NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
0201-20-2300	August 1955	4279

PHOTOMETRIC TESTS OF AN AVQ-2A AIRCRAFT SEARCHLIGHT EQUIPPED WITH A PRECISION-GRADE, PARABOLIC "NON-ROLL-OFF" EDGE, BACK-SILVERED GLASS REFLECTOR

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Test 21N-21/53

Sponsored by

Lighting Section, EL-5211
Bureau of Aeronautics
Department of the Navy
Washington 25, D.C.

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Approved for public release by the director of the National Institute of Standards and Technology (NIST) on October 9, 2015

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I. Introduction.

Precision back-silvered glass reflectors, as manufactured by the Bausch and Lomb Optical Company for use in the AN/AVQ-2A aircraft searchlight, have been characterized in the past by a "roll-off" edge. This outer annular zone, amounting to about 1/2 inch of radial depth, departs from a parabolic figure to such an extent that its contribution to the beam emitted by the searchlight is negligible. Recent improvements in the manufacturing process have permitted maintenance of the parabolic figure much closer to the edge of the reflector. A sample of such a "non-roll-off" reflector (#A324) was submitted by the manufacturer to the National Bureau of Standards in July 1953 for evaluation tests.

II. Scope of Test.

This report gives the results of photometric tests conducted on an AVQ-2A aircraft searchlight equipped with a non-roll-off precision reflector (#A324). For comparison, results are also given on similar tests of a searchlight equipped with conventional reflectors having roll-off edges. Two reflectors of the latter type were selected for the tests - #A5149 and #A6375, respectively the best and the poorest of those available.

III. Test Procedure.

Candlepower distribution measurements were made on a 277-meter (909 ft.) outdoor range. The searchlight was mounted on a goniometer at one end of the range and the illumination measured at the other end with a luminosity-corrected photocell whose output was fed into one axis of a Leeds & Northrup automatic recorder. In order to obtain horizontal candlepower distributions, the goniometer on which the searchlight was mounted was rotated around its vertical axis so that the beam traversed the photocell. Vertical distributions were obtained in a similar manner by rotation of the goniometer around its horizontal axis. Runs of 50-second duration were made at 0.5-degree intervals, and the average candlepower of the last 30 seconds of each run, allowing 20 seconds for stabilization, was computed. Two runs were made at each point in the distributions, except at the peaks where at least 10 runs were made.

An AVQ-2A searchlight with modifications as described in NBS Report 1354, "Instruction Book for Modification of the AVQ-2A Aircraft Searchlight", was used for the tests. This light burns 11 mm carbons, and

normally draws an arc current of 120 amperes. Previous experience has shown, however, that more stable operation can be obtained at reduced current. For these tests, therefore, the current was held at approximately 104 amperes. A special arc-regulating circuit was employed which limited the current variation to about ± 4 amperes. The optical figure and surface quality of each reflector was evaluated by examining the projected shadow patterns for each reflector as obtained on a shadow-projection device designed and built by NBS for this purpose. The general operating principle of this device is described in NBS Report 2234, "Methods of Focusing the AVQ-2A Aircraft Searchlight" (Focusing Method #3) and in the NBS Technical News Bulletin for June 1953, pp. 93-94.

IV. Results.

Figure 1 gives the average horizontal and vertical candlepower distributions of the AVQ-2A searchlight when equipped with each of the three reflectors tested. Since the arc was operated at reduced current (104 amperes) for these measurements, the candlepower obtained was appreciably lower than that which would have been obtained at the normal operating current of 120 amperes. However, the curves may be used for intercomparison of the relative performance of the three reflectors.

The difference in the two types of reflectors is demonstrated by a comparison of their shadowgraphs; Figs. 2 and 3 are those of the roll-off type, and Fig. 4 that of the non-roll-off type. The effect of the non-roll-off edge of the improved reflector (A324) is shown by the straight, clear corners of the projected shadow of the square diaphragm and the visibility of the Bausch & Lomb trade mark etched near its periphery as contrasted to the rounded corners of the diaphragm shadow and the almost complete absence of the trade marks in the shadowgraphs made with the conventional reflectors. The trade marks are similarly located on all three reflectors. The roll-off zone on the unimproved reflectors is about 1/2 inch in radial depth and amounts to about 10% of the projected area of the reflectors.

V. Discussion.

The differences in the candlepower distributions of the three reflectors are small. Accurate determination of these differences is difficult because of the inherent instability of the arc lamp, even when operated at reduced closely controlled current, and also because of the variability of arc carbons. Since the values of peak candlepower are based on considerably more data, they are more reliable than values obtained elsewhere in the candlepower distributions.

