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Effect of Painting Type 327A and 227A Transmitting Tubes For Blackout Purposes

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Report on

Effect of Painting Type 327A and 227A Transmitting Tubes For Blackout Purposes

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EFFECT OF PAINTING TYPE 327A AND 227A TRANSMITTING TUBES FOR BLACKOUT PURPOSES

1. Introduction. In a letter from the Bureau of Ships, reference (a), it was requested that the Naval Research Laboratory furnish information as to any detrimental effects which might result from painting type 327A and 227A tubes in order to cut down the emission of visible light. Reports from the fleet indicated that the light from these tubes in some installations made it very difficult to maintain a complete blackout. A brief report of preliminary tests at the Naval Research Laboratory was given in a letter to the Bureau of Ships, reference (b). The following report covers all the tests on painted tubes, including the data in reference (b).

Reference (a) Letter, Chief BuShips to Director, NRL, Radar, Model SC, SC-1, Effect of Painting Type 227A and 327A Transmitter Oscillator Tubes, Request for information, C-S67-5/38(982C) Serial C-982-3480, dated 6 November 1942.

Reference (b) Letter, Director NRL to Chief BuShips, Att: Comdr. W.A. Eaton, Radar, Model SC, SC-1, Effect of Painting Type 327A and 227A Transmitter Oscillator Tubes, C-S67/36(SC)(375), dated 28 November 1942.

2. Abstract of Tests. Tests were made to determine the suitability of Glyptal as a paint for "blacking-out" type 227A and 327A tubes. Experiments were made to determine the best way to reduce the emission of light from the tubes and still get satisfactory performance. The tests led to the following conclusions and recommendations:

(a) Red or gray Glyptal seems to be a satisfactory paint to use if tubes must be painted for blackout purposes. The best results were obtained when red Glyptal was sprayed on and dried in an oven for two hours at 125° C.

(b) Tubes which were completely painted, except for the lead projections, sparked over from grid to plate leads when placed in an oscillator circuit. Completely painted tubes are unsatisfactory in SC and SC-1 transmitters.

(c) The tubes will operate satisfactorily only if the bulge opposite the anode, as well as the lead projections, are left unpainted. This reduces the emission of light to about 20% of that from an unpainted tube. Tubes painted in this way appear to have a life at least 75% that of unpainted tubes. If type 227A or 327A tubes are to be painted, the bulge opposite the anode and the lead projections must be left unpainted.

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(d) A complete blackout of a Radar transmitter can only be obtained by properly screening the transmitter. Painting the tubes should be considered only as a temporary emergency expedient.

3. Choice of Paint. The paint to be used must be relatively opaque, be readily available, be able to withstand relatively high temperatures, and be a good insulator. On the basis of past experience on similar problems, it was decided to use red Glyptal paint, which is manufactured by the General Electric Company, for the tests on painted tubes. Some test samples were made by painting glass slides with red and gray Glyptal; some were painted by hand and others had the Glyptal sprayed on them and then baked in an oven at 135° C for two hours. The transmission of visible light through these slides was from 1 to 5%, depending on the thickness, being about the same for both red and gray Glyptal. Electrodes were then applied to the test samples and in no case was there any indication of electrical breakdown with potential gradients up to 3,000 volts per cm; no tests were made at higher gradients. These tests indicated that either red or gray Glyptal would be satisfactory, but red Glyptal was chosen primarily for physiological reasons. Red light interferes less with "dark adaptation" and the peripheral perception of the eye is less for red light. Red Glyptal may also absorb less of the near-infrared radiation and thus the bulb might not become quite as warm.

4. Temperature of Tube Envelope. Temperature measurements were made by applying a thermocouple to various parts of the envelope of an unpainted tube. The highest temperatures were observed at the four spots on the upper part of the tube directly opposite the holes in the anode cap through which the filament can be seen; at these spots the temperature ranged from 180 to 200° C with only the filament on and the anode cold. Application of a coat of red Glyptal raised the temperature at these spots about 10° C. In service, the heating of the anode will cause a further increase in bulb temperature, but in the SC and SC-1 equipments the anode is relatively cool. Glyptal will change color if the temperature goes much above 200° C.

