GENESES OF HIGH PRESSURE APPARATUS

The following selection of schematics, B&W and color photographs provide a quick overview of the types of high-pressure apparatus designed and developed by Dr. H. Tracy Hall for *simultaneously* maintaining pressures of one million pounds per square inch at temperatures of 2500 degrees fahrenheit as required for diamond synthesis.

The significance of Dr. Hall's work is that, while many other noted scientists had pursued the dream of diamond synthesis for many decades, it was his invention that actually made the production of synthetic diamond a reality. He was able to First develop the apparatus for obtaining and sustaining ultra high pressures and temperatures, and Second solve the complex chemical problems for converting graphite into diamond because direct conversion did not take place.

A Federal Government Secrecy Order was placed on all of Hall's inventions because of their importance. Secrecy was lifted seven years later, You can imagine the great excitement in the scientific community as new branches of physics, chemistry, and geology could be foreseen for studying properties of matter under high pressures and temperatures.

By this time, Hall had moved to (BYU) Brigham Young University and hundreds of interested scientists came to the Provo, Utah location to discover his high pressure, high temperature technics.

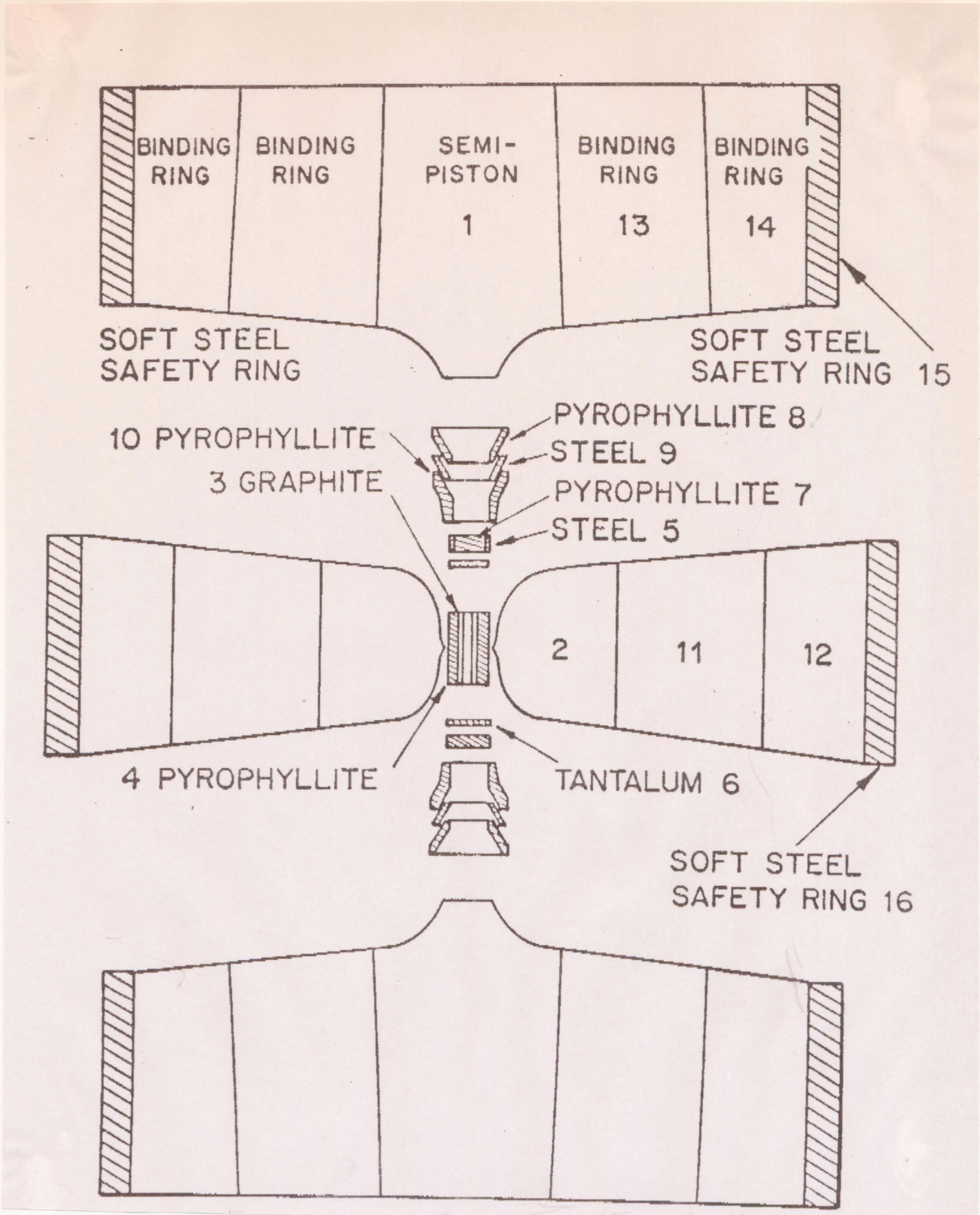
Hall's High Pressure, High Temperature "Belt" apparatus

