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RESULTS OF DC CHARACTERISTIC AND LIFE TESTS OF FILM BARRETTER ELEMENTS

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INTRODUCTION

The film barretter was chosen for investigation as one possible device for monitoring rf power at 2856 Mc. Roughly speaking, there are two requirements that a power monitor for Project M must meet: the circuitry must be simple and must provide an indication that is independent of ambient conditions, and the entire unit must operate continuously without recalibration or zero readjustment. There are, of course, many other requirements that must be met, but these two can be regarded as basic in the selection of a power-monitoring system.

A pair of film barretters could be used in a power monitor in one of two arrangements: (1) one barretter would monitor the rf power, while its mate would serve in some sort of ambient-temperature correction scheme; (2) both barretters could be arranged in unbalanced bridges such that ambient-temperature variations essentially would cancel between the bridges. This twin-bridge scheme is used by both Hewlett-Packard and FXR in their most recent bolometer power meters.

The requirement of simplicity demands that the circuitry associated with the barretters be held to a minimum. Thus the barretters used should have identical characteristics so that there would be no need for circuitry to compensate for or to cancel differences between units.

Therefore, it is desirable to determine how closely two typical barretter elements will "track" and how stable a typical element might be with time.

Both dc characteristics and accelerated lifetime characteristics were observed during July and August of 1961 at the National Bureau of Standards Boulder Laboratories in Boulder, Colorado.

DC CHARACTERISTICS

A precision potentiometer was used to read the voltage drop across the barretter element and the voltage drop across a resistor in series with the element. The barretter element was contained in a water-tight can immersed in a constant-temperature water bath. For this test, in which several units were compared, it was necessary to have a stable constant-current generator as a source. A Weston 149A constant-current generator was used to excite the series resistor and barretter combination. Three barretters in two different mounts were tested. Each barretter wafer bore a number that had been scratched on at the factory; apparently these numbers referred to production runs. The units tested were:

P.R.D.631-D Film Barretters	P.R.D. 628-A Barretter Mounts
#B1155	#827
#A8037	#828
#A8655	

The characteristics of the three barretters in the two mounts are plotted in Fig. 1. The barretter elements are in themselves different (note both the different resistance and different slope of the B unit as compared to the two A units in Fig. 1), as well as having slightly different characteristics depending on which mount was used.

TEMPERATURE CHARACTERISTICS

The two A barretter elements appeared to have similar resistance vs current curves, so they were compared as to their tracking as a function of ambient temperature. The two units were mounted in two mounts and electrically arranged in separate but identical Wheatstone bridges such that their resistance was maintained at 200.00 ohms by controlling the current to each bridge. An American Instrument Company temperature-controlled incubator was used to provide the necessary ambient-temperature variation. Both mounts were fastened together in a large block of brass so that their temperatures were as nearly identical as possible. The characteristics obtained are plotted in Fig. 2.

LIFE TESTS

One barretter in a mount was placed in a water-tight container immersed in a constant-temperature water bath for a period of five weeks (840 hours) and was continuously excited. The barretter was electrically arranged in a Wheatstone bridge circuit such that its resistance was maintained at 10% above its operating resistance of 200 ohms by manually adjusting the total input current to the bridge to obtain a balance. In this manner readings of the current necessary to balance the bridge gave the barretter current necessary to achieve the 220.0 ohms. The characteristic obtained in Fig. 3 is thus an "accelerated" lifetime characteristic, in that the barretter element was run at greater-than-nominal bias current. This was done so that an indication of lifetime behavior might be obtained in a reasonable length of time. The points obtained are plotted in Fig. 3, along with a curve to indicate their general tendency with time.

Perhaps the most disturbing feature of the barretter's behavior was its erratic nature. For no observable reason the bridge circuit would often be very difficult to balance, and the current necessary for balance would be higher than either the previous or the succeeding readings. Roughly speaking, however, after 840 hours of continuous operation the barretter required about 6% less current to maintain 220.0 ohms than it had initially.

When the 840-hour test was completed, a dc characteristic was again run for the unit. This characteristic is compared to the original characteristic in Fig. 4. It is to be noted that the "aged" characteristic falls below that observed before the life test. This seems a bit curious, for the life test seems to indicate that the resistance increases with time. The slope of this characteristic is, however, greater than that observed before the life test. It may well be that the resistance at higher currents was altered.