5. Life-Test Oscillator. Samples of painted tubes were placed in a 2-tube 200 mc grounded-anode life-test oscillator which had self-quenched grid keying, a 5 microsecond pulse and a 60 per second recurrence. The tubes operated under essentially the same conditions as if in the SC-1 and similar to that in the SC transmitter. Considerable data had already been obtained on the life of unpainted tubes in this oscillator.

6. Tests on Completely Painted Tubes. A type 327A tube was completely painted with red Glyptal except for the glass projections on the grid and plate leads. When this tube was placed in the life-test oscillator and paired with another 327A tube, sparkover was observed over the painted glass surface from grid to plate leads. Sparkover was first observed when the plate voltage was about 12 Kv

and became excessive for plate voltages over 13 Kv. Unpainted tubes will work satisfactorily in this oscillator with a plate voltage of 15 Kv. Since these tubes operate with a plate voltage up to 15 Kv in the SC-1 equipment, unsatisfactory operation would result if completely painted type 327A tubes were to be used. This tendency for sparkover would be even more pronounced for type 227A tubes because of the smaller spacing between grid and plate leads.

7. Tests on Partially Painted Tubes. Two type 327A tubes were then painted by hand, as shown in Plate I, leaving the bulge just opposite the anode, as well as the lead projections, unpainted. Since no light is emitted through the anode, leaving the bulge unpainted permits no light to escape directly from the filament and permits only scattered light to escape. In operation the anodes are only a very dull red and consequently emit only a slight amount of visible light. These tubes gave no trouble from sparkover at anode voltages up to 15 Kv even after several hundred hours in a life-test oscillator. However, the paint tends to flake off as is shown in Plate I, which was made after the tubes had run 150 hours in the oscillator. Two type 327A tubes were then painted, as shown in Plate II, by spraying red Glyptal on the tube and drying them in an oven for two hours at 125° C. Except for a slight darkening, the paint on these tubes was satisfactory after 300 hours use in an oscillator. This shows that spraying the tubes, and drying the paint in an oven, is superior to hand-painting. The 227A tubes were also painted by spraying Glyptal on them as shown in Plate III.

8. Life-Tests on Partially Painted Tubes. The life test data on the partially painted tubes is given in Table I. The average life of the 4 type 327A tubes was 283 hours when operating with an anode voltage of 15 Kv. The average life for the 2 type 227A tubes was 440 hours with an anode voltage of 10 Kv. From previous tests at Naval Research Laboratory the average life of unpainted 327A tubes under similar conditions is about 390 hours and about 480 hours for unpainted 227A tubes. The difference in average life between painted and unpainted tubes is 27% for the 327A and 8% for the 227A. These data, however, are too few to accurately determine the change in average life, but they indicate that partially painting the tubes as shown in Plates II and III should not reduce the life of the tubes by more than 25%.

9. Blackout of Radar Transmitters. If a radar transmitter must be blacked-out, painting the tubes is not the recommended method except as an emergency measure. Before resorting to painting the tubes, every effort should be made to either provide suitable baffles so that light from the transmitter cannot be seen from the outside or to locate the transmitter in a room that does not need to be blacked out. In new designs the transmitter case should be so constructed that an excessive amount of light does not escape; for example, the side panels could have louvres instead of punched holes. Such panels would have an additional advantage in that any possible x-ray radiation would be eliminated. If these panels interfere with the normal air circulation, it will be necessary to furnish a blower.

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10. Conclusions and Recommendations. These tests on painted tubes lead to the following conclusions and recommendations:

(a) Red or gray Glyptal seems to be a satisfactory paint to use if the tubes must be painted for blackout purposes. The best results were obtained when red Glyptal was sprayed on and dried in an oven for two hours at 125° C.

(b) Tubes which were completely painted, except for the lead projections, sparked over from grid to plate leads when placed in an oscillator circuit. Completely painted tubes are unsatisfactory for use in SC and SC-1 transmitters.

(c) The tubes will operate satisfactorily only if the bulge opposite the anode, as well as the lead projections, are left unpainted. This reduces the emission of light to about 20% of that from an unpainted tube. Tubes painted in this way appear to have a life at least 75% that of unpainted tubes. If type 227A or 327A tubes are to be painted, the bulge opposite the anode and the lead projections must be left unpainted.

(d) A complete blackout of a radar transmitter can only be obtained by properly screening the transmitter. Painting the tubes should be considered only as a temporary emergency expedient.

