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ham clinic

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Some Thoughts On Extending Tube Life

As pointed out in this column sometime ago, *defective tubes* cause the majority of failures in electronic equipment. Contrary to what the advocates of transistorization may think or say, we are going to have tubes *and* tube failures for a good long while yet.

The care and feeding of tubes receives a lot of attention from equipment designers. Whenever possible, they design circuits so that the tubes are correctly operated and not allowed to run at high temperatures. But no matter the design approach, there will always be HEAT to contend with because a tube's cathode must get hot in order to operate properly. Now, when high voltages are applied to plates and screens, especially those in power tubes, there is yet *more* heat to dissipate.

Some years ago, I conducted experiments relative to the effects of high temperatures on tube operation and longevity. Although my test setup was crude and so were my test results, I assured myself of one thing: tubes do have longer life spans if they are not subjected to voltage and current overloads and *high* temperatures.

Every tube has its own critical operating temperature. This cannot be quickly determined without many hours of environmental testing using special equipment. As well, the how and where of a tube's mounting can have a lot to do with how long it will satisfactorily operate.

Heat is a major problem with tubes containing many elements such as pentode/triodes, double triodes, dual-diode/triodes etc. because the elements must, of necessity, be so close together. At this point, tribute must be paid to tube manufacturers for being able to come up with multi-element tubes that operate so well over a wide range of temperatures.

Overdriving a tube (with RF, line voltage surges, etc.) certainly takes its toll, but the one big "bugaboo" that receives little attention is H-E-A-T, spelled in large letters!

Sometime ago, I was fortunate to get a copy of a really fine report titled "Heat Dissipating Electron-Tube Shields and Their Relation to Tube Life and Equipment Reliability" prepared by John C. McAdam of *International Electronic Research Corporation (IERC)*, 145 West Magnolia Blvd., Burbank, California. After reading it, I was convinced (as I know you will be if you read the whole report) that too little attention has been given to the conservation of tubes through heat reduction—this being especially true in ham radio equipment.

Few people realize that the ordinary JAN shield actually makes a tube run *hotter* than it would if operated bare. Take a look at Fig. A to see what I mean! Taken from Mr. McAdam's paper, this graph really shows the difference when an ordinary shield, no shield and IERC's special heat dissipating shields are compared. Note the curves for the TR and B type shields. Now look at Fig. B and note how much longer tubes will operate before going sour when properly designed tube shields are used. Amazing isn't it?

The findings of various research organizations indicate that the evolution of gas within a tube due to elevated temperatures is the principle cause of tube failure. Other high-temperature-caused failures are: getter migration, grid emission, glass failure, inter-electrode leakage, contamination, grid loading and loss of emission.

Of course, forced air cooling is a solution to the hot-tube problem and is generally used when possible to obtain maximum cooling efficiency. But the mere direction of air over or under a set of tubes is not always the answer because *all* tubes do not get the proper or the same amount of air due in part to *forced* mechanical design and circuit layout. Then too, forced air cooling is not always an expedient measure in ham equipment nor is it inexpensive!

The shiny surface of the JAN shield reflects heat back into the tube; nothing better for raising tube temperature except maybe a nearby, hot transformer. This is the main reason why all good tube shields are *black* inside and out—for heat absorption. Also, the air space found within the average JAN shield retains heat, further aggravating the situation.

Referring to Fig. C-1, you will see IERC's effective heat-dissipating tube shield. It dissipates the heat by radiation, conduction and convection. It grasps the hot tube bulb and distributes the heat from the hot spot over a large surface area. This way, it not only reduces the average temperature present on the tube glass but also greatly reduces the temperature gradient along the surface of the tube.

In Fig. C-2 is shown a retrofit shield developed by IERC to meet the problem of retaining the old JAN-style base. It merely snaps onto the old type base. It is capable of reducing the temperature of the tube bulb well below the bare-bulb temperature and nearly 100°C below JAN-shield temperatures. This is the shield most amateurs can use on the tubes in their equipment residing in the old-style JAN bases.

To increase tube life, a tube must be operated properly. This means current and voltages as low as consistent with proper operation. Neither a tube's filament nor its cathode appreciate voltage surges so if it's possible, use a surge-voltage limiting device: a variable transformer, Surgistor, etc. Some amateurs (those who can afford it and desire the utmost in stability) turn their receivers on and leave them on. In this way, the tubes are not subjected to starting surges but they still are affected heat-wise if they are using old-style heat shields. Forced air cooling is fine if (and this is a big IF) the air can be directed so that there are no outstanding hot spots. Why cool a tube's base when its envelope is boiling? If the base is of the heatsink type that's all well and good but otherwise you're wasting power. Remember that heat rises so top-mounted ventilation systems are best.