An "exploded" view of the original Belt apparatus invented by Hall at the General Electric Research Laboratory, in Schenectady, New York is shown on the facing page.

In operation, graphite and other metals including iron, nickel, cobalt and other Group Eight elements of the periodic table are commingled in the reaction chamber of the electrical resistance heating tube.

Early heating tubes comprised a high melting metal or graphite.

As the semi-pistons advance, they contact the pyrophyllite assembly. Then by a combination of extrusion and compression, the semi-pistons advance sufficiently to reach diamond making pressure conditions.


BINDING RING
BINDING RING
SEMI-PISTON
1
BINDING RING
13
BINDING RING
14
SOFT STEEL SAFETY RING
SOFT STEEL SAFETY RING 15
PYROPHYLLITE 8
10 PYROPHYLLITE
STEEL 9
3 GRAPHITE
PYROPHYLLITE 7
STEEL 5
2
11
12
4 PYROPHYLLITE
TANTALUM 6
SOFT STEEL SAFETY RING 16

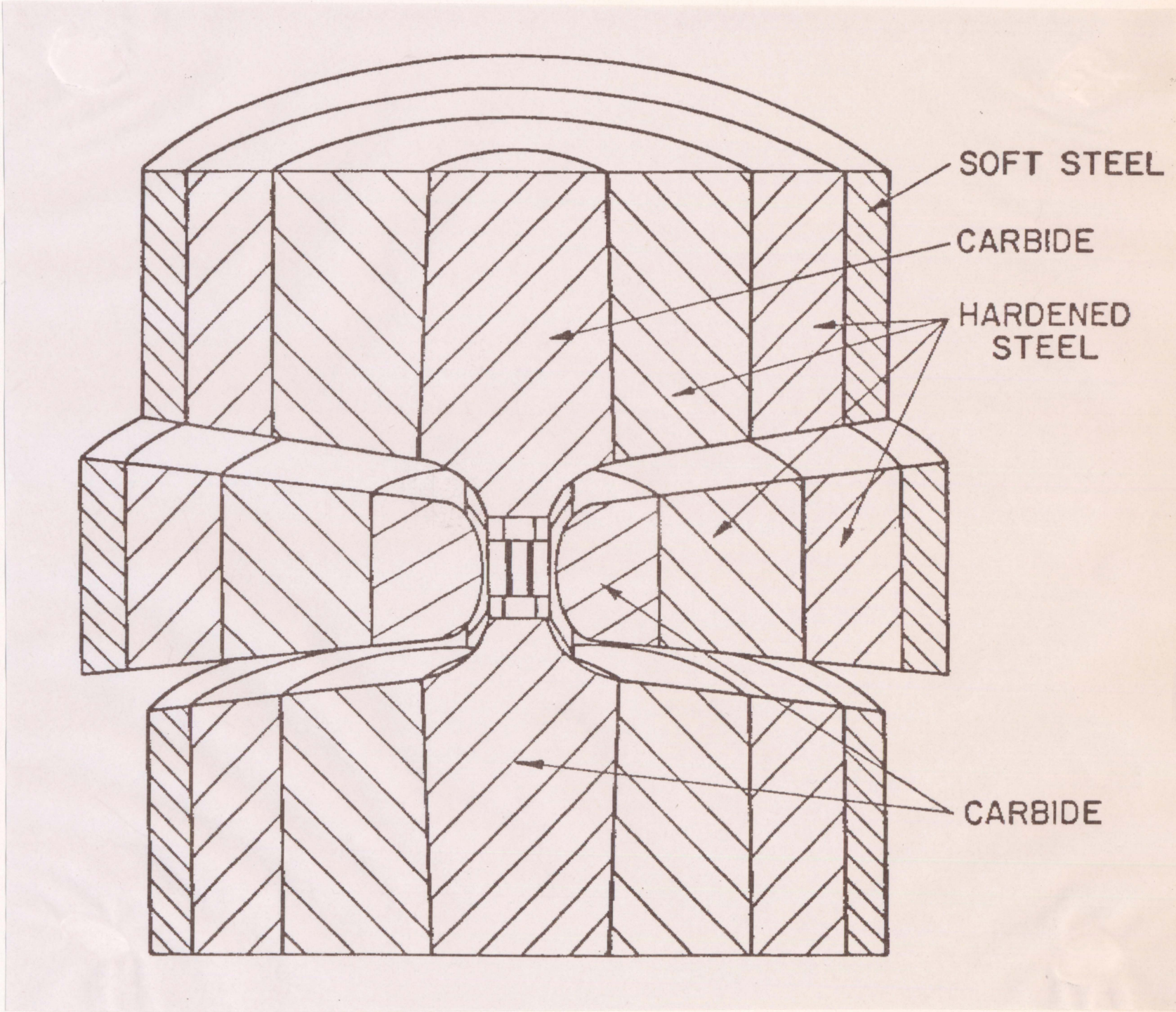
BELT PRESS

