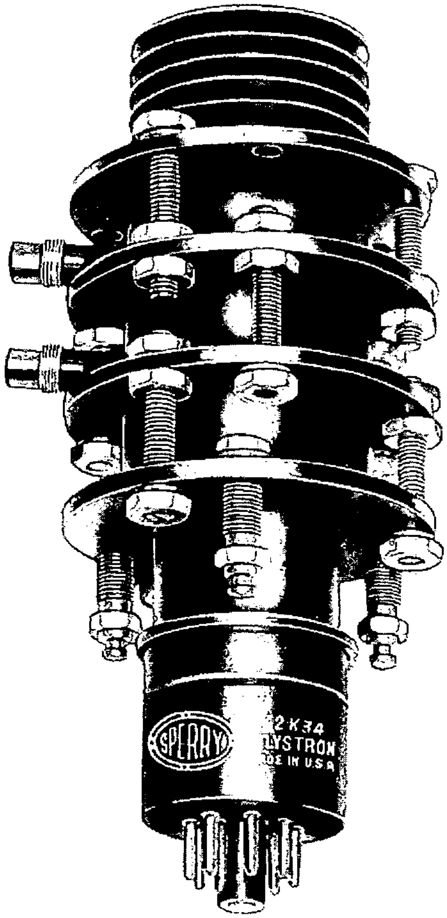
2K34 KLYSTRON

VELOCITY MODULATION OSCILLATOR/BUFFER

The type 2K34 Sperry klystron is a super-high frequency, velocity modulation tube designed for use as a combination self-controlled oscillator and buffer amplifier. A buffer stage is an integral part of the tube and is electron coupled to the oscillator portion of the tube. Inclusion of this buffer stage permits the use of a variable load without appreciably affecting the operating frequency of the tube.

The tube utilizes three resonant cavities which are an integral part of the tube structure. An electrostatically focused electron gun projects an electron beam through these three resonators. One coaxial output terminal, designed for use with Sperry SKL (3/8-32 thread) fittings, is coupled to each of the second and third resonators. The first two resonators are used as the oscillator portion of the tube and are inductively coupled by an internal feedback loop. The third resonator is electron coupled to the oscillator portion of the tube and serves to isolate the oscillator from the load.



The velocity of the electrons in the electron beam is modified by the radio-frequency voltage developed at the grids of the input resonator. Electron bunching occurs in the drift space between the first and second resonators. The second resonator extracts a portion of the radio-frequency energy from the electron bunches in this velocity-modulated beam. A portion of this energy is fed back to the input resonator in the proper phase to maintain the oscillations. The feedback loop is an internal part of the tube. The first resonator has no external radio-frequency terminal. If desired, radio-frequency power from the oscillator section can be supplied to an external load through the coaxial output terminal on the second resonator.

If the radio-frequency output of the oscillator section is fed directly to a variable load, the frequency of the oscillator will vary slightly as the load is varied. In cases where frequency modulation of this sort is not desired, the output should be taken from the buffer stage. This will practically eliminate this type of modulation since variation in load will have practically no effect on the operating frequency of the tube.

This tube is designed for operation on any selected fixed frequency within the stated tuning range. Threaded, thermal compensating, tuning screws are included as part of the structure so that the tube may be set at the desired frequency.

GENERAL DATA
(Tentative)

Frequency Range	2730 to 3330 megacycles
*R-f Power Output (minimum; unmodulated)**	
Oscillator Section	18 watts
Buffer Section	16 watts
Heater (a-c or d-c)	
Voltage	6.3 volts
Current	1.5 [redacted] amperes
*Beam***	
Voltage	3000 max. volts
Current	150 max. milliamperes
Input Power	450 max. watts
Control Electrode	
Voltage	0 to -200 max. volts (never positive)
Current	3 max. milliamperes

Weight 21 ounces

Heater-Cathode Voltage ± 45 max. volts

Cooling Forced air cooling is recommended for all beam power inputs above twenty watts. In any case, sufficient forced air should be supplied to keep the envelope temperature below 100°C. At the maximum ratings, about fifty cubic feet of forced air per minute will be required. The stream of forced air should be directed between the tuning flanges and between the cooling fins.