Sooner or later, most electronic manufacturers will get around to giving consideration to the use of the various types of specially constructed heat shields. I hope that those who make amateur radio equipment will give these items special attention. Even with properly operated and cooled tubes we will still have replacement requirements, so tube manufacturers can take heart. They may have to wait just a little longer for replacement orders and tube prices might rise slightly, but even the best cared for tubes—like humans—do not last forever.

No one can ever say unchallenged—in my presence anyway—that American hams are not personally generous or are disinterested in international goodwill! The response to my appeal to send foreign hams your old issues of CQ, QST, WRA, CRA, QSO etc. is heart warming! Bravo!

I am sure that the recipients of your magazines and call books will not look on your gifts as charity but rather as your contribution to solidifying international ham friendship. There will surely be some reciprocation and I sincerely hope that you will take the time out to thank the donor, whoever he may be.

Some foreign hams will be surprised and wonder what brought on this sudden generosity. All I can say in reply, is "72" to you: "Peace and Friendship in Freedom".

Note: I have taken substantial editorial liberties with this article. While the tone and content remain, it now reads rather more clearly. bp.

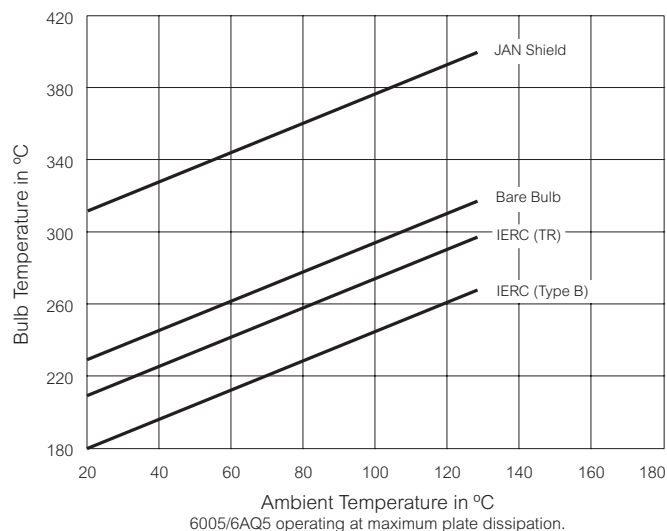


Fig. A. The temperature-effects of running a tube in various ways are shown above. Note the undesirable effect of using the brightly plated JAN-shield.

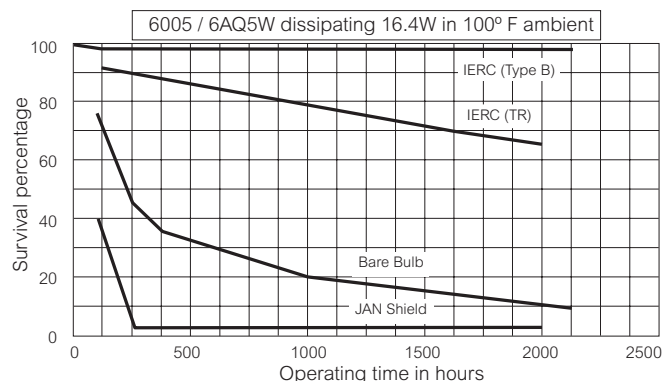


Fig. B. Tube life as a function of the sort of heat-dissipation mechanism employed. Note, once again, the dismal performance of the brightly plated JAN-shield.

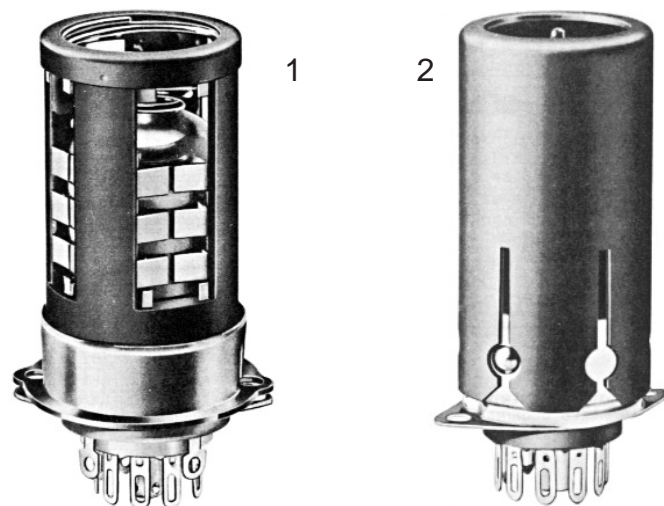


Fig. C. – 1 IERC's Type A heat dissipating tube shield. – 2 The IERC retrofit type shield. While not as effective as the Type A, it will fit on the JAN-type base.