Table I

Life Test Data on Partially Painted Tubes

Oscillator: 2-tube 200 mc life-test oscillator; self-quenched grid-keying, 7 microsecond pulse, 60 cycle repetition.

Oscillator Voltages: 10.5 volts on filaments and 15 Kv on anodes for 327A; 10.5 volts on filaments and 10 Kv on anodes for 227A tubes.

Test Voltages: Filament current measured with 10.5 volts on filaments. Filament emission measured at an anode voltage of 2.5 Kv and the grid connected to the anode through a 100 ohm resistor. Grid emission measured at a grid heating current of 200 ma. Cut-off ratio measured at 3,000 volts with a plate current of 1 ma.

Tube Serial Number	Total Hours Use	Filament Current (Amp.)	Filament Emission (Amp.)	Grid Emission (ua)	Cut-off Ratio
I2-42472	Hand Painted (See Plate 1).				
Type 327A	0	11.0	33	20	22.6
	36	11.1	--	40	22.7
	188	11.59	--	8	22.6
	299	11.90	--	--	21.7
	299	Failure: Filament-emission curve very irregular indicating that some gas was present. Filament open-circuited during this test.			
H2-6393	Hand painted (See Plate I).				
Type 327A	0	10.40	33	0	21.9
	113	10.80	--	20	20.5
	177	11.00	--	10	19.9
	184	Failure: Hole through anode and glass. There apparently was some grid distortion which was also indicated by decreasing cut-off ratio.			
H2-11682	Paint sprayed on and dried in an oven (See Plate II).				
Type 327A	0	10.82	33	0	23.2
	113	11.10	--	15	21.5
	177	11.25	--	5	21.0
	348	11.60	--	10	14.0
	348	Low cut-off ratio indicates excessive filament or grid distortion. Although tube no longer good for satisfactory operation, run was continued.			
	409	10.90	30	10	13.8
	409	Failure: Gassy, grid seal cracked while in oscillator.			

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Table I (Cont'd.)

Tube Serial Number	Total Hours Use	Filament Current (Amp.)	Filament Emission (Amp.)	Grid Emission (ua)	Cut-off Ratio
I2-37107 Type 327A	Glyptal sprayed on and dried in an oven (See Plate II).				
	0	11.0	33	15	21.7
	160	11.27	—	20	20.0
	221	11.40	29	10	19.8
	299	Failed during filament emission test; grid to filament short. Decreasing cut-off ratio indicates some distortion which probably contributed to failure of tube.			
3267T Type 227A	Glyptal sprayed on tube and dried in an oven (see Plate III).				
	0	10.6	32	40	20.0
	293	Failure: Gassy.			
6034W Type 227A	Glyptal sprayed on tube and dried in an oven (see Plate III).				
	0	10.8	33	10	21.4
	293	11.53	24	0	21.9
	546	12.17	--	--	22.0
	587	12.27	20	—	24.2
	587	Failure: Low Filament Emission.			

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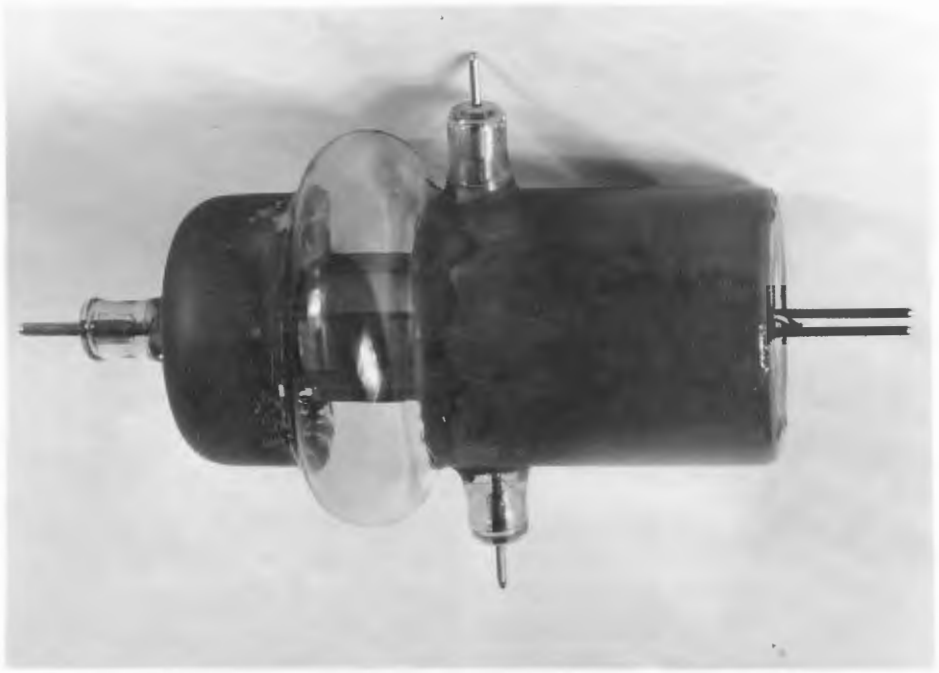

