Reprinted from JOURNAL OF APPLIED PHYSICS, Vol. 41, No. 7, 3194, June 1970

Induction Plasma Design for High Power Levels

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(Received 1 October 1969; in final form 29 December 1969)

Babat[1] investigated the induction heating of stationary air plasmas to produce high-power-density thermal plasmas. Induction coupled plasmas torches with flowing gas at atmospheric pressure were first introduced by Reed.[2,3] Induction heated thermal plasmas have found a wide variety of scientific and technological applications because of the high equilibrium temperatures that can be produced in a variety of gases without contamination from electrodes.

Unfortunately high-power-density plasmas require high voltages between adjacent turns of the induction coil, and in attempting to go to high power levels this high field can cause a breakdown between coils. High power levels also cause more heat transfer to the containing walls, usually made from quartz, and can cause melting of the walls and breakdown. Thus the upper power limit is set by the coil insulation and the nozzle cooling.

A new torch design is described here which gives improved insulation between the coils and at the same time cools the nozzle so that it is possible to go to higher power levels than can be achieved in conventional torches. This is constructed from a helical quartz tube held at the bottom of a coaxial tube either by an external support or by soldering, as shown in Figs. 1 and 2. A flexible conductor is threaded into the quartz helical tube so that water can flow around and along the conductor itself which is heated both by rf losses and by plasma radiation.

The flexible conductor can be a braided shielding of tinned copper wires. The conductor is inserted into the quartz coil by a nylon wire previously inserted with the help of a jet of compressed air.

The quartz coil is easily soldered to the vertical gas carryng tubes that are of quartz too. The soldering is at the bottom of the coaxial tubes but no seal is necessary because the argon streaming is expanding in the free air and the plasma flame may contact the quartz coil.

The torch shown in Fig. 2 has been operated at a calculated power level of 8.1 kW for 3 h without damage. A larger torch was operated at a plasma power level of 37 kW and used to spheroidize uranium dioxide in oxygen. The size of this torch is 20 cm in height and 6 cm in diameter.

The author would like to thank Mr. Arbore for construction of the quartz torches, Mr. Cassina for the use of laboratory facilities of the Soc. Aetron, and the Soc. ARS for financial support.

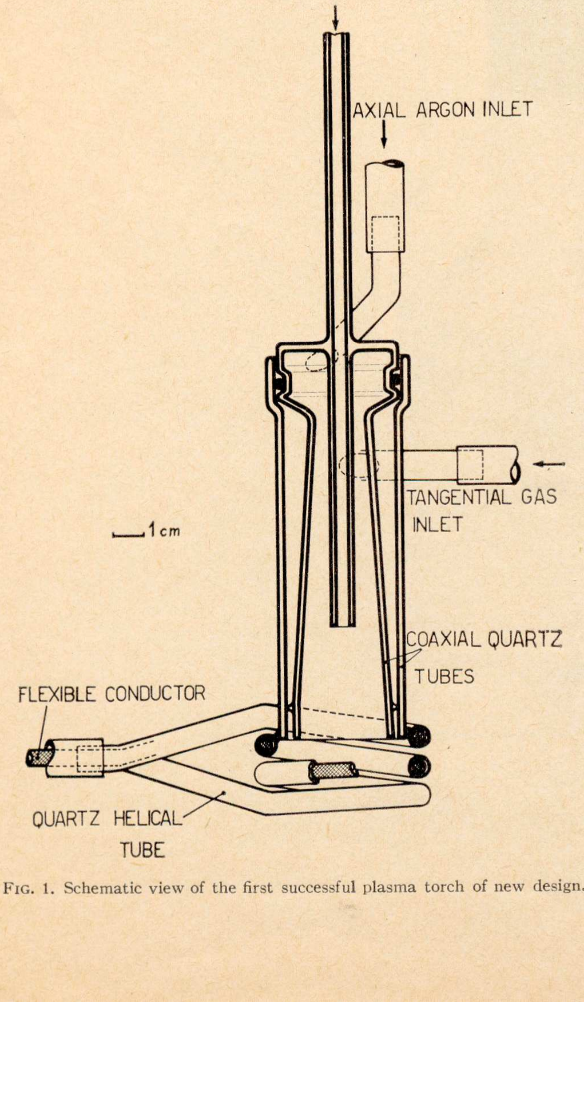

FIG. 1. Schematic view of the first successful plasma torch of new design.

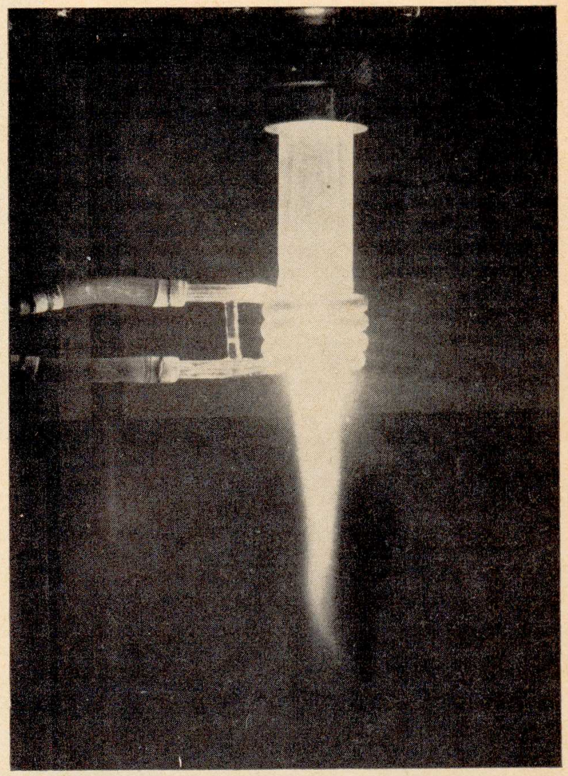

FIG. 2. A typical plasma flame (argon) obtained from the plasma torch of new design.

[1] G. I. Babat, J. Inst. Elec. Engrs. (London) **94**, 27 (1947).
[2] T. B. Reed, J. Appl. Phys. **32**, 821 (1961).
[3] T. B. Reed, J. Appl. Phys. **32**, 2534 (1961).