and for condensed-mercury temperature range of 10° to 60°C.

The coated filament is intended for a-c operation from a secondary winding of a power transformer. This filament source, provided with a center-tap in the transformer secondary or suitable center-tap resistor, should supply at the socket terminals the rated voltage of 2.5 volts under all operating conditions. The filament voltage, measured at the tube terminals, should not vary more than plus or minus 5% from the rated value. This tolerance should include the effects of regulation caused by transmitter-modulation load as well as the normal power-supply regulation. Less than the recommended filament voltage may cause a high voltage drop with consequent bombardment of the filament and eventual loss of emission. Higher than the rated voltage will greatly shorten the life of the filament.

The filament of the 866 should be allowed to come up to operating temperature before the plate voltage is applied. The temperature of the air surrounding the tube will vary the delay period required for preheating the filament. For average conditions, the delay should be approximately 30 seconds. If there is evidence of arc-back in the tube, the time delay should be increased. In radio transmitters during "standby" period, the filament should be kept at its rated voltage to avoid delay in "coming back". A protective relay having an obtainable delay period of one minute is desirable in the plate circuit to prevent automatically the application of plate voltage until the filament has reached operating temperature.

When a Hytron 866 is first placed in service, its filament should be operated at normal voltage for approximately 15 minutes without plate voltage in order to distribute the mercury properly. This procedure need not be repeated unless, during subsequent handling, the mercury is spattered on the filament and plate.

Shields and R.F. filters should be provided for the 866 if it is subjected to extraneous high-voltage and high-frequency fields when in operation. These fields tend to produce breakdown effects in mercury vapor and are detrimental to tube life and performance. External shielding is employed when the tube is in proximity to high-voltage field. R.F. filters are employed to prevent damage caused by radio-frequency currents which might otherwise be fed back into the rectifier tubes.

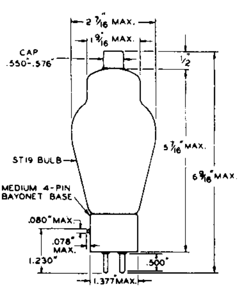
OPERATION

As a single-phase or multi-phase rectifier, Hytron 866 should be operated under conditions such that the maximum rated values under characteristics are not exceeded. Maximum Peak Inverse Voltage and Maximum Plate Current are the fundamental limitations in the operation of this tube.

Two or more 866's may be connected in parallel to give a corresponding increase in output current over a single tube. In this service a stabilizing resistor of approximately 50 ohms should be connected in series with each plate in order that a proportionate share of the total load current will be carried by each tube. In special cases where it is desirable to minimize the small power loss caused by the voltage drop through the stabilizing resistor, an inductance of approximately one-third henry may be connected in series with the plate lead of each tube in place of the stabilizing resistor. The inductance has the added advantage of limiting the peak current to each tube, is especially desirable when a condenser-input type of filter is used.

Filter circuits of either the condenser-input or the choke-input type may be employed. If the condenser-input type of filter is used, special consideration must be given to the instantaneous peak value of the a-c input voltage which is about 1.4 times the RMS value as measured with an a-c voltmeter. It is important, therefore, that the filter condensers (especially the input condenser) have a sufficiently high breakdown rating to withstand this instantaneous peak value. With the condenser-input type of filter, the peak plate current of the tube is considerably higher than the load current. When choke input to the filter is used, the peak plate current is substantially reduced. This type of circuit is preferable from the standpoint of obtaining the maximum continuous d.c. output current from the 866 under the most favorable conditions.

Table 1 gives definite values of choke inductance (L) and condenser capacity (C) for choke-input-to-filter circuits which will keep the peak plate current below the recommended maximum, provided the average d.c. load current for any installation does not exceed the maximum load current figures given in the table. Values of (L) and (C) are based on a 60-cycle a.c. voltage supply. It is important that a good quality input choke be used so that its inductance will not drop below the required minimum value under full load-current conditions. The capacitance (C) given in the table is small enough to prevent excessive surges when power is first applied to the circuit and yet is large enough to give adequate filtering. If the inductance (L) is increased, it is permissible to increase the capacitance in the same proportion. In a two-section filter with two inductances of unequal value, the larger inductance should be placed next to the rectifier tubes. With such an arrangement, the maximum value of each capacitance should be determined on the basis of the value of the inductance preceding it. The first three circuits (figs. 1, 2 and 3) of Table 1 will have a ripple voltage of less than 5% when used with a two-section filter having a minimum of inductance and the corresponding maximum of capacitance. For most purposes, this is adequate filtering. Similarly, the next two circuits (figs. 4 and 5) will give a ripple voltage of less than 1%. The last set of conditions in the table applied to a single-phase, full-wave system using two tubes with condenser input to the filter. It will be noted that the maximum d.c. output voltage available at the filter is 25% higher than for the choke-input system (fig. 1), but the permissible d.c. load current is 50% less. Similarly, these same percentages will hold for the single-phase, full-wave system using four tubes. (fig. 2). For any of these circuits, better filtering may be obtained with inductance larger than the minimum given in the table. With the use of larger inductances, the corresponding capacitances may be increased by the same per cent as the inductances to give still better smoothing. The use of additional sections in the filter, of course, is another way of obtaining greater smoothing.