Base MEDIUM [redacted] shell, octal, 8 pin

Mounting Position - Any

Output Terminal Fittings
(Not supplied with tube)

	Sperry Cat. No.		JAN Type No.
Straight plug	50-1200	similar to	UG-275/U
Right Angle plug	50-1201	similar to	UG-276/U
Plug to Type N jack adapter	50-1202	similar to	UG-131/U
Coaxial cable for fittings	50-1203	similar to	RG-5/U RG-21/U (attenuating)

Typical Operation

Heater Voltage	6.3 volts
Heater Current	1.5 [redacted] amperes
Beam Voltage	1900 volts
Beam Current	75 milliamperes
Control Electrode Voltage	-45 volts
Heater-Cathode Potential	0 volts
R-f Output Power	14 watts

* This minimum r-f output power is obtainable within the maximum rated operating conditions at any frequency within the published range of the tube when the load is adjusted to produce the best output power. These output powers cannot be obtained from both sections simultaneously, and apply only to the independent use of either output condition.

** Absolute maximum values, not design center values.

INSTALLATION

METAL ENVELOPE - The metal portion of the tube envelope is operated at ground potential in most klystron applications. This is the most convenient method because it allows any tuning adjustments on the klystron to be made without danger of electrical shock. In this type of operation, the positive side of the beam electrode power supply is operated at ground potential and the negative terminal of this power supply is connected to the cathode circuit of the klystron.

CATHODE - The cathode of this tube is connected to a separate base pin connection. In most application it should be connected either directly to one side of the heater at the tube socket, or to the electrical midpoint of the heater transformer winding. A common lead throughout the circuit for the connections to the cathode and to one side of the heater should not be used. This arrangement would introduce modulation into the beam voltage circuit when alternating current is used for the heater supply. In cases where the cathode is not directly connected to the heater, the potential difference between them should be not more than 45 volts. The control electrode and beam circuit returns should be made to the cathode connection on the tube socket and not to some related point in the heater circuit.

CONTROL ELECTRODE - For simplicity of operation, the control electrode is frequently connected to the cathode at the tube socket, but it may be connected to a low impedance voltage supply for control of the beam focusing and the beam current. In no case should the tube be operated with the control electrode not connected to the circuit, or with the control electrode operated at a potential which is positive with respect to the cathode.

POWER SUPPLIES - The beam and control electrode power supplies should be free of hum or ripple voltage if a radio-frequency output is desired without amplitude and frequency modulation. Hum, or other modulation on the control electrode, produces an amplitude modulation of the output and also enough frequency modulation to be objectionable if only amplitude modulation is desired. Any low frequency variation of the beam voltage produces mainly frequency modulation of the output, although some amplitude modulation is also present if the voltage swings are large enough. The amount of power supply hum or ripple voltage that can be tolerated depends upon both the particular application and upon the operating voltage. At the 1900 volt operating condition that is quoted under "Typical Operation", about 10 kilocycles per second per volt of frequency modulation is obtained for small variations in the beam voltage. The modulation sensitivity is inversely proportional to the operating beam voltage so that at higher beam voltages this modulation sensitivity is less and at lower beam voltages it is greater than the quoted value. Electronically regulated power supplies are therefore recommended for these applications. The output voltage of the power supplies should be adjustable over a range of several hundred volts, so that the operating voltages for the tube may be adjusted to obtain the best output power for a selected operating frequency. While the oscillator portion of the tube will operate with a beam voltage as low as 500 volts, an appreciable output will not be attained with a beam voltage much under 1000 volts.

When the beam electrode of this tube is operated at ground potential, the cathode, the control electrode, and the heater circuits must be insulated for four times the beam voltage plus 1000 volts. This requirement applies to the heater transformer insulation and to any control electrode supply that may be used.

OPERATION

PRECAUTIONS

1. Allow heater to warm up for 30 seconds before turning on other voltages.
2. The application of beam voltage must not precede the application of any of the other voltages.
3. Klystron beam voltages are dangerous. Turn off power supplies and discharge capacitors before handling klystron circuits.

STARTING - After the tube has been installed in accordance with the above instructions and has the proper voltages applied, the first step is to get it into operation on the proper frequency and with maximum output.