A closed view of the BELT press is shown on the facing page. The inner capsule comprises pyrophyllite, graphite, tantalum and steel. The outer components consist of hardened steel binding rings and a soft steel retaining ring.

This device can easily maintain a pressure of one million pounds per square inch at a temperature of 2500 degrees fahrenheit.

These conditions can be maintained for weeks when water cooling jackets are placed around the binding rings.

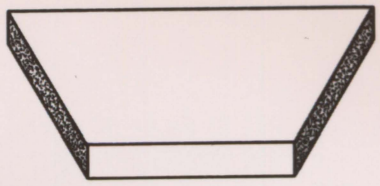
The BELT assembly is actuated by being placed inside of a double acting hydraulic press that advances and retracts the upper and lower semi-pistons in which the binding rings are enclosed.


SOFT STEEL
CARBIDE
HARDENED STEEL
CARBIDE

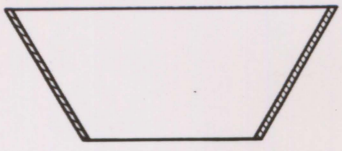
THE REACTION CELL WHERE THE TRANSFORMATION TAKES PLACE

After a run, a cylindrical punch is used to push the chamber parts out. The chamber is then crushed with a hammer and the diamond and metallic catalyst which is now a solid cylindrical piece falls free. This is now placed in an acid bath which disolves the metal and frees the diamond crystals.