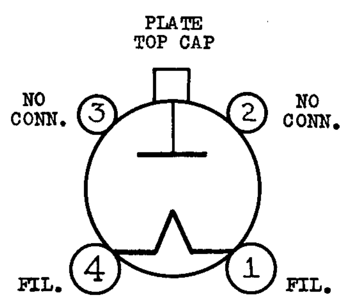


TABLE I

CIRCUIT	A-C INPUT VOLTS (RMS)	MAX. D-C OUTPUT VOLTS TO FILTER	CHOKE INPUT ONE-SECTION FILTER		MAX. D-C LOAD CURRENT AMPERES
			MIN. CHOKE (L) HENRYS	MAX. CONDENSER (C) uf	
SINGLE-PHASE FULL-WAVE (2-tubes)	2650 max. per tube	2385	6.0	1.6	0.5
	2000 per tube	1800	4.9	1.8	0.5
	1500 per tube	1350	3.3	2.8	0.5
	1000 per tube	900	2.1	4.2	0.5
SINGLE-PHASE FULL-WAVE (4-tubes) Bridge Rect.	5300 max. total	4770	12.0	0.8	0.5
	4500 total	4050	10.0	1.0	0.5
	4000 total	3600	8.4	1.2	0.5
	3000 total	2700	6.8	1.5	0.5
THREE-PHASE HALF-WAVE (3-tubes)	3065 max. per leg	3585	2.2	1.8	0.75
	2500 per leg	2925	1.7	2.4	0.75
	2000 per leg	2340	1.0	3.0	0.75
	1500 per leg	1755	0.8	4.0	0.75
THREE-PHASE PARALLEL DOUBLE-Y (6-tubes)	3065 max. per leg	3585	1.5	0.7	1.5
	2500 per leg	2925	1.0	0.9	1.5
	2000 per leg	2340	1.0	1.1	1.5
	1500 per leg	1750	0.7	1.5	1.5
THREE-PHASE FULL-WAVE (6-tubes) Bridge Rect.	3065 max. per leg	7175	1.5	0.84	0.75
	2500 per leg	5850	1.2	0.9	0.75
	2000 per leg	4680	1.0	1.0	0.75
	1500 per leg	3510	0.8	1.3	0.75
SINGLE-PHASE FULL-WAVE (2-tubes) Cond. Input	2650 max. per tube	3000	-	-	0.25
	2000 per tube	2260	-	-	0.25
	1500 per tube	1700	-	-	0.25
	1000 per tube	1150	-	-	0.25

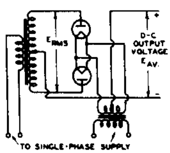


FIG. 1

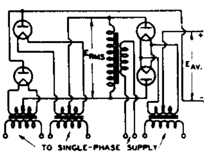


FIG. 2

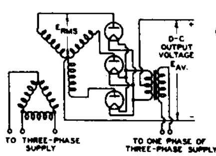


FIG. 3

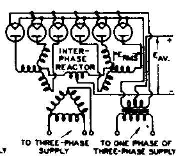


FIG. 4

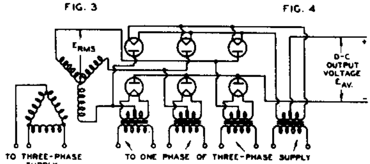


FIG. 5

FIGURE	CIRCUIT	$E_{AVERAGE}$	$E_{INVERSE}$	$I_{AVERAGE}$
1	SINGLE-PHASE FULL-WAVE (2 TUBES)	$0.318\ E_{MAXIMUM}$ $0.450\ E_{RMS}$	$3.14\ E_{AVERAGE}$	$0.636\ I_{MAXIMUM}$
2	SINGLE-PHASE FULL-WAVE (4 TUBES)	$0.636\ E_{MAXIMUM}$ $0.900\ E_{RMS}$	$1.57\ E_{AVERAGE}$	$0.636\ I_{MAXIMUM}$
3	THREE-PHASE HALF-WAVE	$0.827\ E_{MAXIMUM}$ $1.170\ E_{RMS}$	$2.09\ E_{AVERAGE}$	$0.827\ I_{MAXIMUM}$
4	THREE-PHASE DOUBLE-Y PARALLEL	$0.827\ E_{MAXIMUM}$ $1.170\ E_{RMS}$	$2.09\ E_{AVERAGE}$	$1.91\ I_{MAXIMUM}$
5	THREE-PHASE FULL-WAVE	$1.65\ E_{MAXIMUM}$ $2.34\ E_{RMS}$	$1.045\ E_{AVERAGE}$	$0.955\ I_{MAXIMUM}$

CONDITIONS ASSUMED :-
(1) SINE-WAVE SUPPLY (2) BALANCED PHASE VOLTAGES (3) ZERO TUBE DROP (4) PURE RESISTANCE LOAD (5) NO FILTER USED

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