



Travelling-Wave Amplifier

Code: W7/2D (CV2188)

The W7/2D is a travelling-wave amplifier for use in the frequency range 3 600 to 4 200 Mc/s. It has a bandwidth of the order of 1 000 Mc/s which makes possible the amplification of signals of large bandwidth and operation over a wide frequency range without retuning.

ELECTRICAL DATA

Cathode

Indirectly-heated, oxide-coated

| | | |
|--------------------------|-----|-----|
| Heater voltage | 6.3 | V |
| Nominal current | 1.0 | A |
| Minimum pre-heating time | 120 | sec |

Characteristics

| | | | |
|---|---|-------------|------|
| *Amplification | { at Collector current 14 mA } { and Helix voltage† 3 kV } | 20 | db |
| Amplification, at one watt output | | 18 | db |
| Maximum output (at Collector current 14 mA) | | 2.5 | W |
| Bandwidth between 3 db gain points, greater than | | 1 000 | Mc/s |
| Operating frequency range | | 3 600–4 200 | Mc/s |
| Cold transmission loss | | 40 | db |

* The figure quoted for amplification is that obtained at small signal levels. At maximum output it is approximately 4 db lower. See Figure 2.

† The helix voltage should be set within ± 20 volts of the optimum value for the valve. See Figure 5.



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MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

S.H.F. Amplifier at 3 900 Mc/s

Maximum Ratings

| | | |
|---|-----|---------|
| Maximum direct second anode and helix voltage | 3.2 | kV |
| Maximum direct second anode and helix current | 4.0 | mA |
| Maximum direct first anode voltage | 2.0 | kV |
| Maximum direct first anode current | 500 | μ A |
| Maximum direct collector voltage | 3.5 | kV |
| Maximum direct cathode current | 18 | mA |

*Typical Operating Conditions

| | | |
|--|----------|---------|
| † Direct second anode and helix voltage, nominal | 3.0 | kV |
| ‡ Direct collector voltage, nominal | 3.05 | kV |
| § Direct collector current, adjusted by V_{a1} | 14 | mA |
| Direct first anode voltage, V_{a1} | 1.3 | kV |
| Direct first anode current | 20 | μ A |
| Direct cathode current | 15 | mA |
| Amplification (low level) | 20 | db |
| Maximum power output (approx.) | 2.5 | W |
| Input and output voltage standing wave ratio, 3 600 to 4 200 Mc/s, less than | 2.5 to 1 | |

* These figures are obtained when using the recommended circuit.

† Adjusted to give optimum gain. The appropriate helix voltage for individual valves lies between 2.8 and 3.2 kV. See Figure 5.

‡ The collector is operated at 50 volts positive with respect to the helix.

§ Recommended value. The required first anode voltage will be between 800 and 1 600 volts initially, rising to 2 000 volts towards the end of tube life.

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OPERATIONAL DATA

General

The tube fits into the approved circuit and is held rigidly by an alignment ring around the base and by the radiator mounting. Optimum adjustment of focussing, to allow for variations from tube to tube and in circuit manufacture, is achieved by the use of deflector coils around the gun, each requiring about 20 mA current. See Figure 6 for a sketch of the circuit, showing the deflector coils.

The electron beam, which is directed through the helix to the collector electrode, has available sufficient power to cause damage to the helix and other internal parts if the beam should be out of alignment. It is desirable to make the initial alignment, by means of the deflector coil currents, with a beam current of a few milliamperes, using a low first anode voltage and preferably a reduced helix voltage of about 2 000 volts, the collector electrode being maintained at 50 volts positive with respect to the helix. The alignment will require some readjustment when the helix voltage and beam current are raised to their full values. At no time must the second anode and helix current exceed 3.5 mA.

It is recommended that the tube be operated with the helix or collector earthed and the cathode at a negative potential with respect to earth.

To obtain optimum performance, the tube should be operated at the rated collector current of 14 mA. The helix current will be between 0.5 and 2.0 mA and the first anode voltage between 800 and 1 600 volts initially, rising to 2 000 volts towards the end of the life of the tube. Since the first anode current is less than 500 μ A, the anode voltage may be obtained from a potentiometer across the helix supply or alternatively the circuit shown in Figure 7, which stabilises the cathode current by automatically adjusting the anode voltage, may be used.

