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QUARTZ LASER PUMP SOURCE LAMPS.(U)

JAN 69 P G CHACONAS DAAK02-68-C-0105

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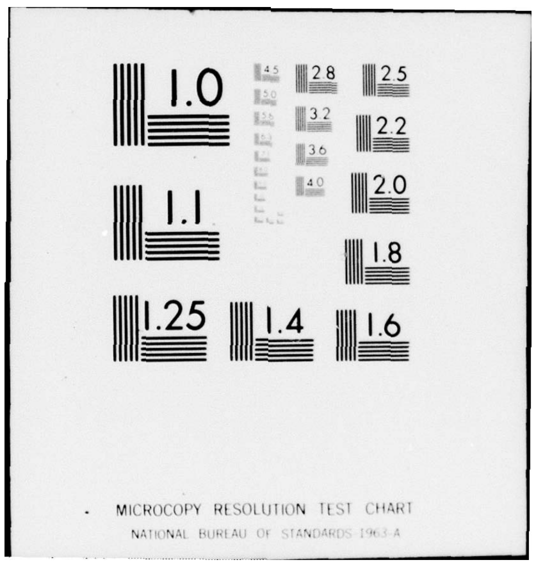
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QUARTZ LASER PUMP SOURCE LAMPS

Final Report

by P.G. Chaconas

January 1969

Night Vision Laboratory
Fort Belvoir, Virginia

DAAK02-68-C-0105

UNCLASSIFIED

PGC Corp., Bethesda, Md.

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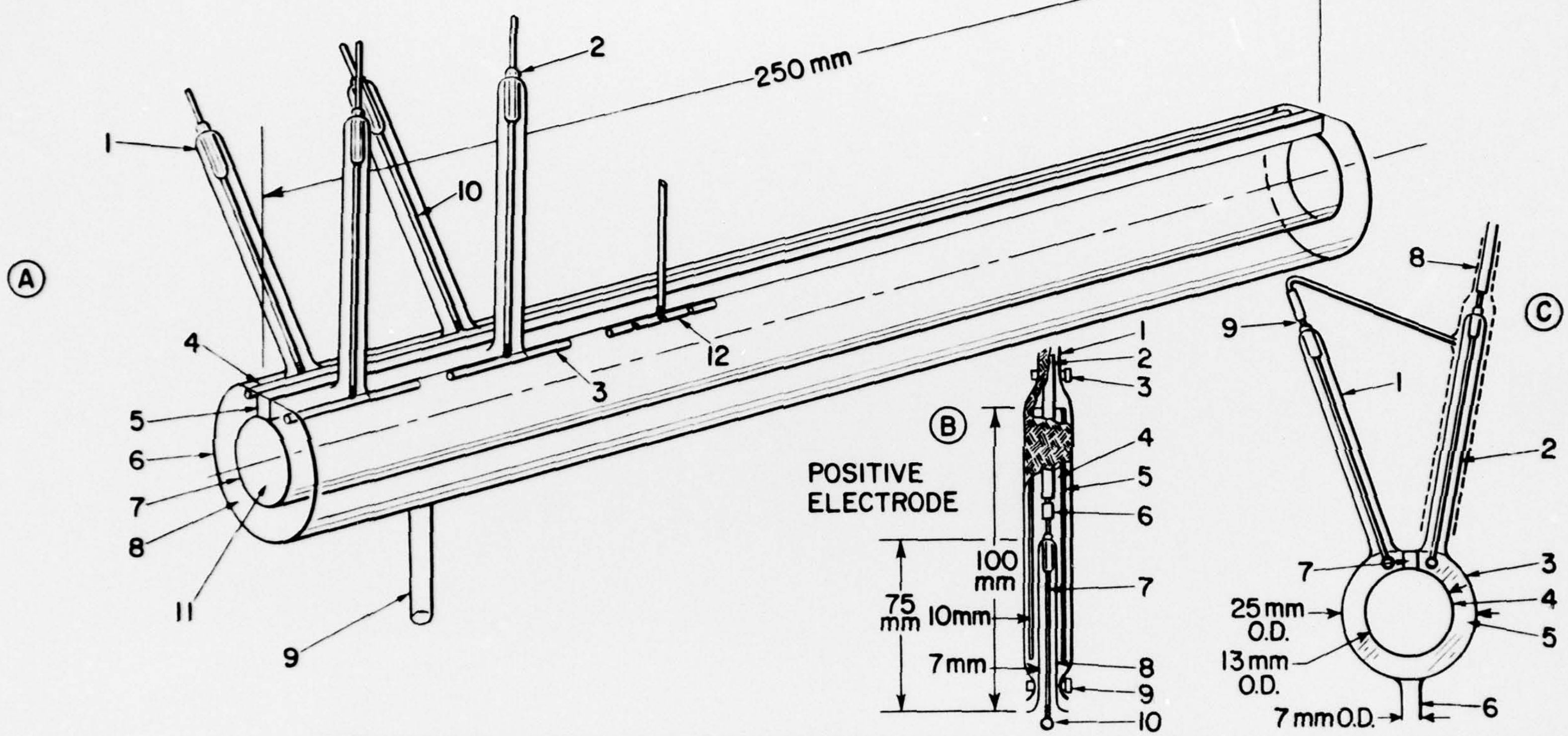
QUARTZ LASER PUMP SOURCE LAMPS

