

## 455A - Amplifier For Submarine Telephone Repeaters



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After the experience gained on the [HQ175](#) high-rel pentode, over than 80 million-hours of reliable operation already totalized, Bell Telephone started the design of the 455A for the new [SD system](#). The system requirements appeared definitely impossible to approach: 20 years of uninterrupted service were expected. The system had to transmit 128 audio channels of 3 KHz bandwidth in each direction over a single coaxial cable. The distance, over than 3500 miles, required the use of 183 signal repeaters, one every 20 miles, each repeater containing six high-gm tubes: a total of 1098 tubes. For tube failures not minimized by redundancies a mean time between failures of 26,100 years was required. Duplicating amplifiers in each repeater cell and neglecting parametric variations through the system life, the estimated m.t.b.f. for this tube dropped to a mere 885 years!

Production of the tubes at the Allentown Works of Western Electric went on for about four years. In the production for most operation each operator carried out six tubes at a time, updating the related tracking record. The design philosophy, as well as the production approach were derived from those applied for the HQ175 with even more selective control steps. Every tube and every element inside, cathode, grids and anode, were identified by serial numbers and complete traceability was kept of each significant operation and of every lot of material batches and of group of parts. Even absolute cleaning from oxides, grease and any contaminant agent, as well as storage in clean containers for a limited time were mandatory through the some 350 operations of the manufacturing process. Ten inspections, six of which for searching unwanted particles, were performed through the manufacture of each tube.

Each tube was aged for 5000 hours and tested six times through the aging. Individual electrical characteristics and relevant parameters were recorded. The full story of each tube and every deviation were carefully evaluated by a selection committee. Tubes were finally selected in groups of six, A to F, as kit for each repeater. Selection

was made evaluating the total heater voltage drop, the transconductance and even the noise, the ones with lower noise being assigned to input stages.

Here is the full article from the [BST Journal](#) describing this outstanding tube.