The recommended procedure is first to start the oscillator section working. Assuming that the tube has just come from the factory or has been in normal use and is therefore not completely out of adjustment the procedure is as follows:

Connect an r-f indicating device, such as a crystal detector and milliammeter, to the output of the second (middle) resonator to detect the presence of oscillation. The crystal detector should be connected to the tube through from 5 to 20 db of lossy line to prevent damage to the crystal. In order to start oscillation, it is recommended that the beam voltage be swung back and forth approximately 100 volts about the chosen beam voltage (1000-3000 volts, depending on the output power desired). This can easily be done by connecting a 110 volt 60 cycle source in series with the beam voltage supply as shown in Figure 3. Now tune the second resonator, first one way and then the other, until the tube starts to oscillate as indicated by a reading on the milliammeter.

RESONATOR TUNING PROCEDURE - The resonators are tuned by varying the distance between each pair of tuning rings by means of three tuning screws. One end of each screw is threaded into one of the rings and is held by a locknut. The other end passes through the other ring and is held by two nuts, one on each side of the ring. The tuning ring is moved by loosening the nut on the side in the direction of the motion desired and tightening the opposing nut. It must be recognized that the complete published tuning range of the system is covered by about a 0.060 inch displacement between each pair of rings. This displacement is made by approximately two turns of the three tuning nuts on each ring. The tuning rings must also be kept reasonably parallel to maintain proper positioning of the vane grids. Therefore, no one tuning nut should be turned more than a quarter turn in the desired direction without turning the other two comparable nuts on the same tuning ring. The total number of turns of any one nut should be limited to less than two turns in order to stay within the tuning range.

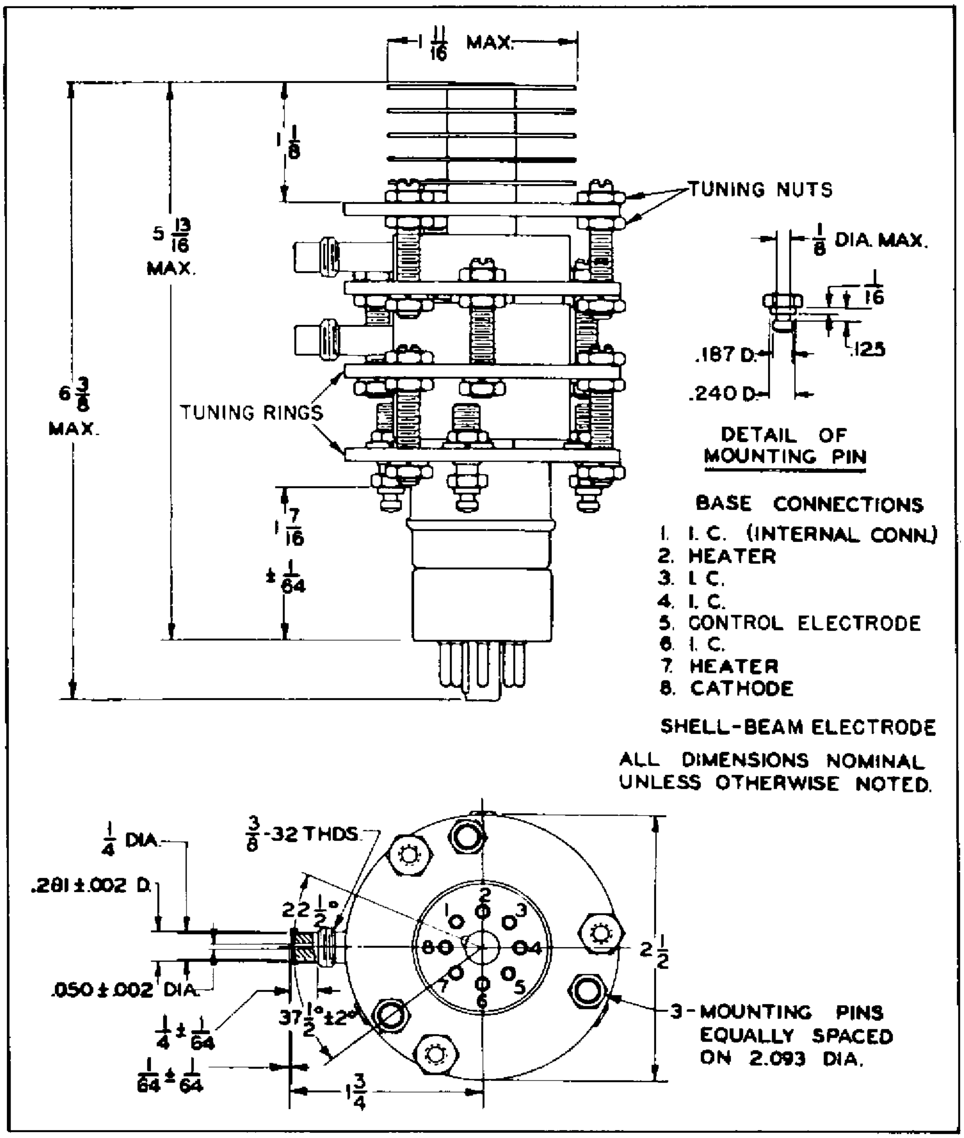
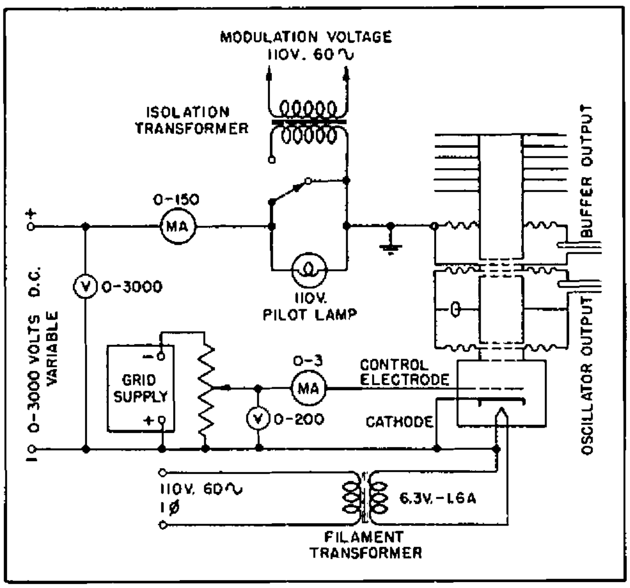


