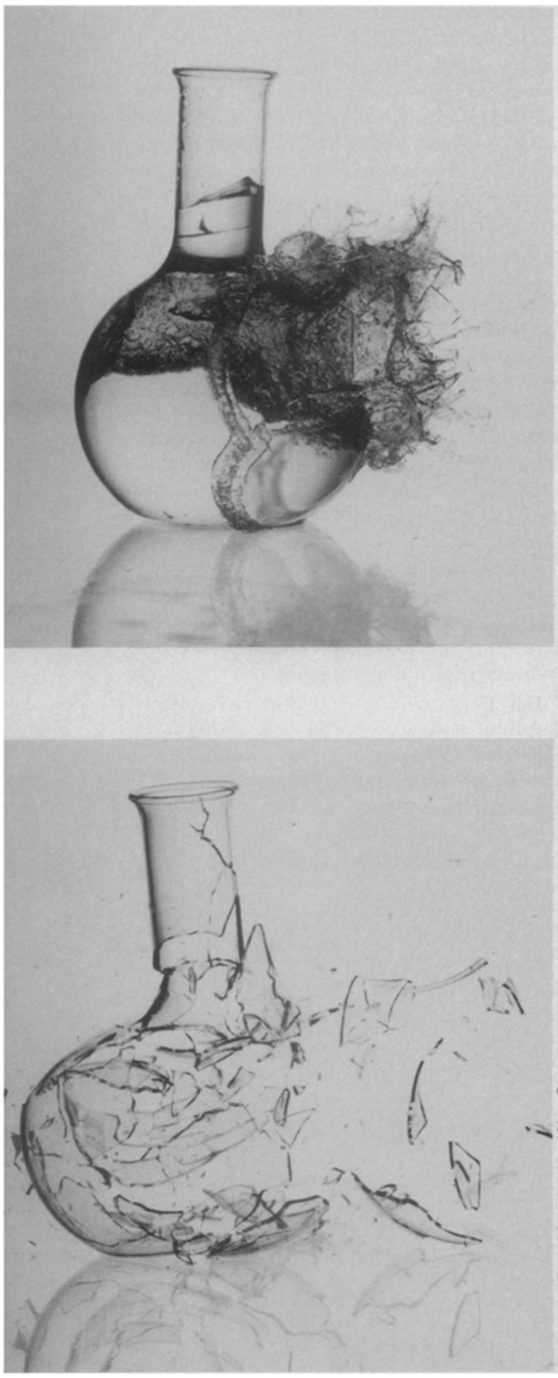
Cameras that Stop Time

New high-speed cameras capture an event's finer details



Peter Krehl, Ernst-Mach-Institut, West Germany

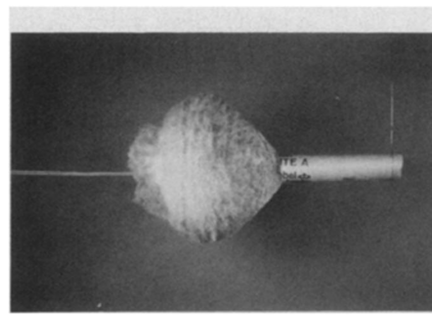
Photo contest second prize went to this pair of images showing an air-gun bullet striking an empty flask and a water-filled flask.

By IVARS PETERSON

High-speed photography is a world of violence and beauty, of jagged fragments and graceful patterns, of images of bullets shattering glass and hummingbirds sipping nectar. It is also an important research tool. Recently, more than 100 practitioners from around the world gathered in San Diego, Calif., to compare notes on topics like new ways of achieving ever shorter light pulses, capturing the intimate details of nuclear fusion reactions, measuring athletic performance and monitoring explosions (SN: 9/4/82, p. 154).

The 15th International Congress on High Speed Photography and Photonics was the most recent of a series of meetings that began in 1952. In the three decades since the first congress, high-speed cameras have gone from photographing thousands of frames per second to several millions. Video systems now provide instantaneous results at up to 12,000 frames per second (SN: 9/11/82, p. 164). Applications have widened to include many explosion and combustion processes, crack propagation in materials and fluid flow patterns.

Hallock F. Swift of Physics Applications, Inc., in Dayton, Ohio, said at the opening session of this year's meeting, "It appears that throughout the world there's an overall rebirth of activity in high-speed photography." One reason is that microprocessors for camera control and computers for data analysis provide new flexibility and accurate, rapid data retrieval. The development of precise timing devices that fit within cameras allows cameras many miles apart to be synchronized. "You can accurately compare the events from multiple sources and know the pictures were indeed taken within one frame of each other," Swift said. In addition, light-emitting diodes can project data (like time, altitude and groundspeed for an airborne camera) onto each frame to provide useful supplemental information.



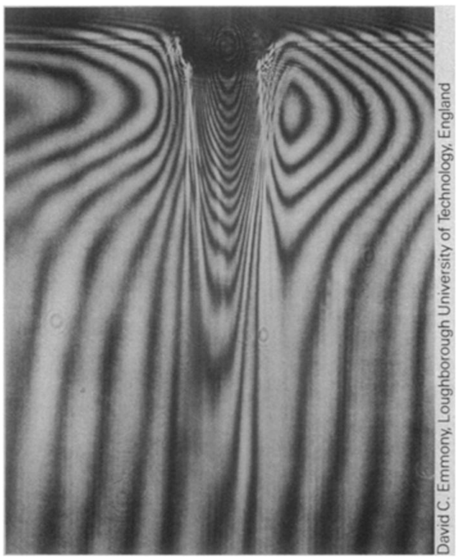
Lars-Ake Almgren, Nitro Nobel AB, Sweden

A detonating cartridge.

