File Copy
Drafting Room

REPORT NO. R-2067

DATE May 17, 1943

SUBJECT

Portable Ultra-Violet Lantern

[redacted]

FR-2067

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

U. S. GOVERNMENT PRINTING OFFICE 16—21908

May 17, 1943

NRL Report No. M-2067

NAVY DEPARTMENT

Report on

Portable Ultra-Violet Lantern

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Number of pages: Text 4 Plates 5

Authorization: Bureau of Ships Project Order No. 2218/42.

Date of Tests: March, April, 1943.

Prepared by: _____
E. O. Hulburt, Superintendent
Physical Optics Division

Approved by: _____
A. H. Van Keuren, Rear Admiral USN
Director

Distribution: BuShips (20)

ii

PLATES

ABSTRACT

A portable ultra-violet lantern, weighing about 4 pounds, is described which gave a fluorescent illumination sufficient to enable one to perform various tasks on the topsides of darkened ships at night, and which was not visible beyond about 500 yards to observers with unaided eyes.

1. Authorization. The present work was carried out under the authorization of the Bureau of Ships Project order No. 2218/42 of 11 March 1942.

2. References.

(a) Coordinator of Research and Development letr. to NRL, February 22, 1943, "Night illumination by ultra-violet."

3. The problem. Portable hand lanterns were desired which would satisfy simultaneously two mutually antagonistic requirements.

(a) The lanterns should provide illumination on the topsides of of darkened ships at night sufficient to enable one to see objects, handle gear and perform various tasks.

(b) The lanterns themselves should not be visible to observers with unaided eyes at distances beyond about 500 yards.

4. The problem was brought to attention by the United States Coast Guard, reference (a), who had witnessed a demonstration of ultra-violet lanterns. A somewhat similar problem had led this Laboratory to the development of certain ultra-violet lanterns, and it was only necessary to modify these to some extent in order to examine their adaptation to the present case.

5. Preliminary experiments had brought out the following fact: A point source of visible light, whose visual range on a very dark night to an average good-sighted dark adapted observer was 500 yards with unaided eyes, is too weak to illuminate an object usefully unless it is held within a few inches of the object. For example, when such a source and the eyes of an observer are both at 4 feet from a 1 foot square white card in total darkness, the white card is just visible to the observer. Therefore, visible lanterns used directly do not satisy the two requirements of paragraph 3, because they are too visible to a distant observer and do not provide enough illumination to a near-by observer. Conceivably, an indirect use of visible lanterns might be envisaged, such as lanterns with screened lights and a gravity switch so devised that the light would be extinguished when the lantern was tilted so that its light showed above the horizontal plane. Such devices have been considered, but may be awkward to use and may not afford essential security.

6. The ultra-violet lantern shown in the photograph of Plate 1 and the diagram of Plate 2 was found to satisfy to a certain extent the requirements of paragraph 3. The lantern weighed about 4 pounds of which about 2 pounds was due to the dry cells. An RP12 fluorescent lamp, Westinghouse Electric Manufacturing Company, served as a source of ultra-violet light. It operated on 28 volts, 4 watts, from 4 Burgess "C" batteries No. 5540, connected in series and held in compartment B, Plate 2. The electrical circuit is shown in Plate 3. The reflector was 3.5 inches in diameter of spun aluminum. The fluorescent lamp was screened by a filter of corning glass "Violet ultra" 5 millimeters thick.

7. The intensity curve of the light from the lantern is shown in Plate 4. When lighted intermittently, "on" for 10 minutes and "off" for 50 minutes, the life of the batteries was about 12 hours, or 2 hours of lighted life. When lighted continuously the intensity fell off with the time according to the curve of Plate 5, the light going out after about 60 minutes; during the last 15 minutes of the curve the intensity flickered increasingly. After a 24 hour rest the dry cells recovered to some extent. To obtain a longer life dry cells of larger capacity than No. 5540 "C" would be required; these would increase the weight of the lantern.