FIGURE 2

OSCILLATOR TUNING - After oscillation is detected, disconnect the 60 cycle modulating voltage and retune the second resonator slightly for best output. The retuning necessary should require less than a quarter turn of any one tuning nut. Now measure the frequency of oscillation with any convenient wave meter. Retune to the frequency desired by varying both the first and second resonators. If the desired frequency is higher than the measured frequency, the resonator grid spacings and therefore the tuning ring spacings must be widened. If the desired frequency is lower, the spacings must be narrowed. It is desirable that these resonators be adjusted alternately so that they do not get out of tune with each other and cause loss of oscillation.

After the frequency of the oscillator section has been established on the desired frequency, the output stage should be peaked. If the buffer stage is used, the crystal detector or other r-f indicating device is shifted to the third resonator and the output is peaked by tuning the third resonator for a maximum and then alternately tuning the second and third resonators until maximum output is obtained. It is possible that this peaking operation may shift the frequency of the oscillator section slightly. Therefore, the frequency should be checked with an absorption type wavemeter at the output of the buffer (third) resonator. If the frequency has shifted beyond the required tolerance it will be necessary to retune the oscillator section to bring it back on frequency and repeak the second and third resonators as outlined in this section. Care in the tuning of the three resonators will give maximum output on the desired frequency. It must be noted at this point that the recommended procedure as outlined has been predicated on a fixed beam voltage. Any change in beam voltage will cause a frequency shift in the oscillator section of the tube and a consequent detuning of the output voltage. Therefore, when restarting the tube, the beam voltage must be brought up to the same value as used in the original tuning of the tube.



SIMPLIFIED CIRCUIT DIAGRAM
FIGURE 3

RESONATOR PRETUNING - The procedure outlined above has been based on the assumption that the resonators were not initially too badly out of tune. If, for any reason, the resonators have been detuned, it is recommended that they be pretuned before starting the outline procedure. This pretuning may be done as follows:

Apply a signal from a signal generator to the second resonator. Tune the second resonator for a dip in output. Then tune the first resonator until a rise appears in the output of the signal generator, indicating resonance. The third resonator may be tuned directly with the signal generator for a dip in the output. If no signal generator is available, the resonators can be pretuned roughly by adjusting the spacing of the three pairs of tuning rings until they are approximately 0.660 inches apart, measuring from the inner faces of each pair of rings. The resonators should now be close enough in tune to follow the procedure given for putting the tube in operation.

Inquiries regarding service information, operation, or performance of klystron tubes should be directed to Field Service Engineering Department, Sperry Gyroscope Company, Inc., Great Neck, New York. Do not return klystrons before making this contact.

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