Produced under Contract
DAAK02-68-C-0105

from Night Vision Laboratory
Fort Belvoir, Virginia

PGC Corporation
Bethesda, Md.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



DIMENSIONS ARE IN MILLIMETERS	CONTRACT NO. DAAK02-68-C-0105 PGC CORPORATION DWG NO. LPS-1	NIGHT VISION LABORATORY, FORT BELVOIR, VIRGINIA
MATERIAL TRANSPARENT FUSED QUARTZ	APPROVED — DATE CHECKED DRAWN	LASER PUMP SOURCE LAMP SERIES 1-14
		SIZE A — CODE IDENT NO — LPS-1
		SCALE NONE — SHEET 1 OF 2

EXPLANATION OF FIGS. A, B AND C -Page #3

FIG. A

1. GRADED SEAL 7052 GLASS TO VYCOR
2. *KOVAR TO 7052 VACUUM SEAL
3. CYLINDRICAL POSITIVE ELECTRODE DRILLED AND TAPPED
4. CYLINDRICAL NEGATIVE ELECTRODE DRILLED AND TAPPED
5. SOLID QUARTZ PARTITION SEALED TO INNER AND OUTER QUARTZ CYLINDERS
6. OUTER QUARTZ ENVELOPE
7. INNER QUARTZ ENVELOPE
8. DISCHARGE SPACE
9. VACUUM AND FILLING TUBE
10. FLEXIBLE COPPER WIRE
11. CYLINDRICAL SPACE FOR RUBY LASER ROD
12. SAW TOOTH ELECTRODE