8. Tests on Navy ships operating at night under darkened conditions, showed, as is well known, that many objects fluoresced and hence were visible when illuminated by the light from the ultra-violet lantern. Such objects were painted and varnished surfaces, natural wood, old and new manilla line, cloth, oiled, greased and tarred objects and parts. In general most organic and many inorganic materials fluoresce to a greater or less extent under ultra-violte light; clean metal surfaces do not; glass, unless of a special type, usually fluoresces weakly. The personel of the ships concluded that the lanterns gave an illumination useful for performing various tasks on the topsides, as adjusting a gun, handling lines, finding one's way about, etc.

9. The illumination of the shipboard objects by the lantern was due entirely to the natural fluorescence of the objects. The fluorescence of any particular object or important part could of course be enhanced greatly by painting with fluorescent paint.

10. The visual range of the lantern was determimed on a clear night with no moon by a number of observers, the observers being on the ship and the lantern being carried away to various known distances. The following observations were made:

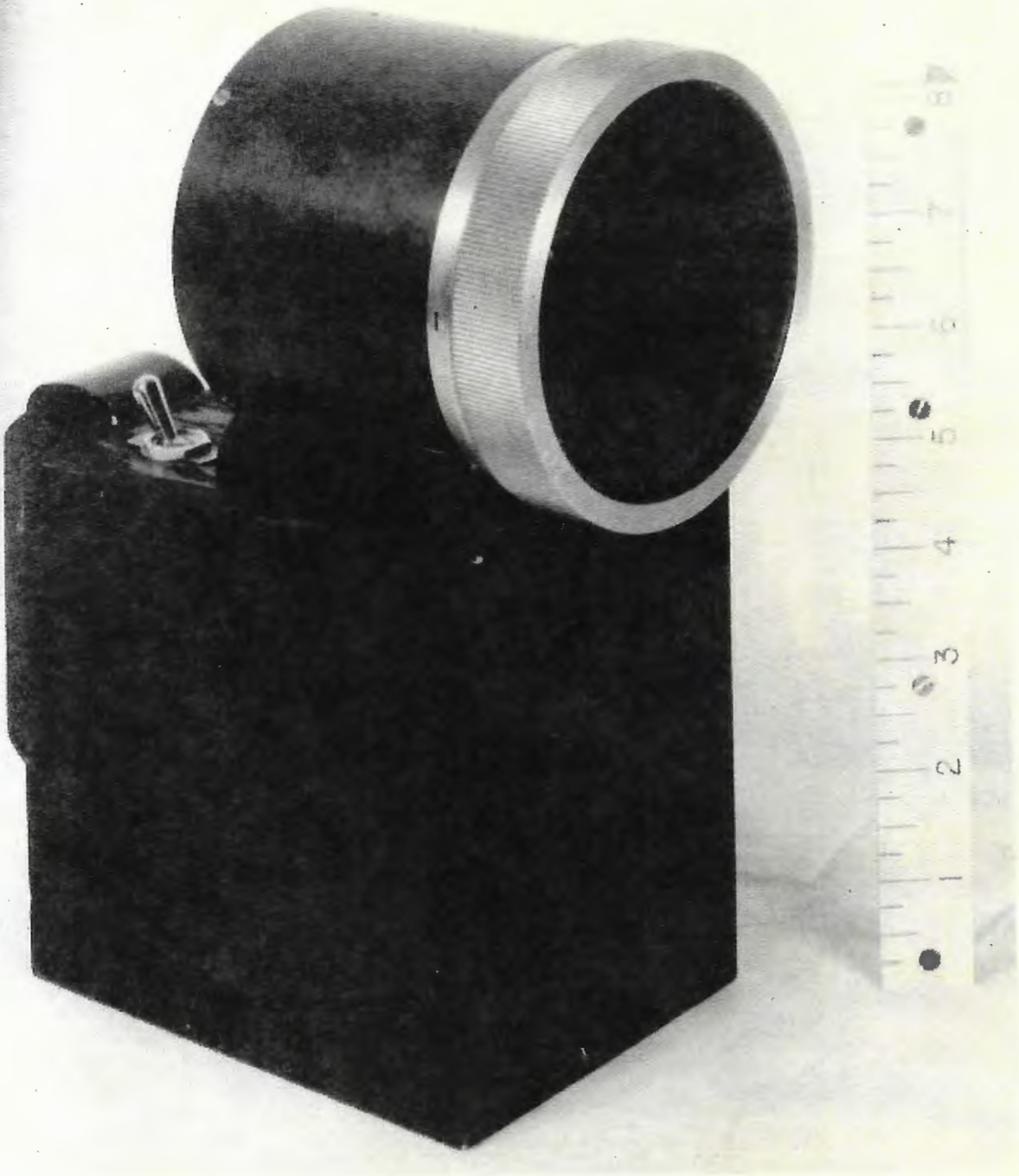
	Visual range
observers, 23 to 26 years old, with unaided eyes	500 yards
observers, 23 to 26 years old with 6 x 30 binoculars	1000 yards
observers, 42 to 52 years old, with unaided eyes	100 - 150 yards