CONCLUSIONS

DC Characteristics

The accurate low-current (below rated bias level) measurements of dc characteristics have shown that film barretter elements are decidedly different among themselves and have different characteristics depending on their associated mounts. A single measurement of the characteristic of a unit would not be sufficient as a calibration for the characteristic changes as the unit ages under use.

Temperature Characteristics

Even if two barretters have similar resistance vs current characteristics, they can have different temperature characteristics. From this and the results of the dc characteristic tests one can conclude that if barretters are used in a power monitor scheme, they must be operated at a constant resistance with some circuit provision to compensate for differences in the characteristics of individual units.

Life Tests

The life tests seem to indicate that, unless some sort of automatic compensation scheme is employed, the film barretter is not very useful as a continuous power monitor. This in conjunction with the results of the dc characteristic and temperature tests indicates that the minimum circuitry associated with a barretter power monitor is probably of the magnitude of that found in commercial power meters. The apparent necessity for constant-resistance operation and continuous characteristic correction dictates some sort of feedback scheme that must, of course, employ active elements, which will further degrade the reliability of a monitor.

As a result of these tests it might be concluded that the film barretter is not adaptable to a simple, long-lived power-monitoring scheme.

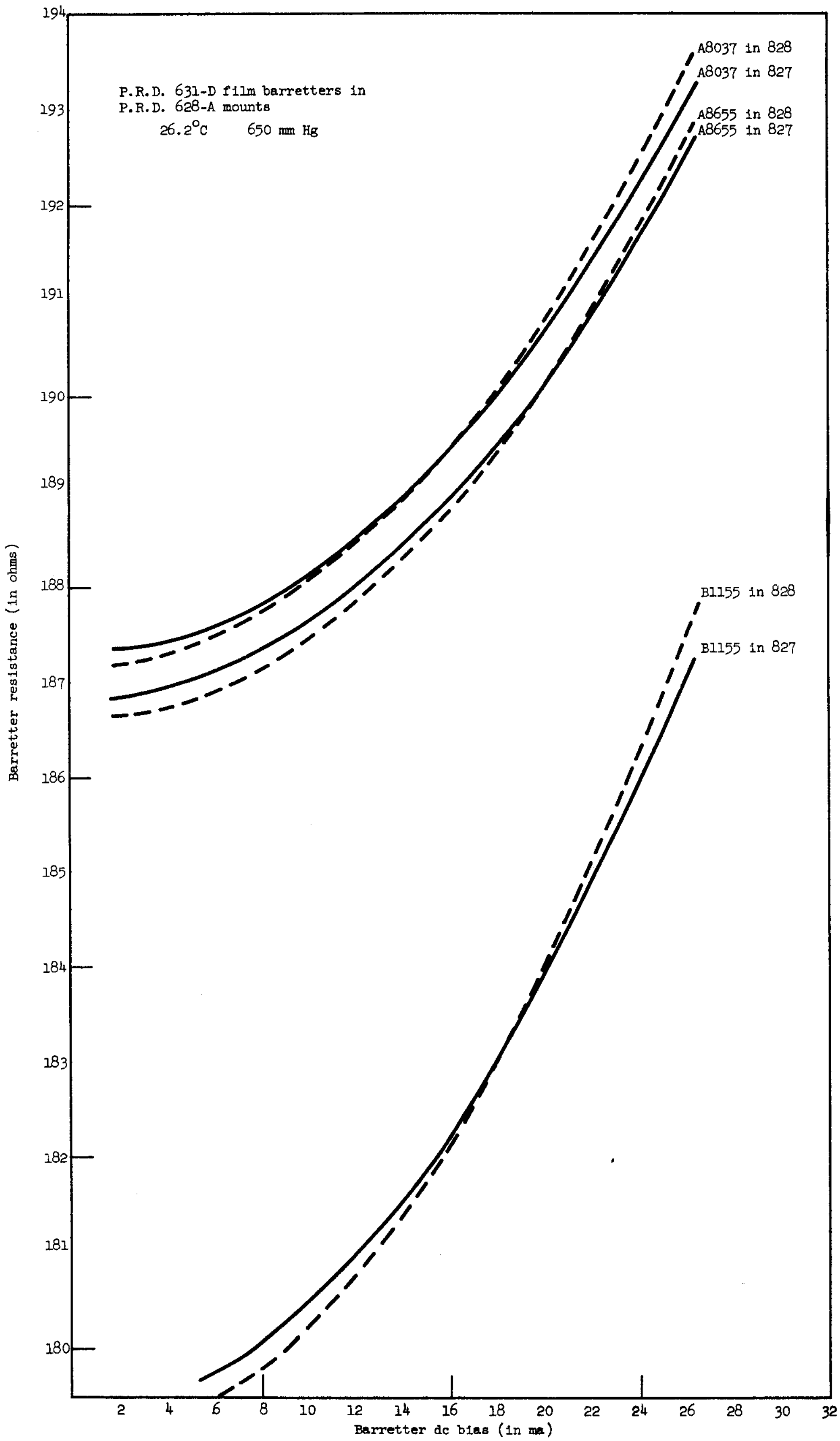

FIG. 1--DC characteristics of three barretters in two mounts.

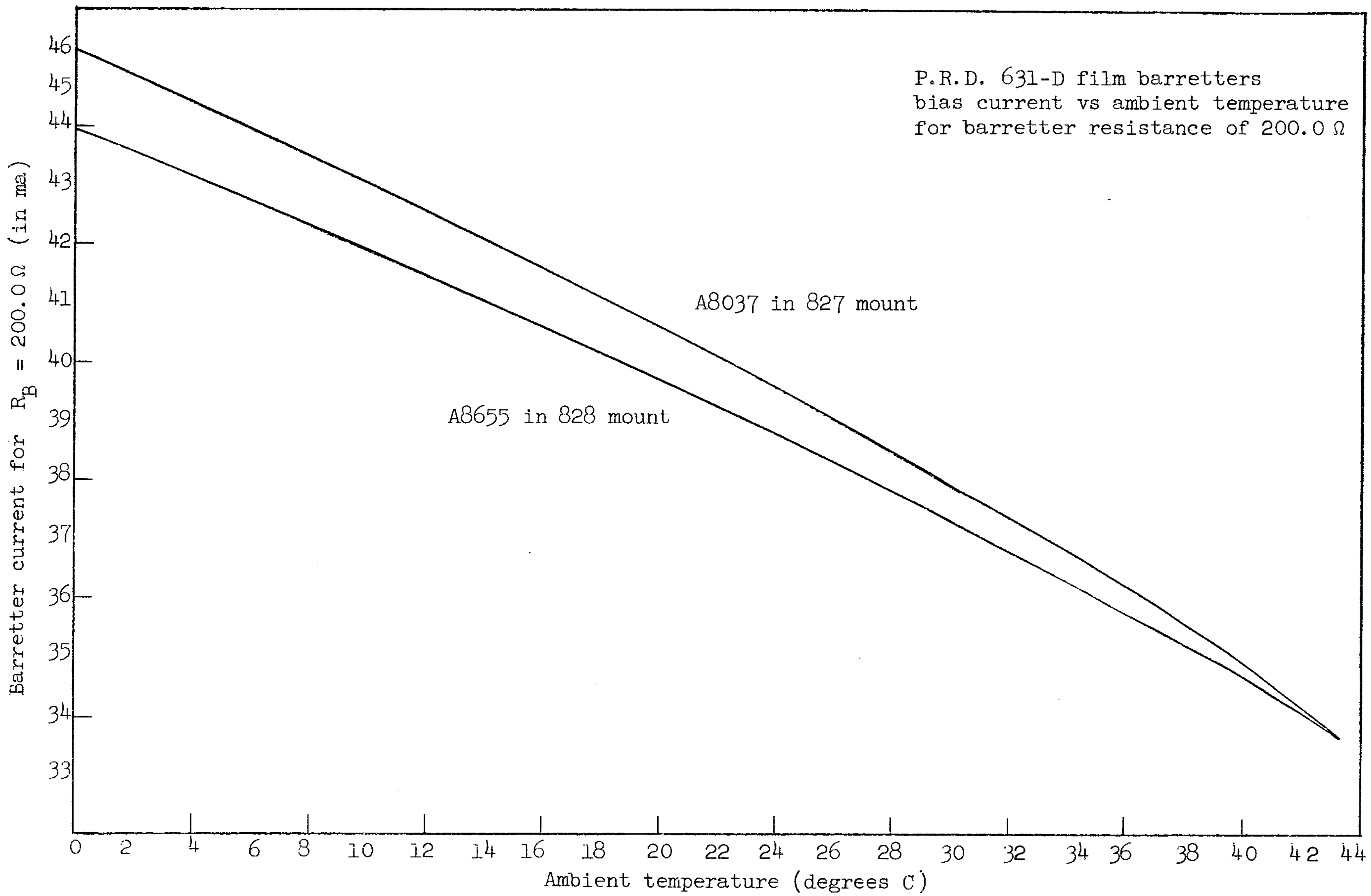

FIG. 2--Temperature tracking characteristics.