FIG. B

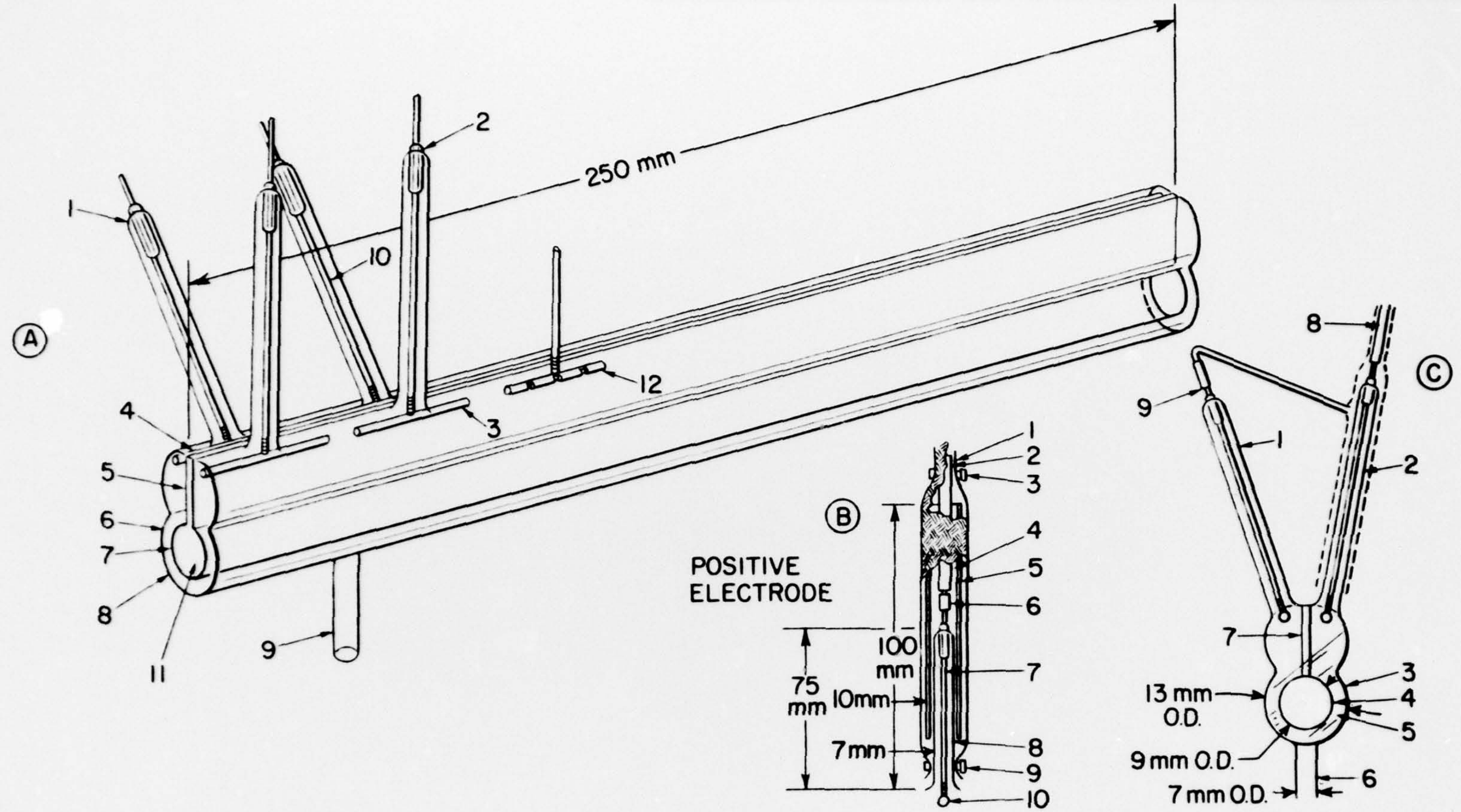
1. COPPER BRAID GROUND CABLE
2. HIGH VOLTAGE LEAD
3. PLASTIC CLAMP
4. HIGH VOLTAGE INSULATION (RTV-102, GE)
5. GLASS CYLINDER
6. BRASS THREADED CYLINDER
7. KOVAR LEAD
8. GRADED SEAL
9. PLASTIC CLAMP
10. CYLINDRICAL ELECTRODE

FIG. C

1. GROUND ELECTRODE
2. POSITITIVE ELECTRODE
3. OUTER QUARTZ ENVELOPE
4. INNER QUARTZ ENVELOPE
5. DISCHARGE SPACE
6. VACUUM AND FILLING TUBE
7. QUARTZ PARTITION
8. COPPER BRAID CABLE
9. CYLINDER SOLDERED TO GROUND CABLE #8