11. It was observed that the lantern did not disturb dark adaptation appreciably even if held for some minutes within six inches of the eyes. The eyes were of course filled with the usual fluorescent blue glow when the lantern was directed at the eyes, but upon removal of the lantern the blue glow disappeared instanteously and within less than 5 seconds the observer had recovered his dark adaptation completely. It is hardly necessary to mention that the ultra-violet light from the lantern, being the wave-length region from about 3300 to 3900A is entirely harmless to

the eyes. The amount of such radiation in daylight is very much greater than in the lantern.

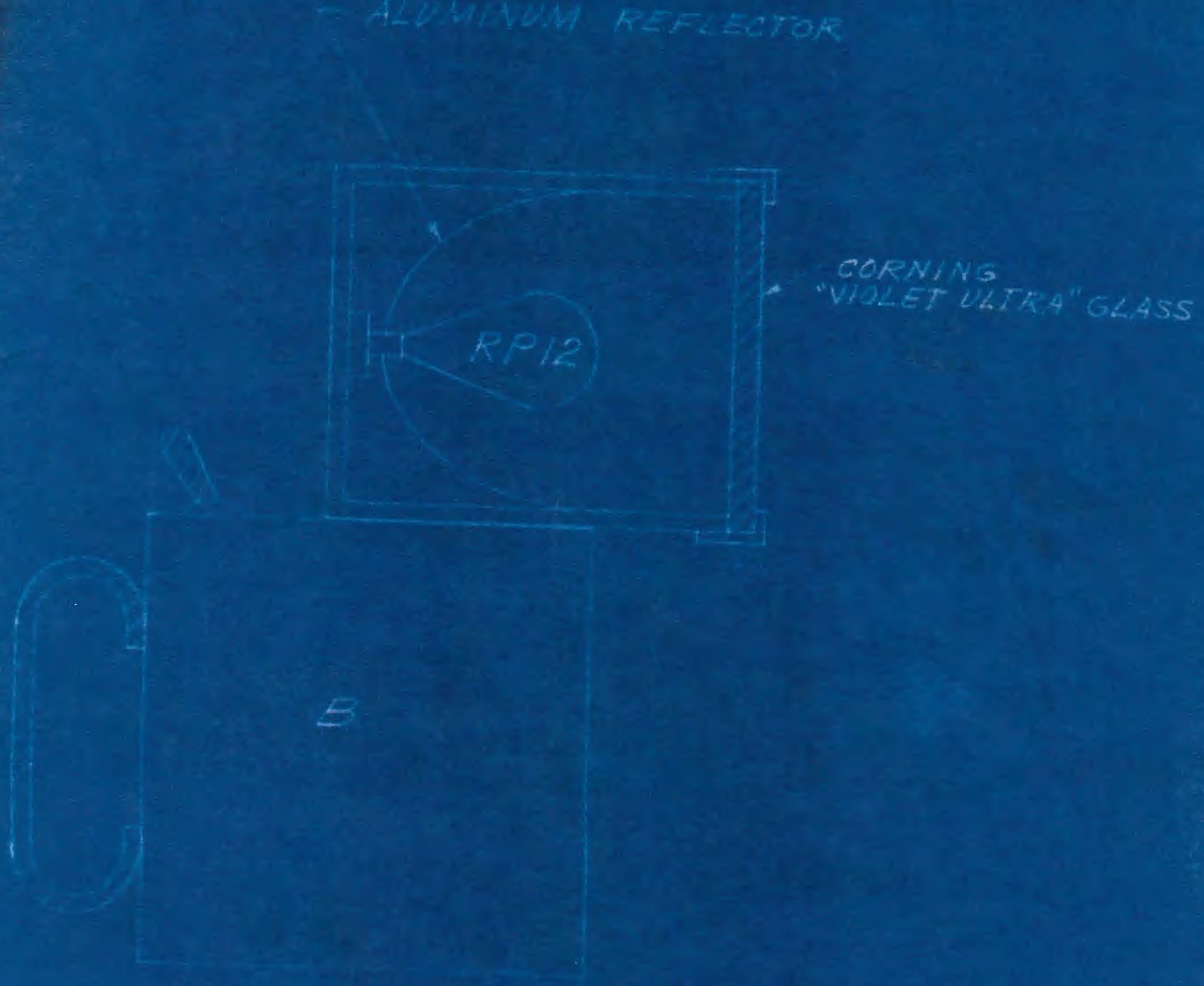
12. The above lantern appeared to be the most efficient that could be readily devised from available commercial products. The RP12 bulb is among the most efficient sources of ultra-violet light in the region 3300 to 3900A, since it was developed especially for fluorescent purposes. The life and uniformity of the RP12 bulbs are not known. The Violet Ultra-filter is conceivably open to improvement, for at the wave-length 3600A of maximum transmission a 5 mm thickness of Violet Ultra transmits only about 30 percent. However, the development of an improved filter, which transmits more light at 3600 A and at the same time no more above 3900A than Violet Ultra, does not seem immediate, because the desirability of such an improvement has been apparent for a long time.