Under no conditions should the collector electrode be operated at a lower potential than the helix as this may give rise to spurious oscillation and excessive interception current.



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Amplification

The helix voltage must be adjusted to give maximum gain. At the optimum helix voltage, and with a collector current of 14 mA, the average low level gain is 20 db.

Figure 2 shows the variation of low level gain which may be expected over the frequency range when operated in the approved circuit with no adjustments.

Figure 5 is a graph of the low level gain as a function of helix voltage. From this it will be seen that in order to maintain the gain within 1 db of maximum, the helix voltage must be within ± 50 volts of the optimum value.

Power Output

The input power required for maximum power output is 75 mW. The variation of power output with signal power input is shown in Figure 3.

Although increased power output may be obtained by operating the helix above the optimum voltage, this is not recommended because of the lower gain. Graphs showing power output as a function of frequency and helix voltage are given in Figures 1 and 4 respectively.

Matching

The backing piston in the waveguide may be tuned to give a voltage standing-wave ratio of less than 2.5 : 1 over a 1 000 Mc/s band in wide band amplifier applications.

Where a better match over a narrow band at a particular frequency is required, the piston position should be fixed and a tuning device used, details of which are available.

Circuit

A sketch of the recommended circuit, showing the principal external dimensions, is given in Figure 6.

The focus coils require an energising current of 250 mA and, when temperature equilibrium has been reached, the circuit power input is 50 watts. This does not take into account the power needed to energise the deflector coils. These have a resistance of 45 ohms each pair and provision should be made for passing 40 mA through each pair in either direction.

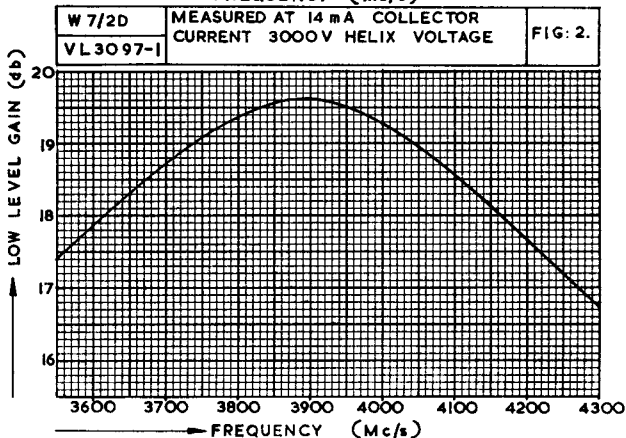
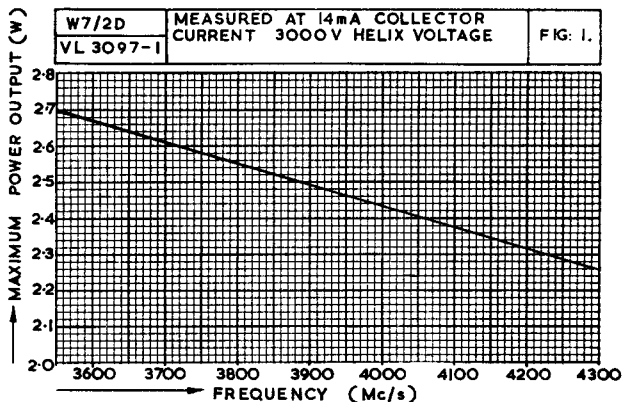
The waveguide size used with the recommended circuit is 2 in by 0.667 in internal, giving a ratio of major-to-minor dimension of 3 to 1.

Detailed information concerning the circuit and focus coil assembly is available on request.

