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APR 79 D L WINDSOR, D R HEINE, M B DENTON N00014-75-C-0513
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OFFICE OF NAVAL RESEARCH
Contract N00014-75-C-0513
Task No. NR 051-549
Technical Report No.22

A HIGH POWER INDUCTIVELY COUPLED PLASMA TORCH AND IMPEDANCE MATCHING NETWORK

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Prepared for Publication

in

Applied Spectroscopy

Approved for Public Release: Distribution Unlimited

80 2 11 081

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 22 14) TP-22	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER technical
4. TITLE (and Subtitle) 6) A HIGH POWER INDUCTIVELY COUPLED PLASMA TORCH AND IMPEDANCE MATCHING NETWORK		5. TYPE O~~F REPORT & PERIOD COVERED~~ 9) INTERIM repts
		~~6. PERFORMING ORG. REPORT NUMBER~~
7. AUTHOR(s) 10) D. L. Windsor, D. R. Heine [redacted] M. B. Denton		8. CONTRACT OR GRANT NUMBER(s) 15) N00014-75-C-0513
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Chemistry University of Arizona Tucson, AZ 85721		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 051-549
11. CONTROLLING OFFICE NAME AND ADDRESS Office of Naval Research 11) 13 Apr 79 Arlington, VA 22217		12. REPORT DATE April 13, 1979
		13. NUMBER OF PAGES 3
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12) 15		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Prepared for publication in Applied Spectroscopy.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Inductively Coupled Plasma Torch
Inductively Coupled Plasma Matching Network

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An improved dismantleable inductively coupled plasma torch and matching network are described. This torch and network provide convenience, improved power handling capabilities, and a high degree of flexibility.

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A HIGH POWER ICP TORCH AND IMPEDANCE MATCHING NETWORK

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Index Headings: Inductively Coupled Plasma Torch;
Inductively Coupled Plasma Matching Network

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A HIGH POWER ICP TORCH AND IMPEDANCE MATCHING NETWORK

The relative ease of operation, power handling capabilities and overall performance of an inductively coupled plasma-optical emission spectrometer (ICP-OES) depends upon numerous factors, not the least important of which is the design of the torch. A variety of such designs has appeared in the literature (1-6). Most workers have employed three concentric fused silica and/or pyrex tubes, referred to as an inner sample gas tube, a "flaired mouth" plasma gas tube, and an outer coolant tube. These tubes are either fused into one or two-piece units through glass blowing techniques or mounted in some type of dismantleable base assembly.

Precise alignment of the glass-blown torch can be achieved during construction through the use of an assembly jig. However, this type of torch is not easily repaired should problems be encountered. The dismantleable base approach can be difficult to align if the three tubes are held only near the bottom. This problem is aggravated by the fact that rarely is commercial quartz and pyrex glass tubing perfectly straight or cylindrical.

A torch design which is both dismantleable and self-aligning has been successfully used in this laboratory for several years. A unique feature is the use of nylon or teflon slip fit spacers between the sample and plasma gas tubes and the plasma and coolant gas tubes.

Properly implemented, this approach also provides a significant increase in tangential flow velocity of the coolant gas, which improves heat transfer from the coolant tube, making possible the use of higher powers and longer coolant tubes. The increase in tangential flow is achieved through the use of threads cut into the coolant-plasma spacer with a 60° "v" tool; two cuts of 1.57 thread/cm, (4 threads/inch) offset by 180° and 2.5 mm deep, are made. This spacer is then placed as shown in Figure 1.

The spacer which fits between the sample and plasma gas tubes contains 12 verticle slots which are 1.4 mm wide and 1.2 mm deep. This permits laminar flow of the plasma or auxiliary gas. The dimensions of the glass components are listed in Table I. The sample tube is constricted at one end to 1.5 mm i.d., and the other end contains a 12/5 ball joint for easy attachment of the sample gas line.

A detailed drawing of the base is shown in Figure 2. In operation this assembly is securely fastened to a moveable mount, allowing precise positioning of the observation region. All glass inserts can be easily changed with the base mounted.

Data obtained using this torch for the analysis of carbon and hydrogen in samples from a gas-liquid chromatograph have shown that absolute precision can be increased more than twofold by increasing the coolant tube from 25 cm to 30 cm. (7). This extended the top of the coolant tube from 5 cm to 10 cm above the load coil.