Inasmuch as the effective area of the non-roll-off reflector (#A324) is about 10% greater than that of the other two, it was anticipated that its peak candlepower value would be correspondingly greater. However, as

may be seen in Fig. 1, its peak value is somewhat less than that obtained with conventional reflector #A5149. An examination of Figs. 2 and 4 shows the figure of #A5149 to be exceptionally good, while that of #A324 has characteristic pin-cushion distortion.

It thus appears that the advantage of the additional peripheral zone with the non-roll-off reflector is compensated for in the case of A5149 by the excellent quality of its figure. The peak candlepower obtained with the non-roll-off reflector is, however, about 7% higher than that obtained with the other conventional reflector (#A6375). It is probable that the superiority of the non-roll-off reflector in this case is partly due to the additional contribution of the peripheral zone and partly to its superior figure quality, as shown by the shadow-patterns in Figs. 3 and 4.

It is significant that what appears to be considerable difference in the quality of the three reflectors corresponds to relatively small differences in performance. The quality of superior samples of drop-molded reflectors approaches that of #A6375, the poorer of the two conventional precision reflectors. It may be that the standard of quality for searchlight reflectors presently specified could be reduced to some extent without appreciable loss of performance.

A non-roll-off reflector is estimated to provide 10% more light flux in the beam than an otherwise equivalent conventional reflector. The candlepower measurements made in this test were not sufficiently extensive nor of sufficient accuracy, especially in the off-axis parts of the beam, where zonal contributions to total flux are very high, to verify this expectation reliably. It is felt, nevertheless, that the non-roll-off feature is desirable and that future procurement should call for reflectors with this feature.

