Manufacturing & Prototyping

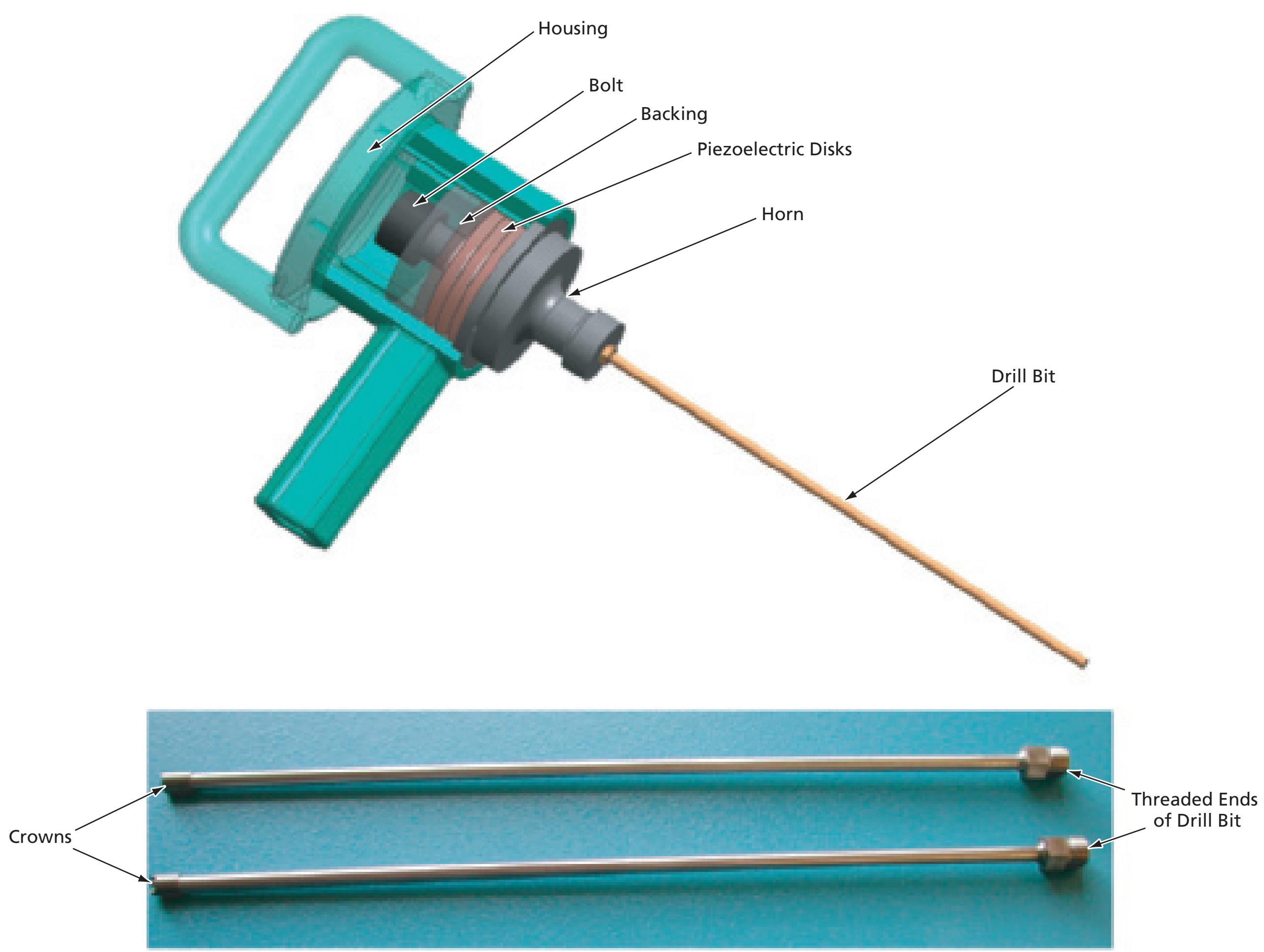
Rapid and Quiet Drill

This is an all-ultrasonic variant of previously reported ultrasonic/sonic drills.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure depicts selected aspects of the rapid and quiet drill (RAQD), which is a prototype apparatus for drilling concrete or bricks. The design and basic principle of operation of the RAQD overlap, in several respects, with those of ultrasonic/sonic drilling and coring apparatuses described in a number of previous *NASA Tech Briefs* articles. The main difference is that whereas the actuation scheme of the prior apparatuses is partly ultrasonic and partly sonic, the actuation scheme of the RAQD is purely ultrasonic. Hence, even though the RAQD generates considerable sound, it is characterized as quiet because most or all of the sound is above the frequency range of human hearing.

The ultrasonic transducer in the RAQD consists of a stack of piezoelectric disks, their electrodes, and a backing layer, all held in compression by a bolt that also holds them in place on a horn. During operation, the piezoelectric stack



DRILL BITS WITH DIFFERENT CROWNS

The **Rapid and Quiet Drill** is designed to make little or no audible sound while penetrating concrete. Because drill bits are thread-mounted, they can be changed in the field.

is driven at a frequency of 24.8 kHz. A drill bit is attached to the horn by means of a simple threaded connection: for this purpose, the proximal end of the drill bit is threaded and widened, and the thread on the drill bit matches the thread in a hole on the tip of the horn. The drill bit is tipped with a crown having a cutting edge (which could be toothed) chosen to suit the specific application. The crown is attached to the bolt by brazing and, hence, can be replaced when it is worn out. The bolt, horn, drill bit, and crown are all hollow so that, optionally, air can be blown through them to remove dust from the drilled hole.