13. Finally, the life of the lantern described here is rather short, due to the small capacity of the dry cells. A longer life would probably be desirable, and this will require larger, and hence heavier, dry cells, A proper compromise between battery life and weight must be decided upon by any one planning to use the lanterns.



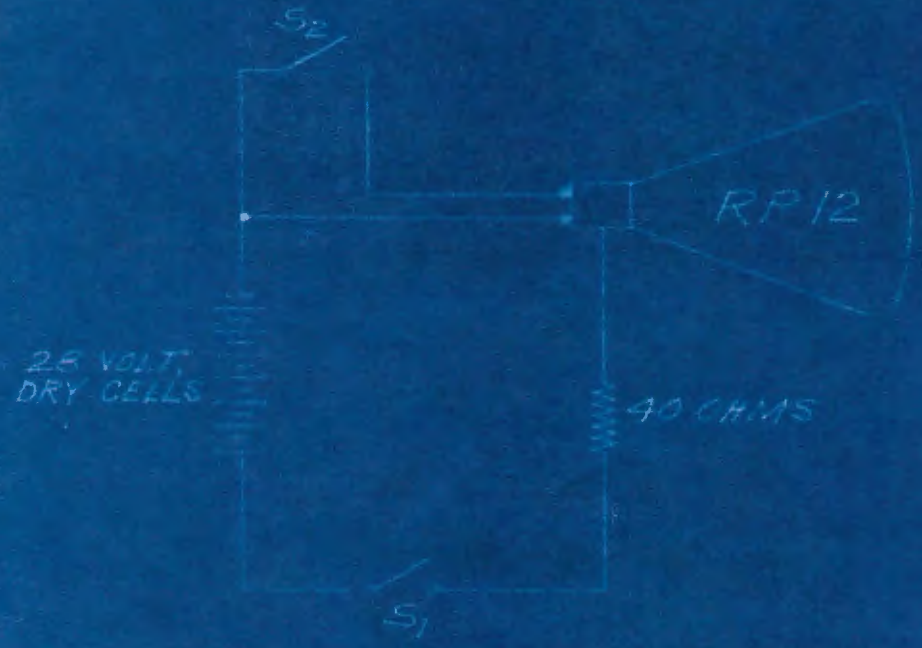
ULTRA-VIOLET LANTERN

PLATE I



ULTRA-VIOLET LANTERN

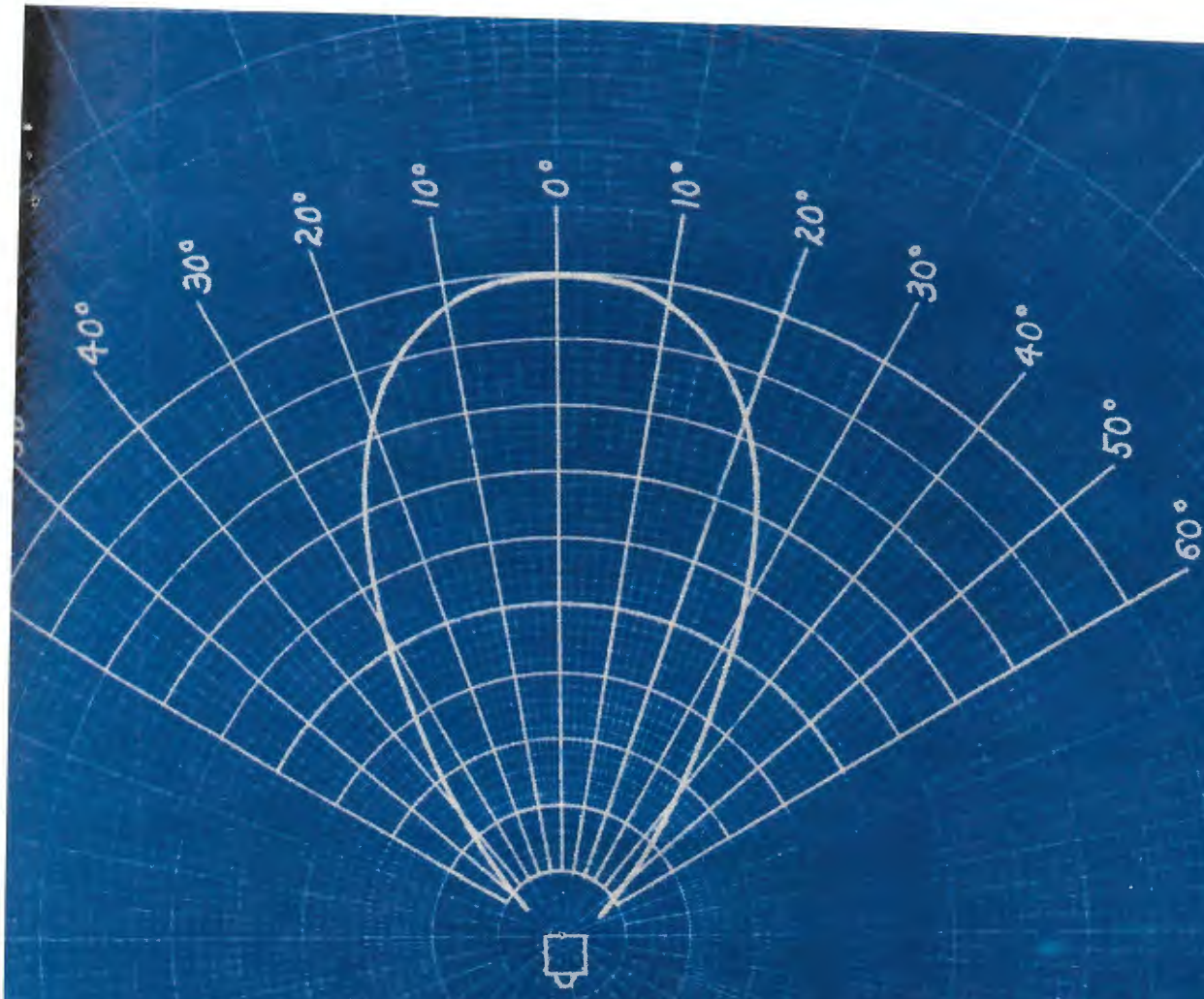
PLATE 2



TO LIGHT RP12 BULB, CLOSE MAIN TOGGLE SWITCH S_1,
CLOSE PUSH-BUTTON S_2 FOR 5 TO 10 SECONDS AND RELEASE.