*KOVAR - Westinghouse Electric Corporation

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



DIMENSIONS ARE IN MILLIMETERS	CONTRACT NO. DAAK02-68-C-0105 PGC CORPORATION DWG NO. LPS-2	NIGHT VISION LABORATORY, FORT BELVOIR, VIRGINIA
MATERIAL TRANSPARENT FUSED QUARTZ	APPROVED / DATE CHECKED DRAWN	LASER PUMP SOURCE LAMP SERIES 15-21
		SIZE A / CODE IDENT NO / LPS-2
		SCALE NONE / SHEET 2 OF 2

EXPLANATION OF FIGS. A, B AND C - Page #5

FIG. A

1. GRADED SEAL 7052 GLASS TO VYCOR
2. KOVAR TO 7052 VACUUM SEAL
3. CYLINDRICAL POSITIVE ELECTRODE (DRILLED & TAPPED)
4. CYLINDRICAL NEGATIVE ELECTRODE (DRILLED & TAPPED)
5. ELONGATED SOLID QUARTZ PARTITION SEALED TO INNER AND OUTER QUARTZ ENVELOPES
6. OUTER QUARTZ ENVELOPES
7. INNER QUARTZ ENVELOPES
8. DISCHARGE SPACE
9. VACUUM AND FILLING TUBE
10. SOLID KOVAR LEAD
11. CYLINDRICAL SPACE FOR RUBY LASER ROD
12. SAW TOOTH ELECTRODE

FIG. B

1. COPPER BRAID GROUND CABLE
2. HIGH VOLTAGE LEAD
3. PLASTIC CLAMP
4. HIGH VOLTAGE INSULATION
5. GLASS CYLINDER
6. BRASS THREADED CYLINDER
7. KOVAR LEAD
8. PLASTIC CLAMP
9. CYLINDRICAL ELECTRODE

FIG. C

1. GROUND ELECTRODE
2. POSITIVE ELECTRODE
3. OUTER QUARTZ ENVELOPE
4. INNER QUARTZ ENVELOPE
5. DISCHARGE SPACE
6. VACUUM AND FILLING TUBE
7. ELONGATED QUARTZ PARTITION
8. COPPER BRAID CABLE
9. CYLINDER SOLDERED TO GROUND CABLE #8

STEPS IN TUBE CONSTRUCTION are listed.

1. CLOSE OFF ONE END OF OUTER QUARTZ TUBE, Pg. 3 A-6, AND ADD VACUUM PORT, A-9
2. SEAL PARTITION ROD TO INNER TUBE, A-5, C-7
3. SEAL END OF INNER TUBE AND PARTITION TO OUTER TUBE
4. REMOVE CENTER PORTION OF INNER TUBE SEAL, A-11
5. ADD GRADED SEALS ON EACH SIDE OF PARTITION, A-1
6. THREAD ELECTRODES ON POSITIVE AND GROUND LEADS, A-3, 4
7. SEAL ELECTRODES, A-2
8. CLOSE FINAL END WITH QUARTZ DISC
9. PREPARE POSITIVE ELECTRODE AS SHOWN ON PAGE 3, FIG. B
10. PREPARE GROUND ELECTRODE AS SHOWN ON PAGE 3, FIG. C

INSULATION OF POSITIVE ELECTRODES is described, and

The positive electrodes were constructed as follows: (See Page 3, FIG. B)

First the high voltage lead wire (2) was attached to Kovar seal (7) by threading a brass cylinder (6) onto the electrode. Then a glass cylinder (5) was slipped over the section where the electrode and high voltage wire are connected. The glass cylinder was held in place by masking tape while the inner part of the cylinder was filled with GE-RTV-102 silicone rubber sealing compound (4). After the compound set, the masking tape was removed and the copper braided ground wire (1) was sheathed over the entire construction. The ground wire is held in place by two plastic clamps (9) and (3)

SILVER GROUND COATING

A coating of silver was deposited over the entire outer surface of the tube which made a complete connection between the copper braided sheath and the ground leads. Small observation windows were left on the ground side of the tube so that the discharge could be studied. The entire outside of the tube was then sprayed with a clear plastic vinyl coating.