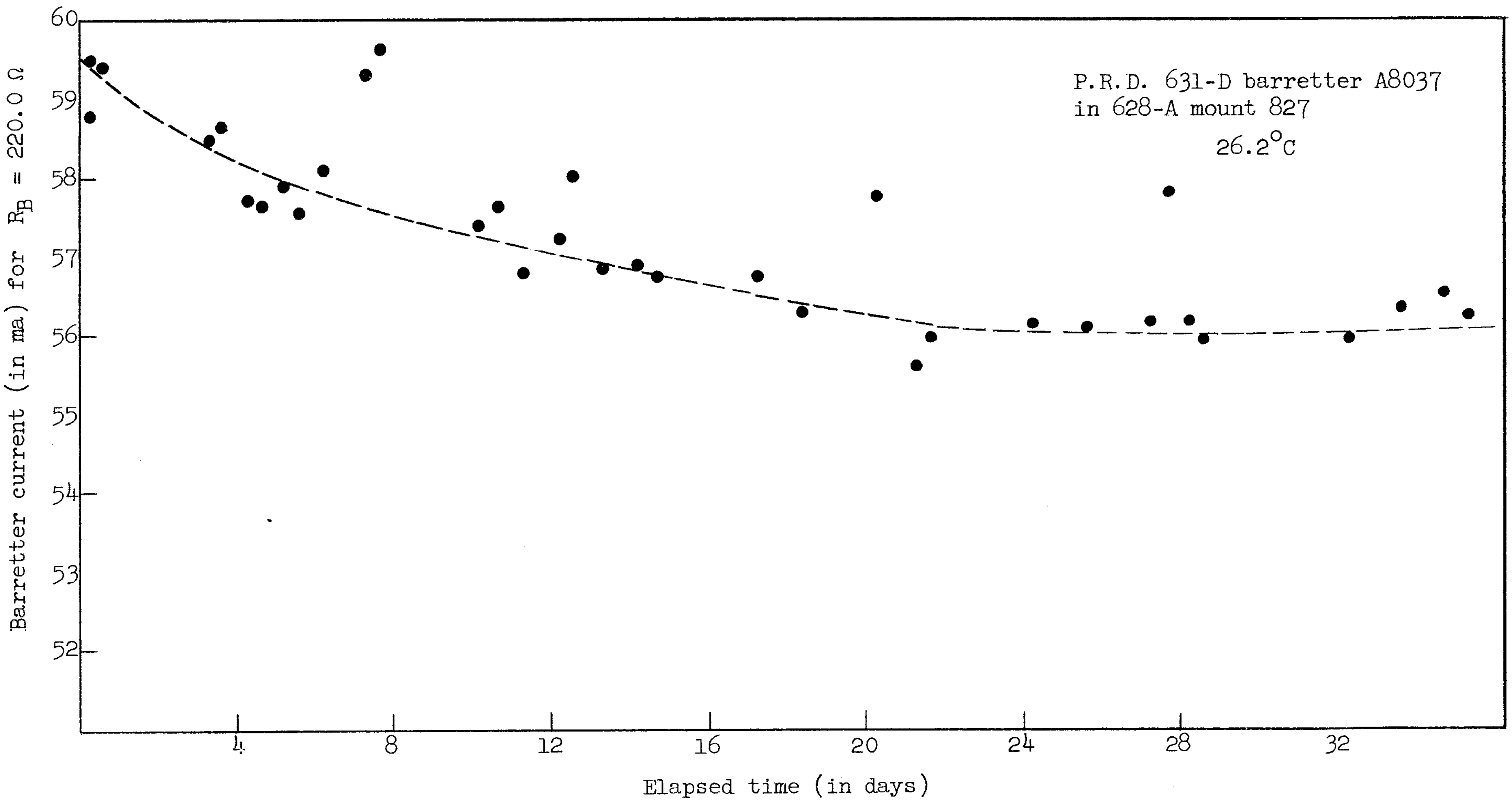

FIG. 3--"Accelerated" lifetime characteristic.