CIRCUIT OF ULTRA-VIOLET LANTERN

PLATE 3



INTENSITY DISTRIBUTION
OF ULTRA-VIOLET LANTERN

PLATE 4

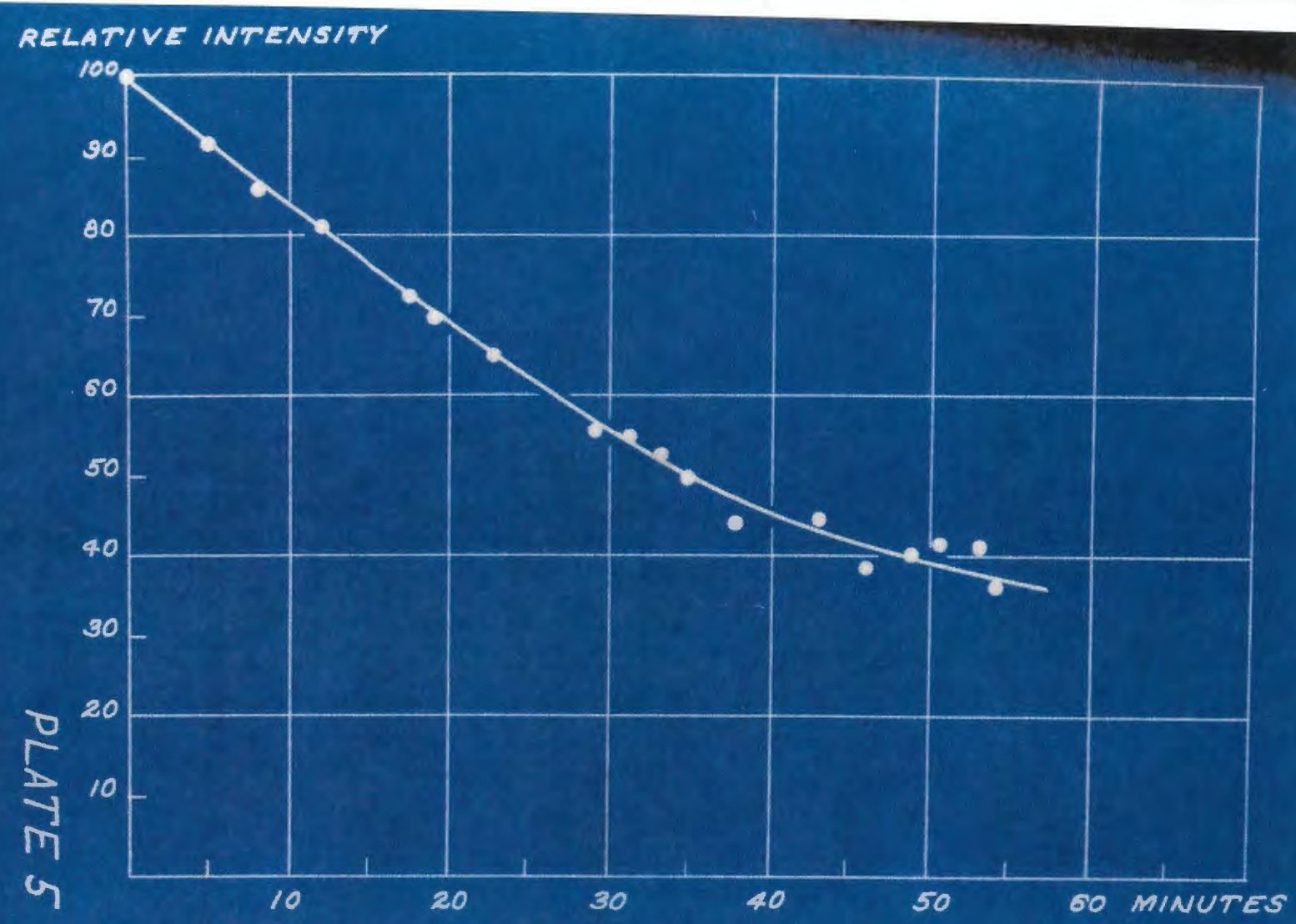


PLATE 5

LIFE TEST OF ULTRA-VIOLET LANTERN