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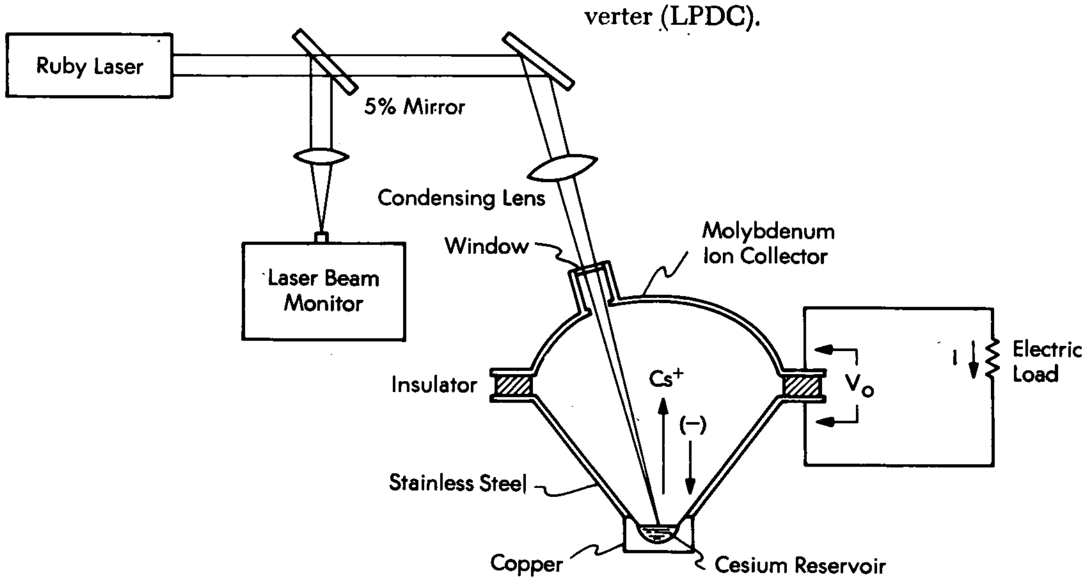
Laser Energy Converted into Electric Power

The problem:

To transmit electric power to remote receivers, such as space probes, installations atop mountains, etc.



The solution:

Project a laser beam of sufficient power to the remote site and then convert the laser energy directly into electric power.

How it's done:

The schematic diagram illustrates an experimental apparatus being used to verify the concepts of converting laser energy directly into electric energy. The ruby laser provides 0.69 μm (visible red) radiation at 1 joule per pulse. A mirror, placed in the beam and inclined at an angle to it, directs a small amount of incident radiation to a monitor which establishes precise power levels and other beam characteristics. A second mirror and condensing lens direct the bulk of the laser energy into a laser plasmadynamic converter (LPDC).

The upper section of the LPDC is fabricated of a metal (molybdenum) which has a relatively high work function; the section is hemispherical in shape and is provided with a sapphire window and an external heater for precise temperature control of the inner surface. The lower section is shaped like an inverted cone with stainless steel sides and a copper apex which contains a reservoir of cesium (low work function). The two sections are insulated from each other and serve as the electrodes of an electric power generator; the upper section is the positive electrode.

(continued overleaf)

The LPDC operates as follows: After the laser energy passes through the condensing lens and the window in the LPDC, it impinges on the surface of the liquid cesium (somewhat obliquely so that no energy is reflected back along the incoming beam). The energy is at such a high density that it first vaporizes, then ionizes a quantity of cesium. When the density of the cesium plasma becomes sufficiently large, it absorbs all incoming energy and becomes almost completely ionized. The ions flow upward to the collector, and power can be extracted by an external electric load connected to the LPDC electrodes. When an ion impinges on the upper electrode which is maintained at a higher temperature than the cesium reservoir, it is neutralized and the neutral atom eventually is condensed on the walls of the cooler lower section and returned to the reservoir. Positively charged cesium ions constitute the source of current in an LPDC, whereas in a thermionic electric generator, current is induced by electrons which are boiled off from a cathode at high temperature.

In the experimental device, the work function of the ion emitter (the pool of cesium) is 1.8 volts. The work function of the ion collector is 3.6 volts, so that the voltage output (V_o) at the terminals of the LPDC is 1.8 volts if no voltage drop occurs within the LPDC. The output current depends on the size of the LPDC and the current density within the laser beam; for a typical experimental device, a current density of approximately 10 A/cm^2 could be realized. Also, such a cell has a theoretical efficiency of 40% if the cesium is 100% ionized and the output voltage is 1.8 volts.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Reference: TSP 73-10353

Patent status:

Inquiries concerning the rights to the commercial use of this invention should be addressed to:

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