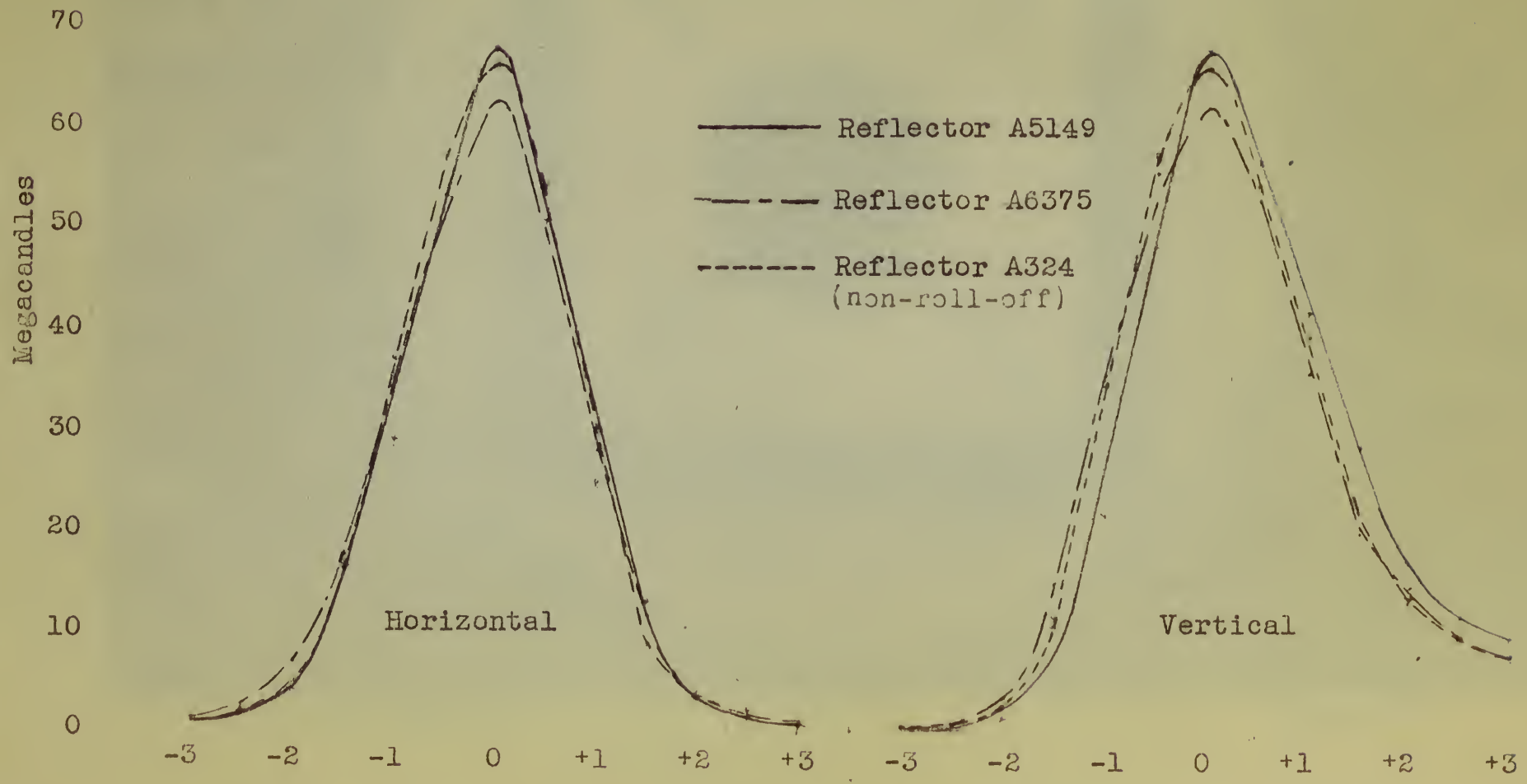
AVERAGE CANDLEPOWER DISTRIBUTIONS

AVQ-2A AIRCRAFT SEARCHLIGHT

EQUIPPED WITH TWO CONVENTIONAL GLASS REFLECTORS

AND

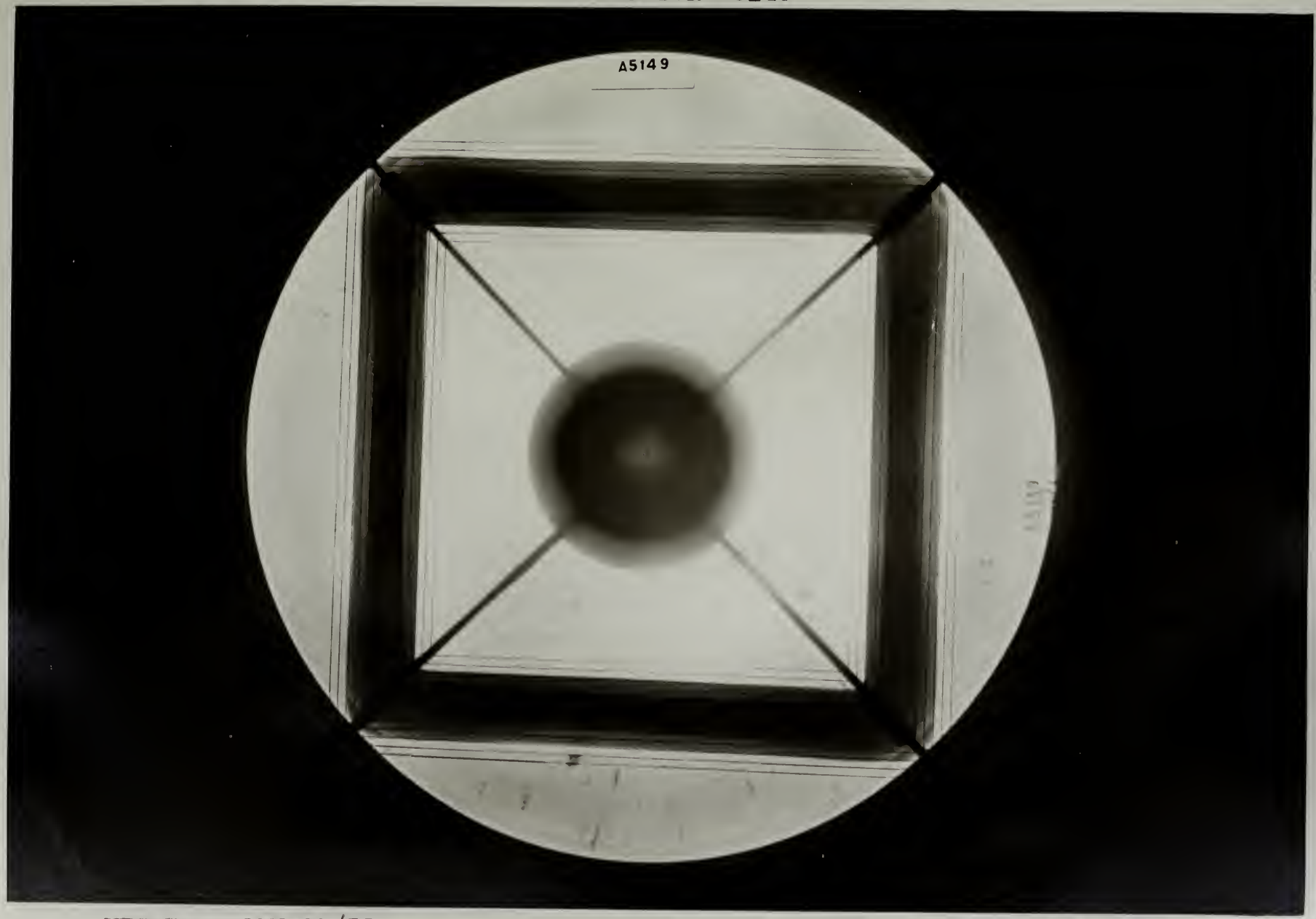