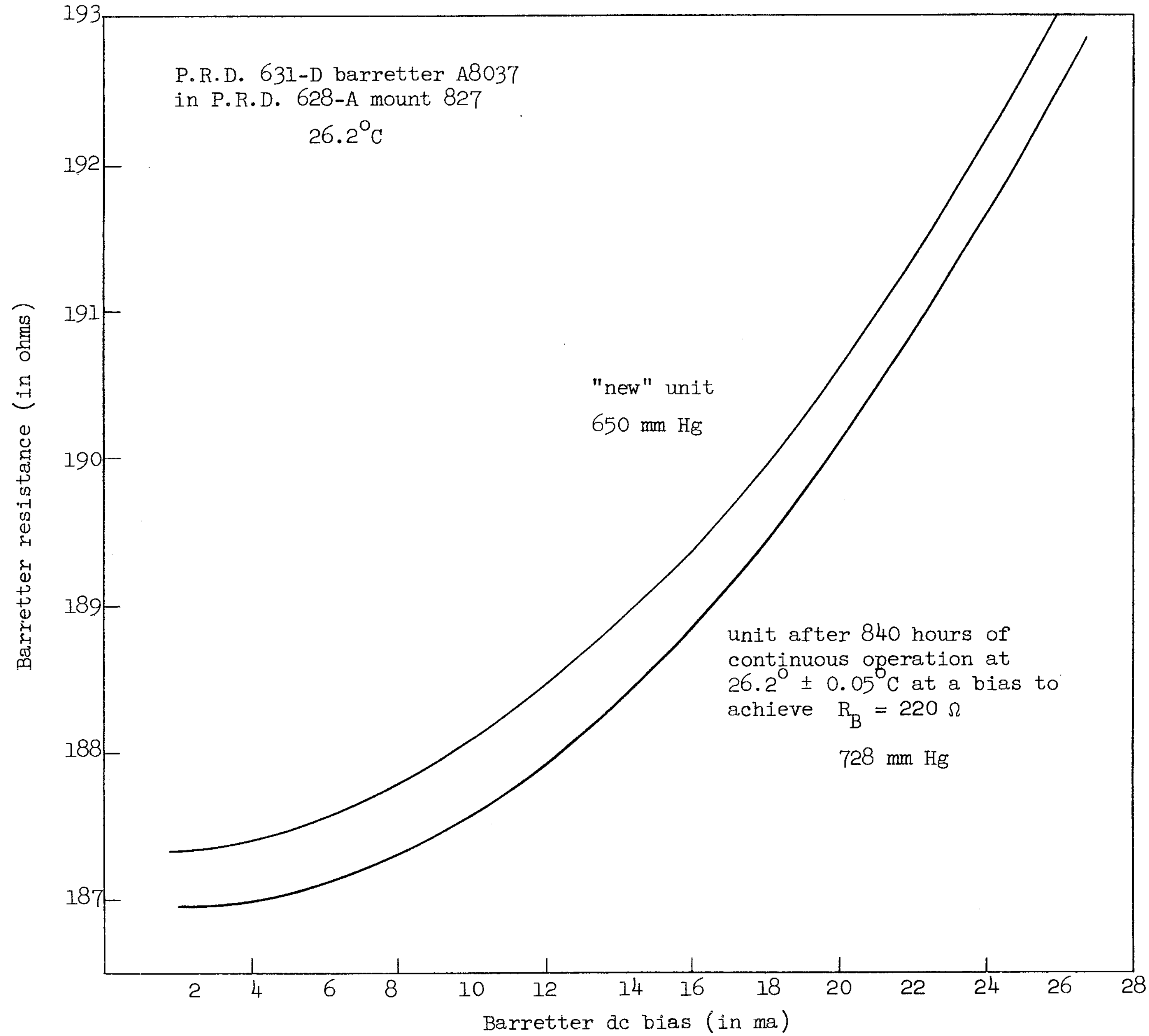

FIG. 4--DC characteristic before and after life test.