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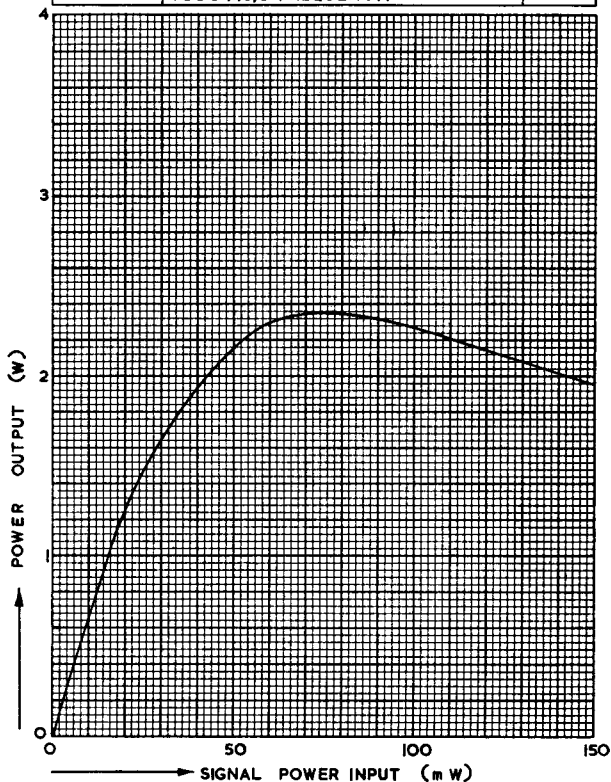




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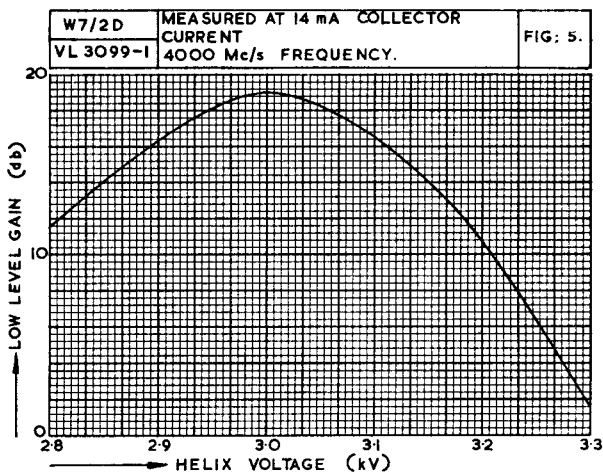
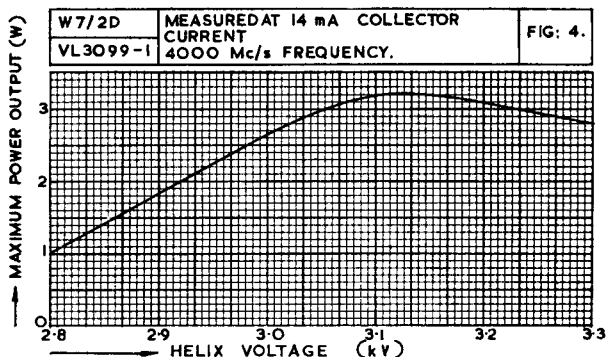
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| | | |
|----------|---|---------|
| W7/2D | MEASURED AT 14 mA COLLECTOR CURRENT 3000 V HELIX VOLTAGE | FIG: 3. |
| VL3098-1 | 4000 Mc/s FREQUENCY. | |



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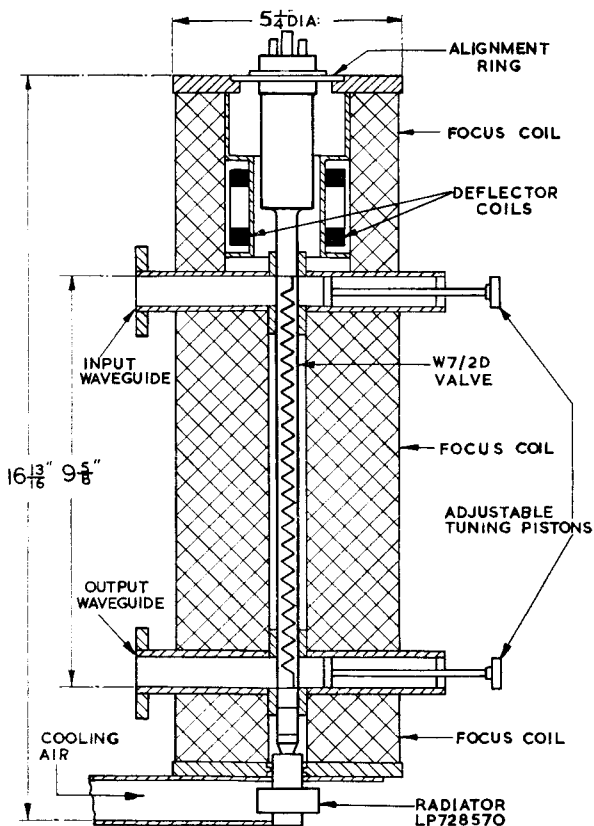