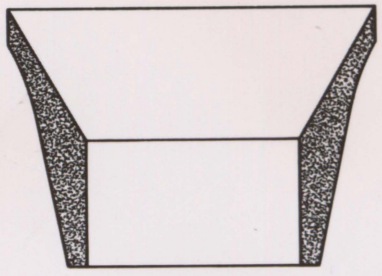
STEEL AND PYROPHYLLITE



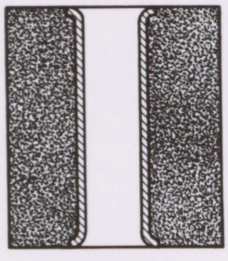
PYROPHYLLITE



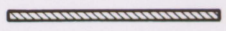
STEEL CONE



PYROPHYLLITE



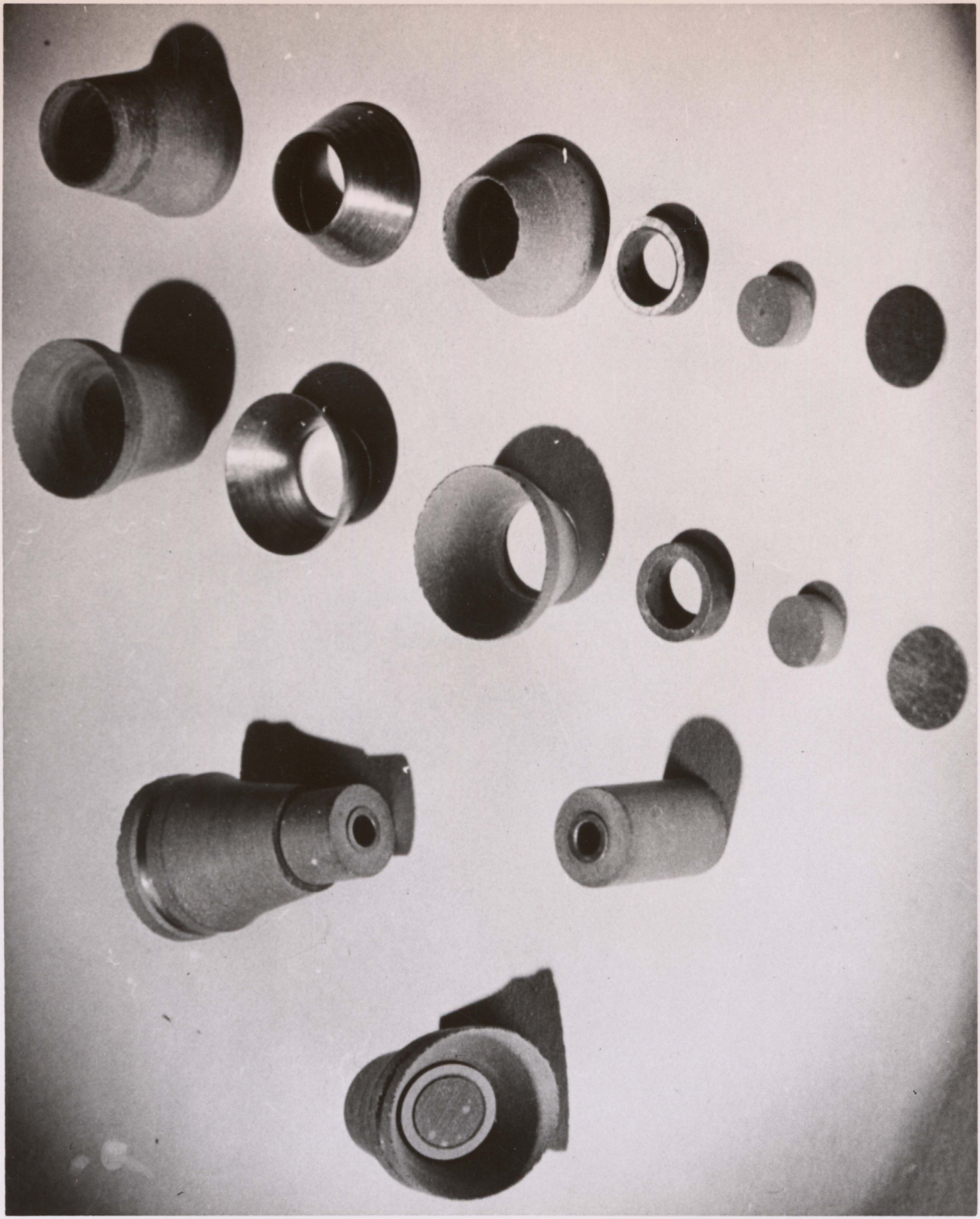
PYROPHYLLITE



METAL DISC

