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Boey et al.

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(54) **ULTRASONIC FLUID PRESSURE GENERATOR**

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,756,575 A * 9/1973 Cottell 261/1
4,619,400 A * 10/1986 van der Burgt 239/102.1
(Continued)

FOREIGN PATENT DOCUMENTS

BE 1013168 A3 10/2001
JP 63-198800 A 8/1988

OTHER PUBLICATIONS

International Preliminary Report on Patentability issued for International Application No. PCT/SG2009/000488 date Jul. 5, 2012.
(Continued)

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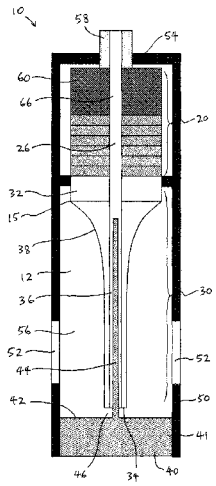
(57) **ABSTRACT**

An ultrasonic fluid pressure generator for generating high pressure head in a fluid. The ultrasonic fluid pressure generator comprises a transducer comprising a piezoelectric actuator and a displacement amplifier, the displacement amplifier having a fluid channel therethrough, the displacement amplifier being connected to the piezoelectric actuator at one end and having a free vibrating tip at another end; a reflecting condenser disposed at the vibrating tip of the displacement amplifier to form a gap between the vibrating tip and a reflecting surface of the reflecting condenser; and a casing configured for establishing a standing wave in the fluid contained within the casing, the transducer and the reflecting condenser being at least in part within the casing.

7 Claims, 6 Drawing Sheets