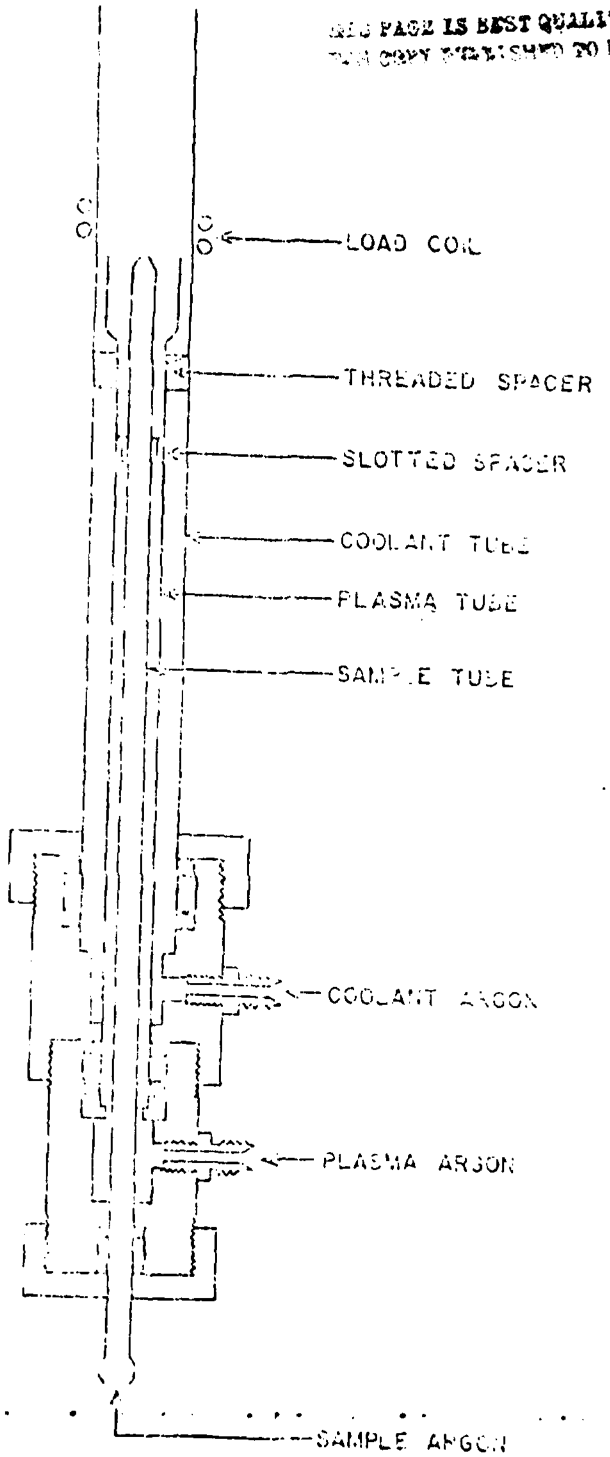
An impedance coupling network which matches the output impedance of the high power rf power supply (50 ohms) to the input impedance of the load coil is shown in Figure 3.

The capacitors are the vacuum variable type, (Jennings Radio - UCSL 750) able to withstand 5,000 volts, and range from 5-750 pf. The circuit is constructed from 4.76 mm o.d., 3.24 mm i.d. (3/16" i.d.) copper tube which carries cooling water during operation.

This matching network-torch combination readily operates in excess of 5 kW forward power with less than 50 watts of reflected power. At forward power levels near 2 kW, the reflected power is less than 5 watts.

TABLE 1. Dimensions of glass used in the dismantleable torch.

TUBE	LENGTH	O.D.	I.D.	TYPE
short coolant	25 cm	20 mm	18 mm	quartz
long coolant	30 cm	20 mm	18 mm	quartz
Plasma				
mouth	2.5 cm	15 mm	13 mm	vycor
stem	22.5 cm	11 mm	9 mm	vycor
Sample	30 cm	7 mm	5 mm	pyrex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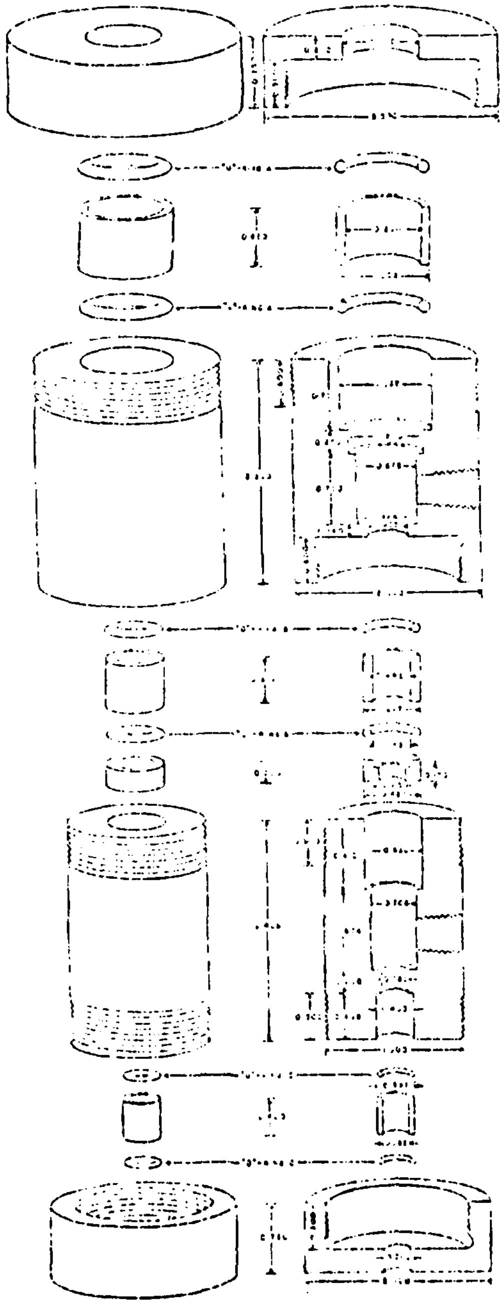