DETAIL OF CHAMBER PARTS

ADDITIONAL PICTURES OF THE REACTION CELL



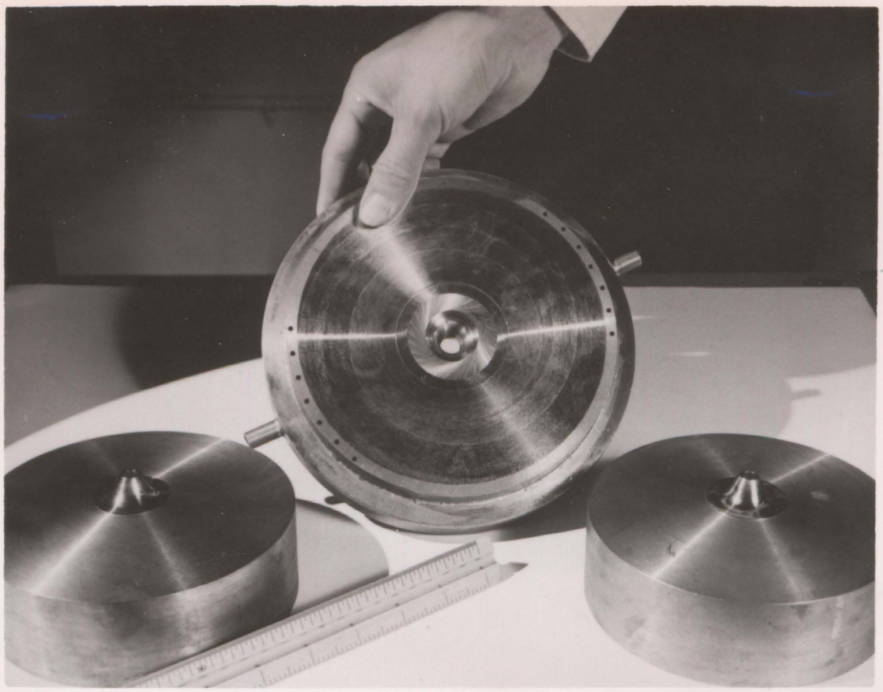
TOP

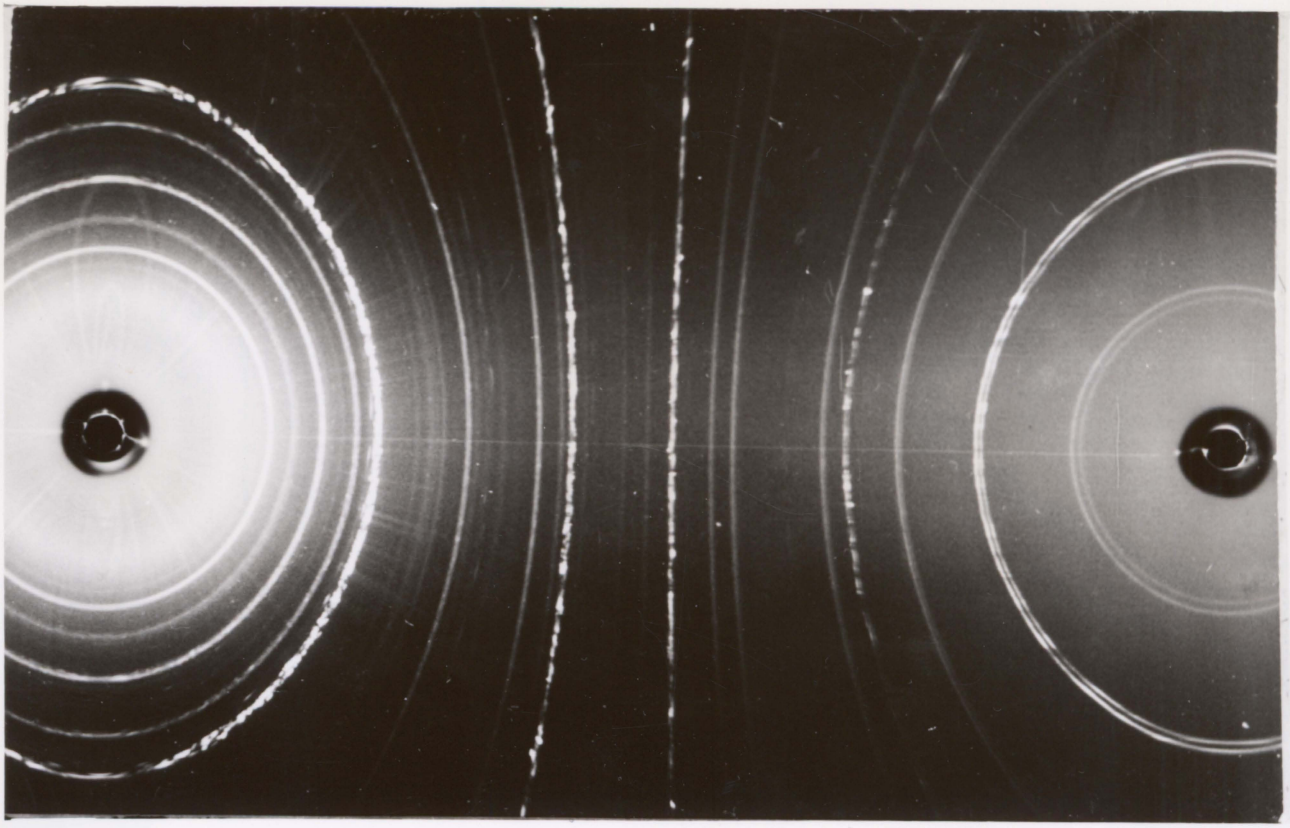
PHOTOGRAPH OF HALL'S FIRST "BELT" PRESS

CONCEIVED AND CONSTRUCTED IN 1953

BOTTOM