EQUIPPED WITH A SPECIAL "NON-ROLL-OFF" GLASS REFLECTOR



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Figure 1

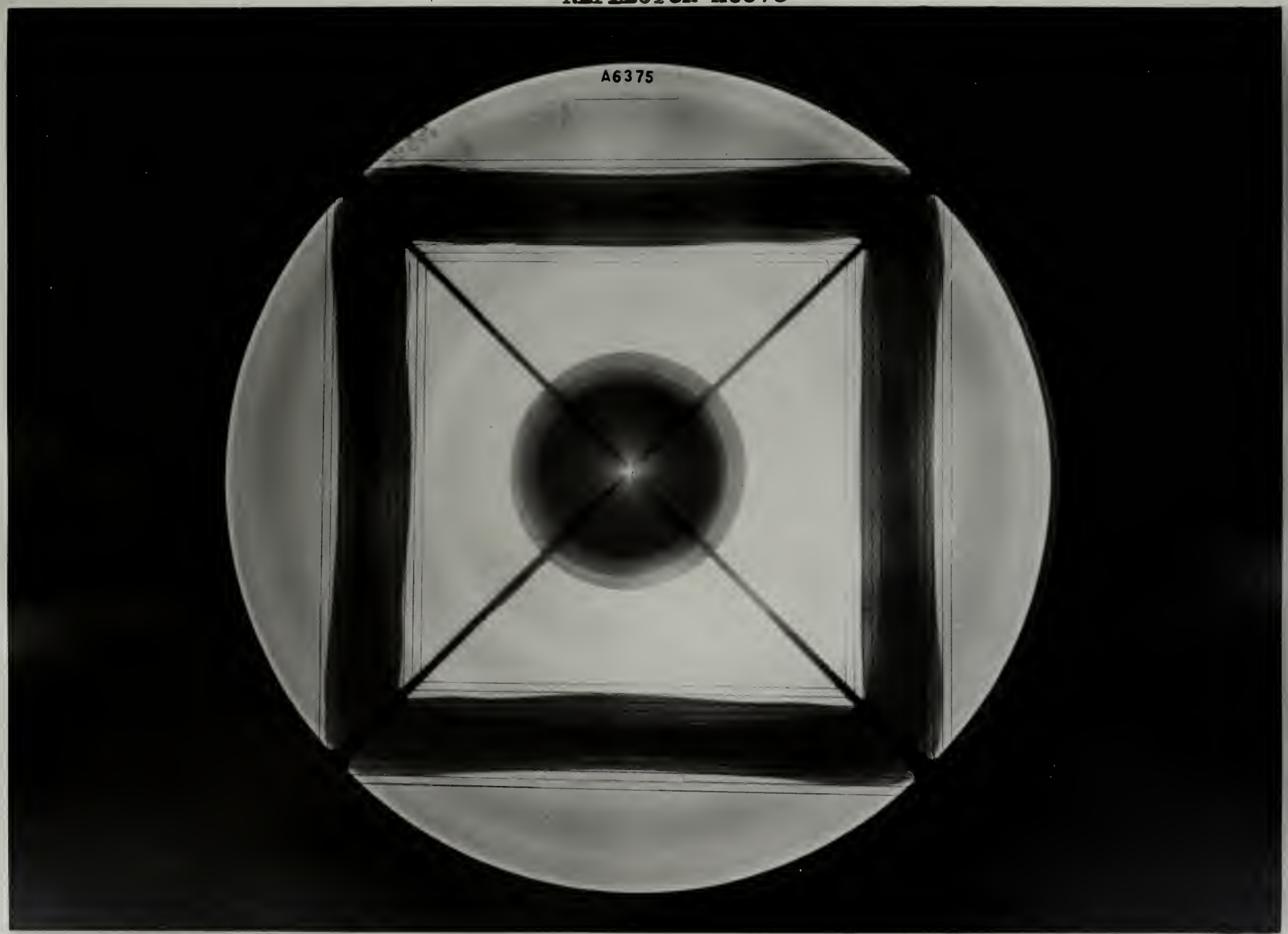
PROJECTED SHADOW PATTERN
REFLECTOR A5149