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FIG. 6



Travelling-Wave Amplifier



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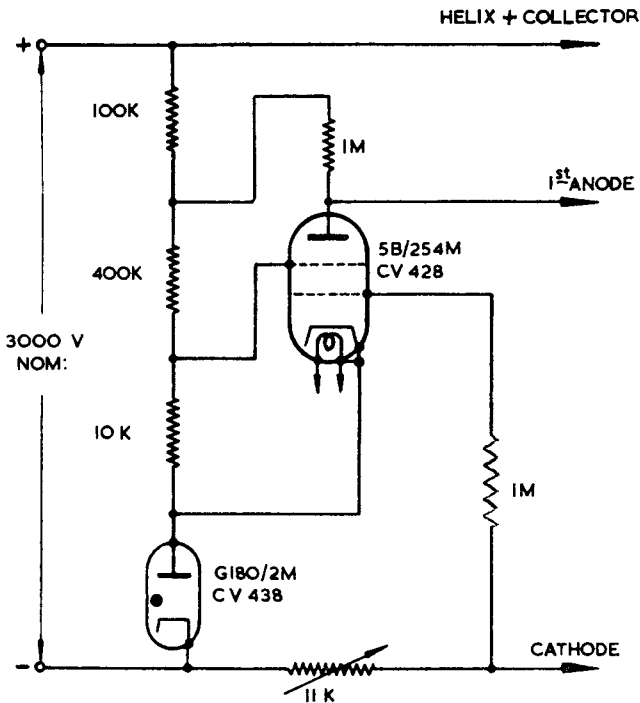
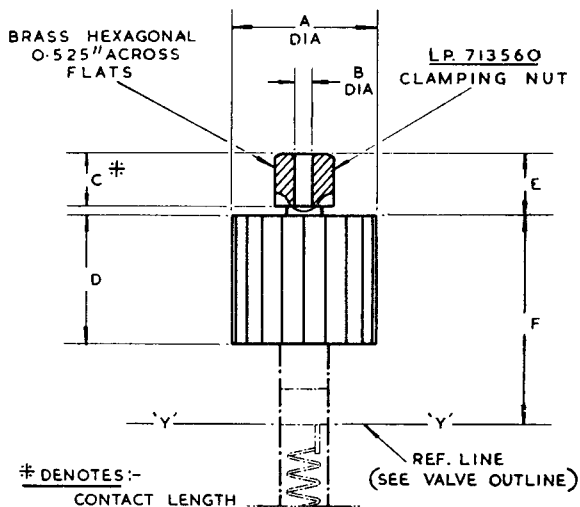


FIG. 7 CIRCUIT FOR STABILISING CATHODE CURRENT



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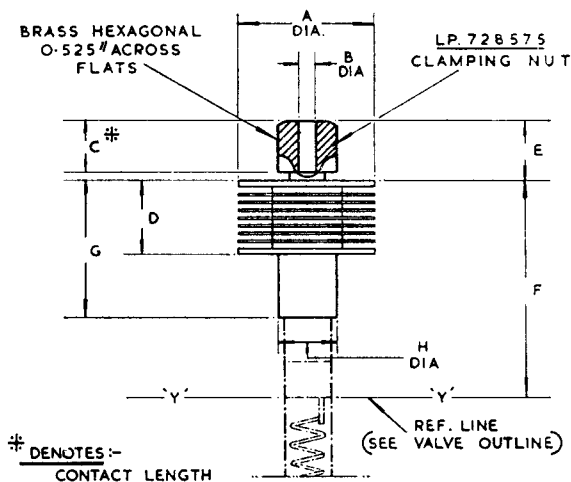
RADIATOR LP.713557

| DIM | MILLIMETRES | INCHES |
|-----|-------------|---------------|
| A | 38.0 ± 1.0 | 1.500 ± 0.040 |
| B | 4.75 ± 0.05 | 0.187 ± 0.002 |
| C | 12.7 ± 1.2 | 1/2 ± 3/64 |
| D | 35.0 ± 1.6 | 1 3/8 ± 1/16 |
| E | 15.1 ± 1.2 | 19/32 ± 3/64 |
| F | 57.2 ± 4.0 | 2 1/4 ± 5/32 |

NOTE:- BASIC FIGURES ARE INCHES.