In the past, the speed at which film could be unwound from spools was limited. Spools holding 400 feet of film could explode if the film were pulled off at rates greater than 10,000 frames per second. Rotating prisms, which flashed images onto continuously moving film, were limited in a similar way. Swift said people are now looking at special spools without sides and small mirrors strong enough to be whirled at high speeds to increase the framing rates of these cameras.

The highest speeds, up to the equivalent of millions of frames per second, are achieved with streak cameras in which the image of a slit is swept across the film. These cameras are usually used to study events that produce their own light and move in a straight line. They provide extremely accurate velocity measurements of transient events, or records of phenomena like emissions from glass targets in laser fusion experiments. A more pure form of beryllium for camera mirrors and computer programs to compensate for distortions due to stress fields in mirrors are already producing spectacular results, Swift said.

J.S. Courtney-Pratt of Bell Laboratories highlighted some other recent achievements. One was the production of laser light flashes that last about a tenth of a picosecond (10^{-12} second), can be repeated at 100 million flashes per second and are powerful enough to allow photog-



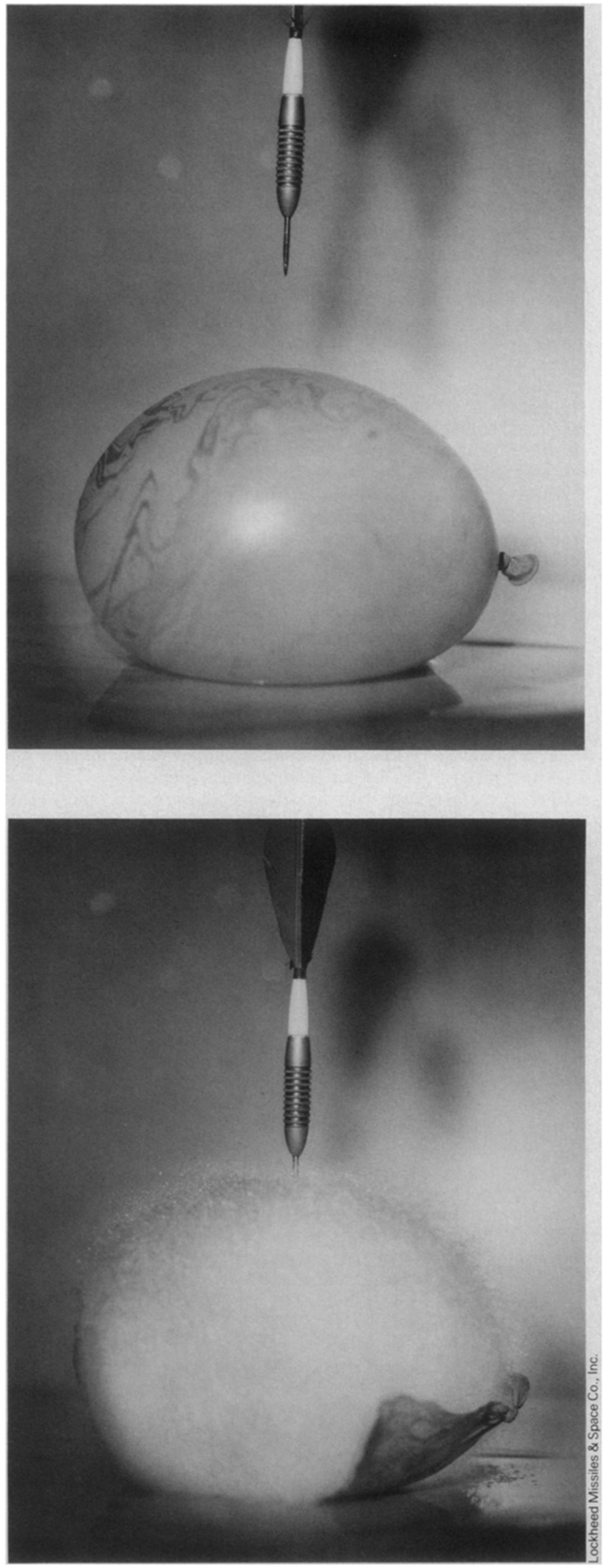
David C. Emmony, Loughborough University of Technology, England

Above: This interferogram shows a carbon dioxide laser pulse's heating effect on the surface of liquid cyclohexane less than 0.5 microseconds after the pulse first penetrates the liquid and produces a high-pressure column. Right: The puncturing of a water-filled balloon.

raphy of near objects by reflected light. However, getting a film or mirror to move fast enough to catch the image is a problem. Picosecond laser flashes are also useful for probing chemical reactions like the bleaching of dyes and for photographing absorption spectra. Fusion researchers use high-power X-rays at increasingly short exposure times to see through "the flash and smoke and plasma" of nuclear experiments.

In terms of future needs, Swift threw down a challenge to developers of electronic framing cameras: to come up with a camera in which the experiment controls the framing rate and decides when the camera should be used.

The congress had its lighter and more artistic side, too. Two film makers from the National Film Board of Canada described their trials and tribulations in using high-speed photography to catch the unpredictable popping of popcorn. The result was an imaginative four-minute film that won a prize at the Cannes Film Festival. Harold E. Edgerton of the Massachusetts Institute of Technology spoke of the joys of photographing hummingbirds. Congress participants also voted for their choices in an informal, high-speed photo contest, the first at a congress. □



Lockheed Missiles & Space Co., Inc.