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Figure 2

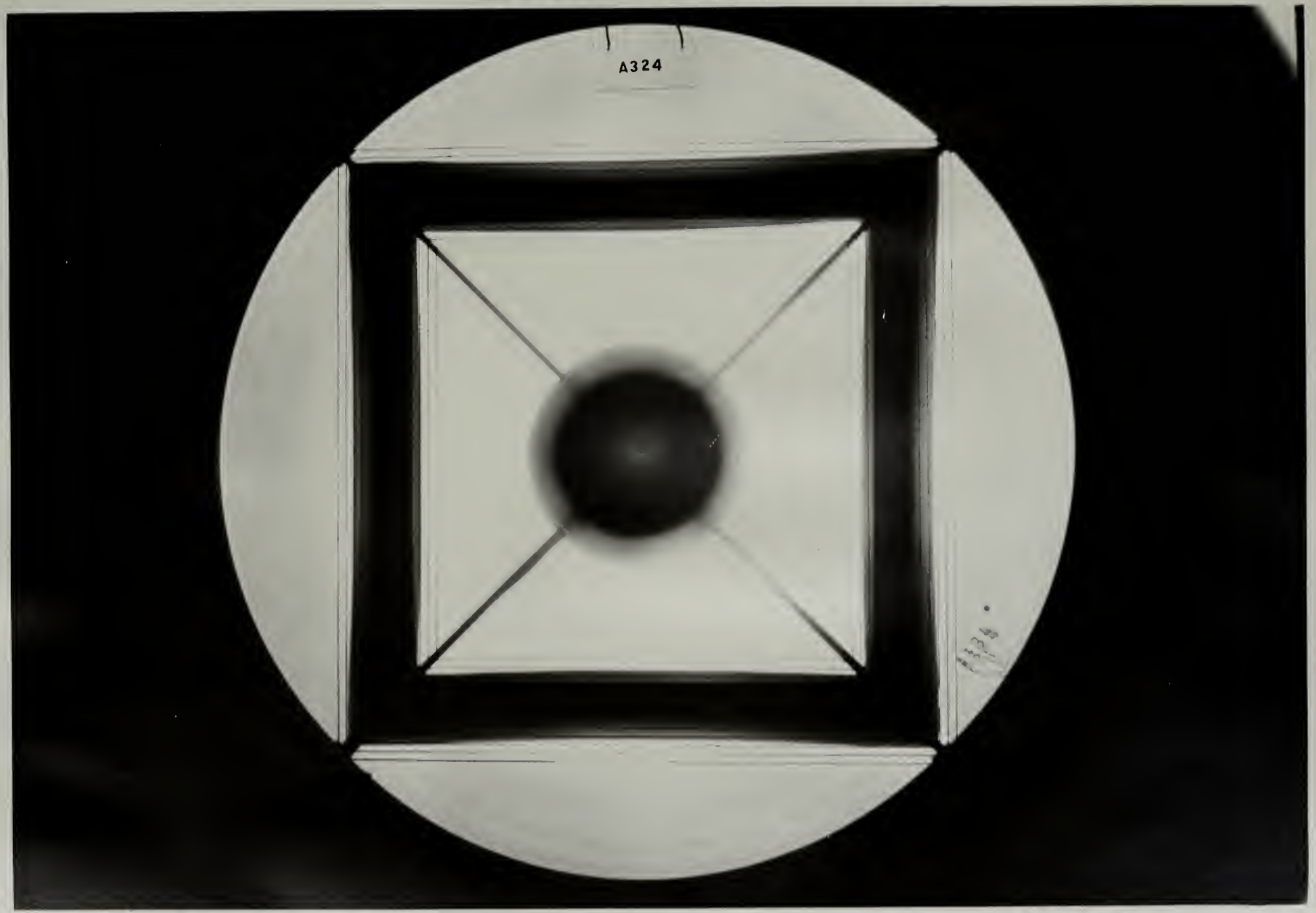
PROJECTED SHADOW-PATTERN
REFLECTOR A6375



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Figure 3

PROJECTED SHADOW PATTERN
"NON-ROLL-OFF" REFLECTOR A324



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Figure 4