Caltech's 80-ft. shock tube – and Hans. W. Liepmann, professor of aeronautics, in charge of this research

SHOCK TUBE

A cannon-like shock tube which cost $100,000 and took two years to build is now in operation in Caltech's aeronautics laboratories. The big tube is used to produce fast shock waves with a very brief lifetime in order to obtain information about the flow of very hot and highly rarefied gases. Such information is needed as a foundation for the solution of many aerodynamic problems in space and missile technology. Typical problems include the design of foils or fins for very-high-altitude vehicles, design of drag brakes for the reentry of vehicles from space, and cooling vehicle surfaces at extremely high speeds.

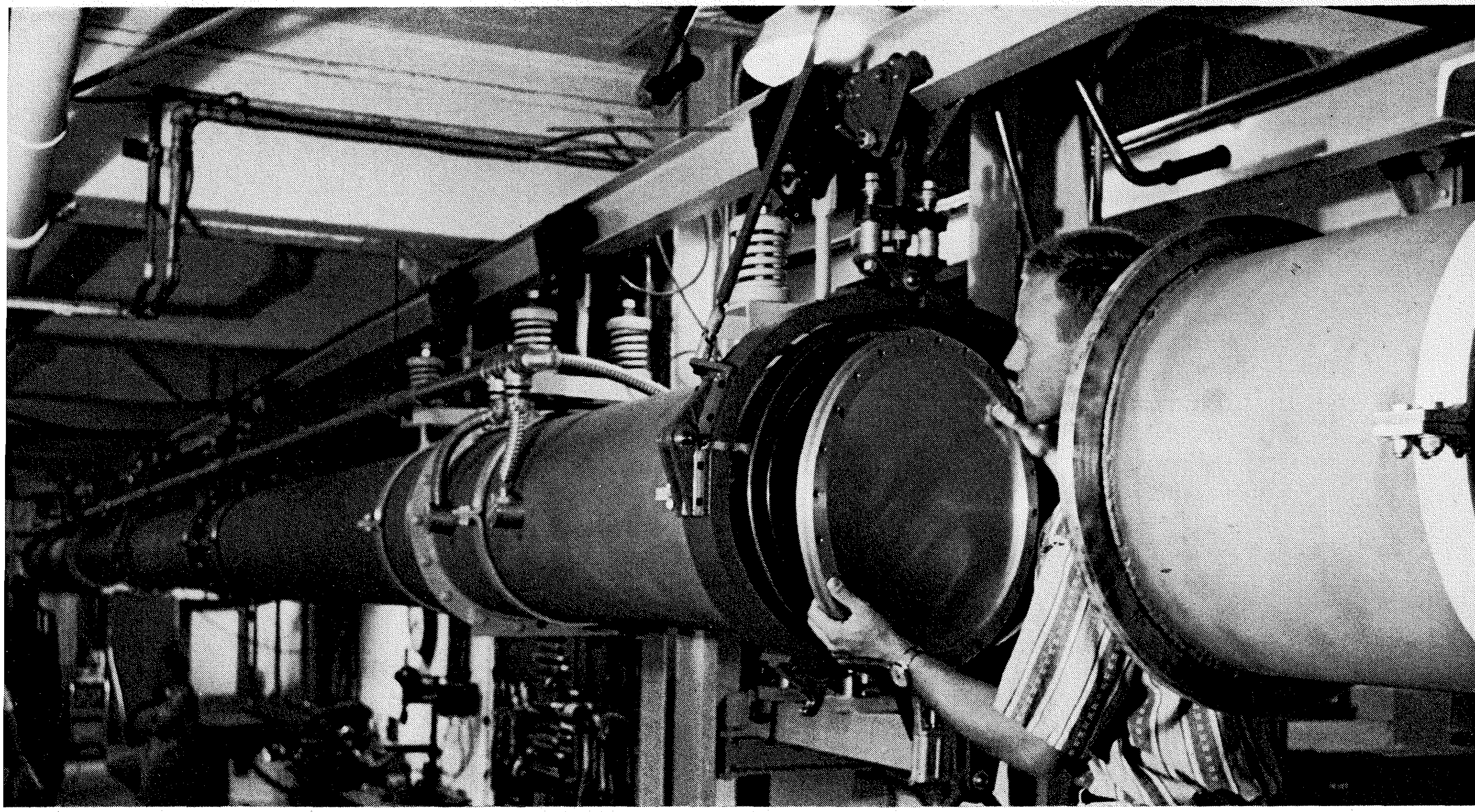
The shock tube is 80 feet long and 17 inches in diameter and fires an initial blast equivalent to that of an intermediate ballistic missile with 50,000 pounds of thrust. The shock wave, confined in the tube, packs a wallop much greater than a sonic boom created when a jet plane breaks the sound barrier, and it travels up to eight times the speed of sound.

The tube consists of seven sections of stainless steel tubing and is enclosed at each end with inch-thick steel plates. The joined sections are mounted individually on wheels on a track suspended from the ceiling, so that they may be separated and interchanged.

The tube is operated somewhat like a cannon. It consists of two parts – a driver, like the cannon's firing chamber; and a test section, similar to the barrel of a cannon. The driver is the first 12 feet of the tube, the test section the other 68 feet. Separating the two parts is the triggering mechanism, a thin aluminum diaphragm.

Firing the shock tube is more complex than loading a cannon. Air is pumped out of the test section until the pressure is equal to that existing some 60 to 70 miles above the earth – one millionth of the pressure in the ordinary atmosphere at sea level. Then helium or nitrogen is pumped into the driver up to 10 times atmospheric pressure – equivalent to the pressure 300 feet under the sea.

Building a differential ratio of one million forces the thin aluminum diaphragm to bulge like the side of a



The Caltech shock tube is used to obtain information about the flow of very hot and highly rarefied gases. The shock tube is operated much like a cannon. It consists of two parts — a driver, similar to the firing chamber of a cannon; and a test section, like the cannon barrel. Above, Research Fellow Bradford Sturtevant fits a thin aluminum diaphragm between the two sections before firing the tube. Below, he removes the end plate from the test section after the shot, to inspect the instrumentation.

balloon on the test side (where there is a near vacuum). Forced by the pressure, the metal diaphragm touches a knife-edged cross that is arched to fit the curve of the diaphragm's bulge. When the pressure increases, the diaphragm presses so hard against the blades that it is sliced into four pie-shaped wedges. This instantly releases the high-pressure gas, which rushes into the near vacuum while the aluminum wedges are slammed back against the tube walls.

The released pressure creates a powerful shock wave that races the nearly 70-foot length of the test section in one one-hundredth of a second. The velocity of the wave is measured by 12 instrument stations located at intervals along the test section. All the measurements are recorded automatically, and the tube is designed to be operated by one man.

Sponsored by the National Aeronautics and Space Adminstration, the shock tube program is headed by Hans W. Liepmann, professor of aeronautics. Donald E. Coles, associate professor of aeronautics, is in charge of the mechanical design; Anatol Roshko, associate professor of aeronautics, of performance; and Bradford Sturtevant, research fellow in aeronautics, is in charge of the research program.