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# V-52 KLYSTRON OSCILLATOR
# REFINEMENT AND PRODUCTION PROGRAM

Progress Report for
February 1954

VARIAN
associates

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**VARIAN ASSOCIATES**
611 Hansen Way Palo Alto California

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Engineering Report
No. 132-20

Copy No. 3

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# V-52 KLYSTRON OSCILLATOR
# REFINEMENT AND PRODUCTION PROGRAM

## Progress Report for
## February 1954

Prepared for: Bureau of Ships
Navy Department

On: BuShips Contract No. NObs-5358

By: Claude Conner

Approved: E. G. Cameron
Emmet G. Cameron
Chief Product Engineer

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## PURPOSE

The purpose of the program covered by BuShips Contract No. NObs-5358 is to refine and produce one thousand (1000) rugged X-band local oscillator V-52 klystrons. This tube is to comply with the specifications of SHIPS E-720, which were subsequently modified at a conference held at the Bureau of Ordnance, Washington, D.C. on 20-21 May 1952 and later at a conference held at Varian Associates on 29-30 September 1952.

## PROGRESS

Window sealing techniques have undergone careful investigation this period. It was determined that the close proximity of the iris loading slug to the window results in large temperature gradients across the glass seal and mica, particularly during the actual sealing operation. The result is that stresses are built up which cause waviness and delamination in the mica and possibly cracks in the glass seal adjacent to the loading slug. The first attempt to remedy this condition involved a baffle, or heat shield, which was used between the loading slug and the window during sealing. Improved but non-uniform results occurred. The second measure was to bend the loading slug away from, and perpendicular to, the window prior to the sealing operation. To facilitate the bending and minimize danger of subsequent window damage, loading slugs of thinner material (.015 inch) were used. This allows better visibility for glassing and easier masking for cleaning and plating after exhaust. The initial several windows made by this method appear to be considerably improved over those made by the standard system. Further tests will be made.

As a result of the continuing effort to discover and control the parameters that affect warm-up drift it is necessary periodically to review and correlate information which is steadily being compiled. In general, a simplified approach is attempted in which (1) the external tuning cavity, (2) the loading slug/iris coupling and (3) the internal cavity configurations are analyzed independently. A further simplification is to give primary consideration to that portion of each "circuit" which is the most sensitive to change, namely: in (1) the tuning screw, in (2) the loading slug gap, and in (3) the interaction gap. It is obvious, of course, that independence does not exist and correlation is attempted between various "major elements." It is known, for example, that change in the loading slug gap produces both a change in frequency and a change in the slope of the tuning curve of the external cavity. Further, the magnitude of both effects varies over the required tuning range. A similar effect is produced by changing the interaction gap (as affected by "pretune" frequency). In addition to this, the effect of thermal expansion of the tuning screw varies with frequency due to the variation in screw insertion over the tuning range. The composite effect of these interactions, coupled with the variation in tuning rate with frequency, produces quite a complex problem of control. It is believed that progress is being made toward resolving this control problem.

Regarding the factors which influence the internal cavity configuration, two things have been under recent investigation: (1) the causes of wide distribution of "initial" frequencies (before pretuning), and (2) the cause of shift of maximum tube frequency after pretuning.

In regard to (1), it has been determined that the internal cavity "post" length (effective drift tube length inside cavity) has varied over considerable limits, due to the jigging method employed. Thus, even though initial interaction gap spacing has been accurately controlled, the cavity dimensions have been varying. The end result is that even with a constant "pretune" frequency the "L/C" ratio has been changing, which undoubtedly has caused variation in coupling between the three "tuned circuits" employed. It is believed that warm-up drift, power output, bandwidth, and modulation sensitivity would all be affected by such a variable. As a result of this finding, all available assemblies have been broken into three control lots based upon the post length, and are being run through to evaluate performance differences. Simultaneously, a new jig has been designed which should enable the tolerance of the post length to be held within ± .001 inch. Some of the new jigs have already been completed and show that this tolerance is attainable.

Concerning (2), the pretuning operation takes place just before the window and stem sealing operations. The frequency set is above the required maximum limit and is held within ± 10 mc. However, completed tubes have maximum frequencies ranging from no change to minus 100 mc with the majority from minus 30-50 mc. Experimental evidence indicates that the presence of the window sealing glass causes a negative frequency shift of the same magnitude, but that the heating due to the sealing operation has no influence. (It is known that interaction gap changes can be produced by high temperature heating of the body - but observation indicates that this produces a positive frequency shift.) Two possible solutions are to be investigated: (1) to control the amount and location of the glass, and (2) to pretune the tube after window sealing. Efforts to pretune after window sealing have been made in the past but were discontinued because seal cracking resulted. It is now believed that the cracking is produced because of stress in the glass which seals to the edge of the reflector header. A new design of reflector header which is hoped to relieve the strain on the sealing glass, and hence prevent cracking, is being installed on an experimental basis. (If this new design proves workable it will enable an improved method of body assembly jigging which will directly control the amount of reflector header insertion into the iris - a feature that is incompatible with the present part.)

With regard to the loading slug/iris configuration, two things are currently being investigated: (1) the effect of variation of loading slug dimensions, and (2) the use of different materials for the loading slug. In the case of the V-110 a marked improvement in drift uniformity over the tuning range was attained through the use of steel loading slugs in place of the original copper part.