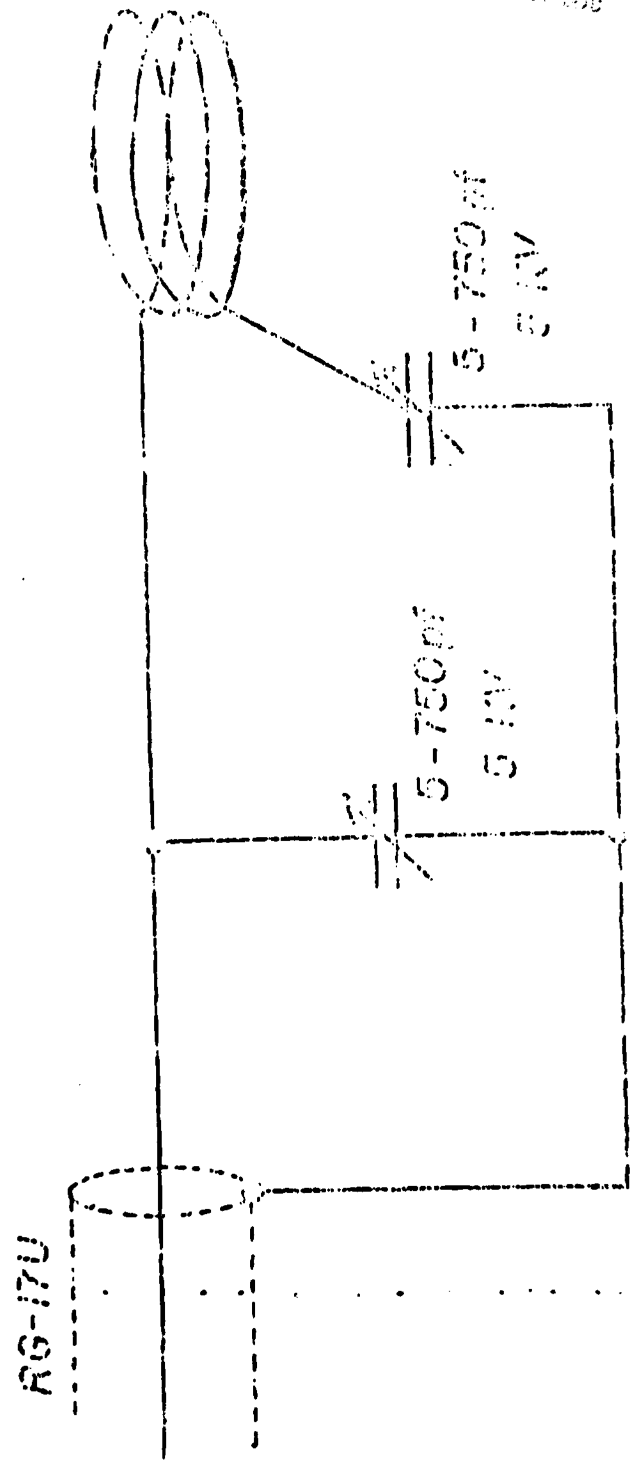
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Acknowledgement

This research was partially supported by the Office of Naval Research and an Alfred P. Sloan Foundation Research Fellowship awarded to M. Bonner Denton.

Figure Captions

Figure 1. Dismantleable ICP torch assembly capable of operating at over 5 kW forward power. Spacers are used to provide precise alignment and improved gas flow patterns.

Figure 2. Detailed drawing of the dismantleable ICP torch base (all dimensions are in inches).

Figure 3. 27.12 Mhz impedance matching network for use with high powers.

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