QUARTZ ENVELOPE

After all the seals were made, the entire quartz envelope was heated with a hydrogen and oxygen flame which drove off all the white silica powder that had condensed on the tube during the sealing process. Then the envelope was soaked in a 5% solution of hydrofluoric acid for about five minutes and then rinsed off with copious amounts of tap water and distilled and finally dried with acetone.

ELECTRODE.

After the Kovar seals were made to the quartz envelope, the oxide was removed by soaking the electrodes in a concentrated solution of hydrochloric acid at 80degrees C until the oxide flaked off. The electrodes were then flushed with tap water then distilled water and dried with acetone.

GRADED SEALS

Quartz graded seals were used on tubes 1 and 2. (see page11, tubes 1 and 2) and Page 3 , FIG. A#1; FIG. B#8) Quartz to 7052 glass graded seals were unsatisfactory. They were found to be weak between the grades. They were also found to be prone to leaks under vacuum because of the many trapped air bubbles. Vycor[1] graded seals were used for tubes 3 to 7. These seals are superior in strength and vacuum tightness.

TUBE PARTITION

Forming a uniform partition (Page 3, FIG. A-5, FIG. C-7) between the two concentric quartz tubes (Page 3 , FIG. A-6 & 7) without excessive distortion led to the use of several types and shapes of materials.

QUARTZ ROD TO QUARTZ TUBING- excessive distortion (when direct sealing technique[2] was used)

VYCOR ROD TO QUARTZ TUBING- less distortion because vycor has lower melting point(direct sealing technique[2]) than quartz.

GENERAL ELECTRIC SEALING GLASS #1[3] TO QUARTZ TUBING- (direct sealing technique[2]) acceptable, but possible leaks through partition because of the great number of trapped air bubbles. Also, seal cannot stand thermal shock as well as the quartz to quartz seals. This type of seal would be the best to use if manufacturer can rid material of air bubbles.

The seal that was finally decided on was quartz rod to quartz tubing using a microtorch of hydrogen and oxygen.

A technique similar to welding was applied.

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[1]Vycor graded seals are manufactured by the Corning Glass Company.

[2]Quartz rod was laid on center tube and flame directed on rod and tube.

[3]92% Silica, 8% Boric Acid

QUARTZ LASER PUMP SOURCE LAMPS #1-21

TUBE	ELECTRODES Positive	ELECTRODES Negative	TUBE LENGTH	# OF ELECTRODES	GAS	PRESSURE	GROUND COATING	METAL ADDED TO DISCHARGE SPACE
1.	.06"x1"Kovar Glass partition bet. electrodes solid leads	.06"x5" Kovar solid leads	6"	5	XENON	300MM	Platinum	None
2.	.06"x1"Kovar Glass on end electrodes	.06"x9"Kovar Solid leads	11"	11	XENON	300MM	Carbon	None
3.	.1"x1"Kovar Glass on end electrodes	.1"x9" Kovar Solid leads	11"	11	Xenon	500MM	Silver	Mercury
4.	.1"x1"Kovar Glass on end electrodes	.1"x9" Kovar Flexible copper leads	11"	10	Xenon	300MM	Silver	Cesium
5.	.1"x1"Kovar Two saw tooth cut. See Fig.A Pg. 12.	.1"x9" Kovar Flexible copper Leads	11"	10	Xenon	300MM	Silver	Mercury
6.	.1"x1"Kovar All electrodes Saw tooth cut	.1"x9" Kovar Flexible copper leads	11"	10	XENON	500MM	Silver	None
7.	.1"x1"Kovar	.1"x9" Kovar	11"	9	XENON	500MM	Silver	Cesium
8.	.1"x1" Al	.1"x1" Al	11"	9	XENON	300MM	Silver	None
9.	.1"x1" Al	.1"x1" Al	11"	9	KRYPTON	300MM	Silver	None
10.	.1"x1" Al	.1"x1" Al	11"	9	KRYPTON	300MM	Silver	None
11.	.1"x1" Al	.1"x1" Al	11"	9	KRYPTON	500MM	Silver	None