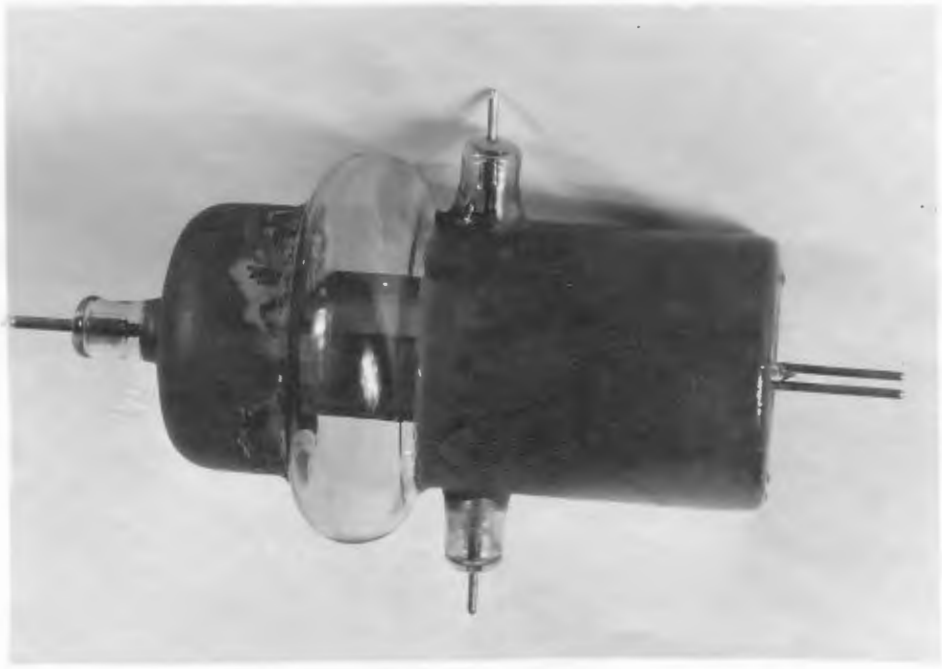

PLATE I

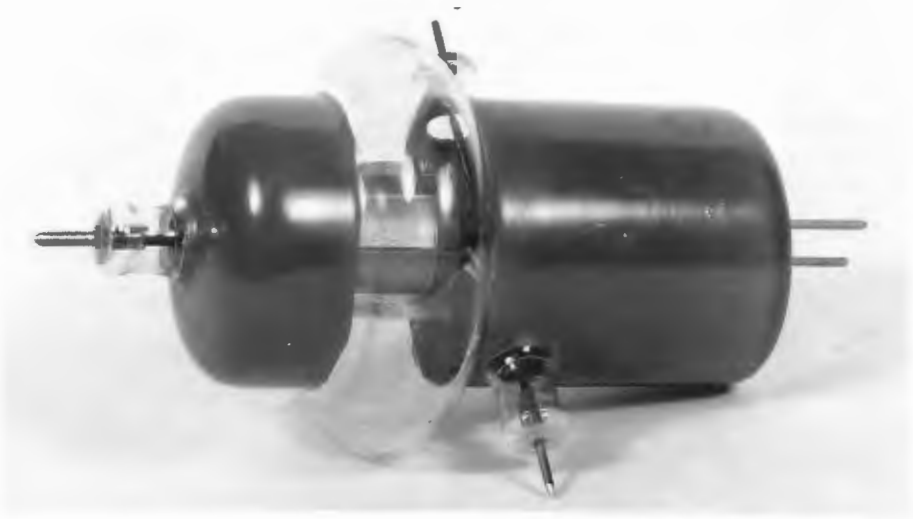

PLATE 2

PLATE 3