Because of information obtained from the prototype V-52 every effort has been made to insure the close concentricity of the center hole (ion pump) in the number one grid (anode grid). As a result, two methods of grid construction have been used. The first method of providing the center hole was to pack a large diameter copper plated aluminum wire in the center of the plated wire bundle and process as with normal copper hex grids.

The end result had a well defined center hole, but generally poor concentricity. Only a small percentage of grids manufactured by this technique had concentricity close enough for use in the V-52 (.003 inch TIR max). The second method of fabrication was simply to drill a center hole in the grid disc before the aluminum wire cores were etched out. The resulting concentricity was within required limits, but the free ends of grid vanes in the hole region had a tendency to break off. After having run a considerable number of tubes using grids of both types of manufacture it has become apparent that the plated hole type offers materially higher bandwidth (electronic tuning range) than the drilled hole type. In the meantime, wire loading techniques have been improved considerably so that an appreciable percentage of the plated hole type will fall within .005 inch TIR. Tests run with plated hole grids having this increased tolerance show performance comparable to those with .003 inch TIR. The superior performance has been attributed to the smaller effective hole diameter attained in the plated hole type, causing a more convergent electron beam, which other tests have shown will improve bandwidth. As a result of these findings, new specifications call for plated hole grids with the .005 inch TIR max concentricity. Further tests are to be performed to determine the effect of greater center hole eccentricities. Tests are also to be run to verify previous conclusions by using drilled hole grids with smaller center hole diameters.

The reflector spacing was changed in some tubes from the present value of .086 inch to .082 inch, in order to improve bandwidth and modulation sensitivity. The resulting decrease in the required reflector voltage, however, has been prohibitive, and thus the spacing will be changed back to .086 inch.

During this month a few of the tubes with all parts brazed together simultaneously[1] were constructed. The conveyor furnace was used for this operation for the first time. Unfortunately, this furnace created abnormally high vibrations, which tilted the reflector shells. Further trials will be run with improved jigging methods.

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[1] Varian Engineering Report No. 132-18

Tubes using pre-cut grids at the interaction gap of the drift tube were tested in February. These tubes employed the new grid-mounting technique mentioned in last month's report[2], which involves silver plating the drift tube before firing the grids. These tubes all proved to be undercompensated for some unknown reason. All the r-f characteristics of the tube were satisfactory, however.

Casting of the external tuner is now being considered. It is certain that the cost of cast tuners will be well below the cost of the present machined and brazed tuners. Samples of cast steel have been received for use in plating trials and to determine the distortion that takes place due to firing.

In regard to new reflector stem cup design, a spherical configuration was tested this month. This configuration appears to produce less movement of the cup under hydraulic pressure. This new cup will also employ a heavier material than the kovar now used.

Performance data of tubes tested in February are given in Table I.

TABLE I

AVERAGE PERFORMANCE DATA OF TUBES TESTED IN FEBRUARY

(First Test)

| | Beam Voltage = 350 v | | Beam Voltage = 300 v | |
|---|---|---|---|---|
| Frequency (mc) | 8800 | 9600 | 8800 | 9600 |
| Beam Current (ma) | 49.59 (22) | 49.23 (22) | 39.93 (57) | 40.02 (57) |
| Reflector Voltage (v) | -104.86 (22) | -142.45 (22) | -59.37 (57) | -87.75 (57) |
| Power Output (mw) | 119.77 (22) | 127.23 (22) | 56.74 (57) | 70.07 (57) |
| Bandwidth (mc) | 54.09 (22) | 32.14 (21) | 70.18 (57) | 43.12 (57) |
| Mod. Sens. (mc/v) | 2.16 (21) | 1.29 (21) | 3.95 (57) | 2.48 (56) |
| Drift, 10 minutes (mc) | ------ | -4.99 (14) | -0.85 (20) | -1.47 (35) |
| Percentage of tubes within 3 mc drift (%) (Tubes tested at both ends of range) | | | 52.6 (19) | |

The number in parenthesis indicates the number of tubes tested.

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[2] Ibid.

Production data for tubes processed in February are given in Table II.

## TABLE II

## PRODUCTION DATA - TUBES IN PROCESS IN FEBRUARY

| Work Station | Number of Tubes Submitted | Yield |
|---|---|---|
| Body Assembly | 136 | 97% |
| Pretune | 135 | 99% |
| Seal In | 126 | 98% |
| Exhaust | 94 | 93% |
| Aging | 61 | 95% |
| First Test | 95 | 82% |
| First Finish | 102 | 93% |
| Final Test | 96 | 89% |
| Final Inspection | 75 | 100% |
| | | 56% Compounded - All Stations |

## PROGRAM FOR NEXT INTERVAL

More tubes with bent loading slugs will be produced and tested. Available test results will be evaluated with regard to internal cavity post length. Test data on revised reflector headers will be evaluated. Investigation will continue on loading slug dimensions and materials. Evaluation will be made of the effect of spherical reflector stem cup on drift.

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| Estimated expenditures during February 1954: | $18,200.00 |
| Estimated man-hours during February 1954: | 1800 |

# Armed Services Technical Information Agency

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