12.	.1x1" Al	.1x1" Al	11"	10	XENON	300-700	Silver	None
13.	.1x1" Al	.1x1" Al	11'	10	XENON	300-700	Silver	None
14.	.1x1" tungsten	.1x1" Al	11"	10	XENON	300-700	Silver	None
15.	.1x1" tungsten Saw tooth elec- trodes	.1x1" tungsten	10"	9	XENON	300-700	Silver	None
16.	.1x1" tungsten Saw tooth Electrodes	.1x1" tungsten	10"	9	XENON	300-700	Silver	None
17.	.1x1" tungsten Saw Tooth Electrodes	.1x1" tungsten Saw tooth electrodes	10"	9	XENON	300-700	Silver	None
18.	.1"x1" tungsten Saw tooth elec- trode	.1"x1" tungsten Saw tooth electrodes	10"	9	XENON	300-700		None
19.	.1"x1" tungsten Point elec.	.1"x1" tungsten Point elec.	10"	8	XENON	300-700		None
20.	.1"x1" tungsten Point elec.	.1"x1" tungsten Point elec.	10"	8	XENON	300-700		None
21.	.1"x1" tungsten Point elec.	.1"x1" tungsten Point elec.	10"	8	XENON	300-700		None

PROBLEM

To develop a laser pump source lamp that will produce more power output with less heat concentration, sputtering and severe shock than a conventional discharge tube of equal discharge length and diameter.

BACKGROUND

The present type of laser pump lamps have in common a discharge path, straight or helical, that must be traversed by all the input power -- one electrode to the other. These types of lamps in continuous operation produce uneven heat concentration, electrode sputtering and are subject to unequal shock waves. The power input is largely limited to the size of the electrode and strength of glass envelope.

APPROACH TO PROBLEM

Tubes with two coaxial quartz envelopes and multiple parallel and equidistant cross-field electrodes were constructed as shown in drawings LPS-1 and LPS-2.

RESULTS

Tube Type LPS-1, Page #3

1. Heat build up evenly distributed
2. Superior shock distribution

3. Sputtering more evenly distributed

Tube Type LPS-2, Page #5

1. Heat build up evenly distributed
2. Good shock distribution

DISCUSSION OF RESULTS

Heat build up for Tube Types LPS-1 and 2 was evenly distributed. This becomes obvious if one looks at drawings on Pages 3 and 5. It is seen that the total input power is distributed simultaneously and equally to all the electrodes. Thus no electrode is taking full input power.

This was found to be the case when the tubes were repeatedly discharged. Only when an electrode or pairs of electrodes failed to discharge and the power shifted to a succeeding electrode was there observed uneven heating and sputtering. Sputtering in tube type 2 was improved by the geometry of the top of the tube LPS -- (See Dwg. LPS-2; A, C.) The sputtered material for the most part concentrated in the upper region of the electrode spaces.

CONCLUSION

The discharge tubes constructed and tested under this contract prove that the geometry and construction techniques are possible and practical and show promise.

Refinement and further study in the following areas is recommended.

1. More stable and reliable power sources.
2. Pressure of discharge gas or gasses in tubes.
3. Addition of alkaline metals to discharge volume.
4. Different types of gasses and gas mixtures.
5. Electrode material configuration and arrangement.
6. Reflective and conductive coatings.
7. Working temperatures.
8. Spectrum studies.
9. Types and configuration of laser rods used.