This work was done by Stewart Sherrit, Mircea Badescu, Yoseph Bar-Cohen, Zensheu Chang, and Xiaoqi Bao of Caltech for NASA's Jet Propulsion Laboratory.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office–JPL. Refer to NPO-42131.

Hydrogen Peroxide Concentrator

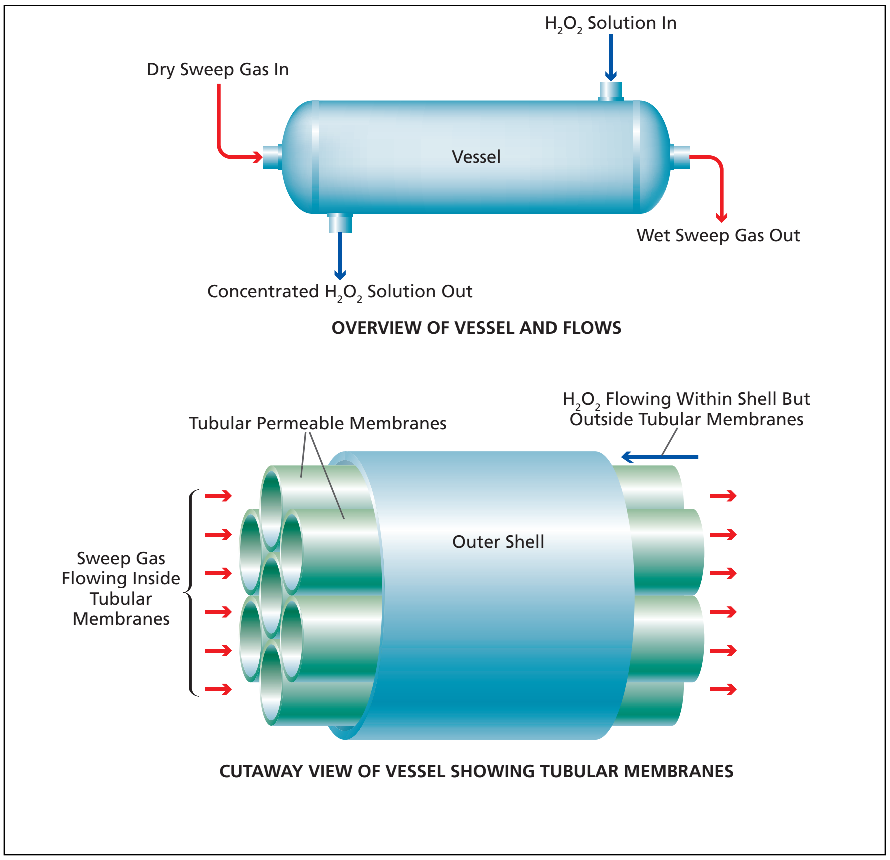
Water is removed through selectively permeable membranes.

John F. Kennedy Space Center, Florida

A relatively simple and economical process and apparatus for concentrating hydrogen peroxide from aqueous solution at the point of use have been invented. The need for this or a similar invention arises for the following reasons:

- The highest commercial grade of hydrogen peroxide has a concentration of 70 volume percent.
- Concentrations of more than 80 volume percent are required in some industrial and some military propulsion applications.
- Prior methods of concentration of hydrogen peroxide are expensive and can entail production of quantities larger than can be utilized immediately. The necessity of storing and handling the excess concentrated hydrogen peroxide poses a safety problem.

The heart of the apparatus is a vessel (see figure) comprising an outer shell containing tubular membranes made of a polymer that is significantly more permeable by water than by hydrogen peroxide. The aqueous solution of hydrogen peroxide to be concentrated is fed through the interstitial spaces between the tubular membranes. An initially dry sweep gas is pumped through the interiors of the tubular membranes. Water diffuses through the membranes and is carried away as water vapor mixed into the sweep gas. Because of the removal of water, the hydrogen peroxide solution flowing from the vessel at the outlet end is more concentrated than that fed into the vessel at the inlet end.



An **Aqueous Hydrogen Peroxide Solution** flows within the outer shell, in the interstices between the tubular membranes. Water diffuses from the solution into the interiors of the membranes, where the flowing sweep gas carries it away.

The concentration process as described thus far would ordinarily and preferably be run in a continuous, counter-flow mode. Optionally, it could be run in a batch mode. The rate of removal of water can be increased by increasing the rate of flow of the sweep gas. Also, the water capacity of the sweep gas and, hence, the rate of removal of water can be increased by heating the sweep gas, taking care to keep the temperature less than the lower of either (1) the boiling point of the hydrogen peroxide solution, (2) the temperature above which the hydrogen peroxide decomposes spontaneously, or (3) the maximum temperature that the membrane can endure without deteriorating. The sweep gas can be air, nitrogen, or any other gas that can be conveniently supplied in dry form and does not react chemically with hydrogen peroxide.

The selections of the membrane, outer-shell, and plumbing materials are governed largely by the following criteria:

- All of the affected materials should be chemically nonreactive with hydrogen peroxide at the highest concentration expected to be encountered.
- The membrane material should be capable of sustaining a high flux of