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RADIATOR LP.728570

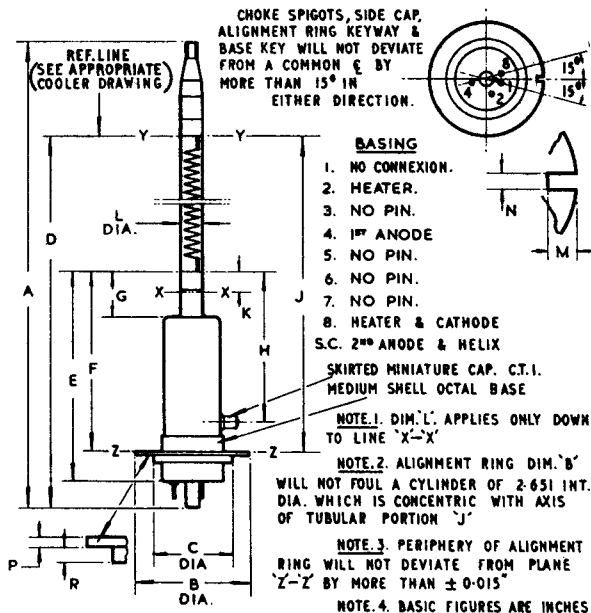
| DIM | MILLIMETRES | INCHES |
|-----|----------------------|------------------------|
| A | 38.0 ± 0.25 | 1.500 ± 0.010 |
| B | 4.75 ± 0.05 | 0.187 ± 0.002 |
| C | 12.7 ± 1.2 | 1/2 ± 3/64 |
| D | 19.1 ± 1.6 | 3/4 ± 1/16 |
| E | 15.1 ± 1.2 | 19/32 ± 3/64 |
| F | 69.8 ± 4.0 | 2 3/4 ± 5/32 |
| G | 38.1 ± 1.6 | 1 1/2 ± 1/16 |
| H | 15.88 ± 0.02 0.05 | 0.625 ± 0.001 0.002 |

NOTE:- BASIC FIGURES ARE INCHES.



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| DIM | MILLIMETRES | INCHES | DIM | MILLIMETRES | INCHES |
|-----|-------------------|-----------------------------------|-----|---|--|
| A | 444.5 MAX. | $17\frac{1}{2}$ MAX. | J | 347.26 ± 0.89 | 13.672 ± 0.035 |
| B | 66.52 ± 0.05 | 2.619 ± 0.002 | K | 11.1 MIN. | $\frac{7}{16}$ MIN. |
| C | 46 ± 0.8 | $1\frac{13}{16} \pm \frac{1}{16}$ | L | 13.08 MAX. | 0.515 MAX. |
| D | 387.3 MAX. | $15\frac{1}{4}$ MAX. | M | 3.18 ± 0.25 | 0.125 ± 0.010 |
| E | 120.65 ± 6.35 | $4\frac{3}{4} \pm \frac{1}{4}$ | N | $1.65 \pm \begin{matrix} 0.25 \\ 0.00 \end{matrix}$ | $0.065 \pm \begin{matrix} 0.010 \\ 0.000 \end{matrix}$ |
| F | 102.79 ± 0.38 | 4.047 ± 0.015 | P | 4.75 ± 0.12 | 0.187 ± 0.005 |
| G | 25.4 ± 4.0 | $1 \pm \frac{3}{16}$ | R | 7.92 ± 0.25 | 0.312 ± 0.010 |
| H | 85.7 ± 3.2 | $3\frac{3}{8} \pm \frac{1}{8}$ | | | |