X-RAY DIFRACTION PATTERN OF THE FIRST LABORATORY DIAMONDS





WORLD'S FIRST SYNTHETIC DIAMOND CRYSTALS

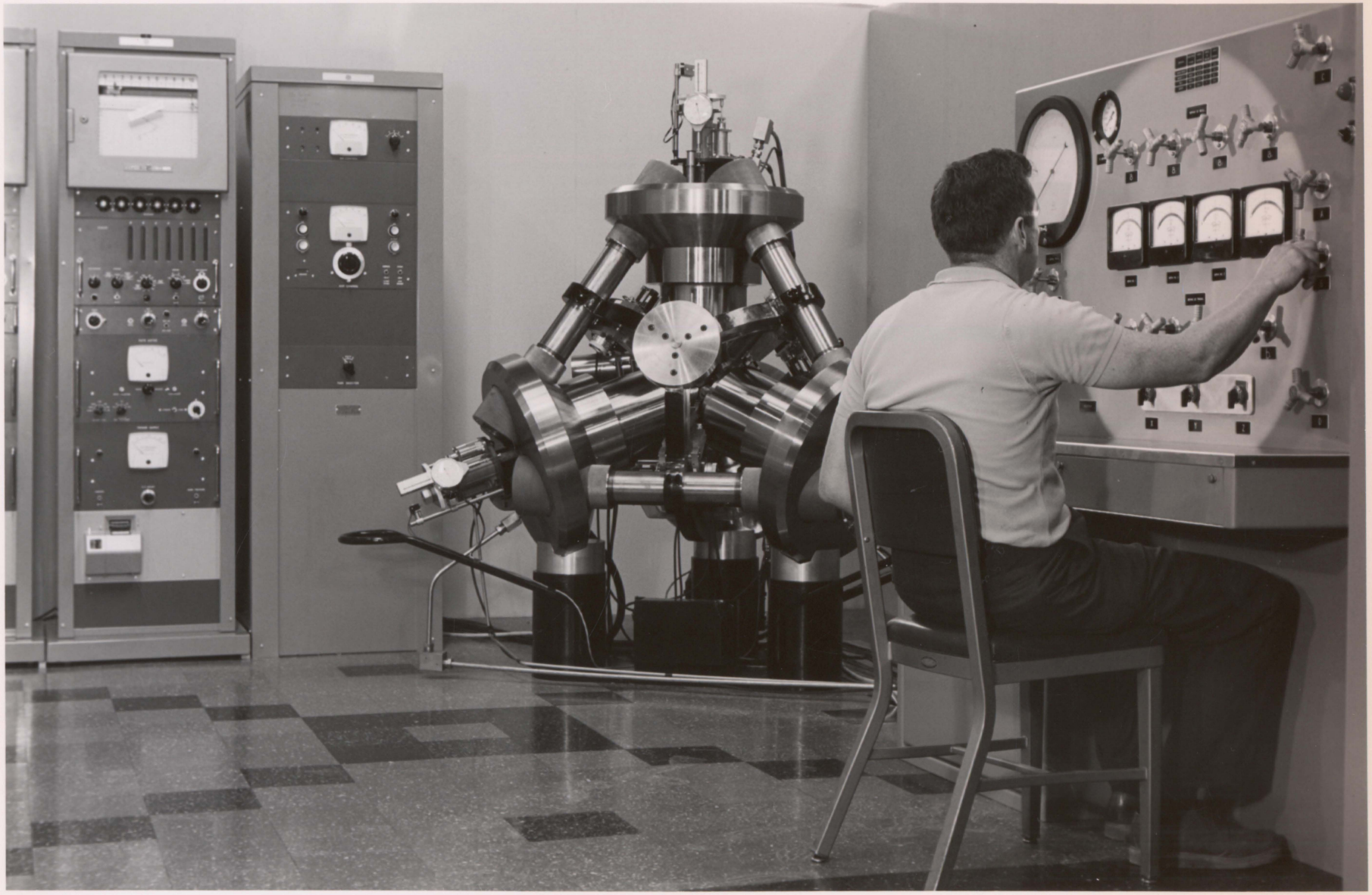
Photographs of synthetic diamond crystals grown by H.T. Hall, December 16, 1954.

Crystals in lower left were burned in O_2 and formed CO_2


100 μ

X-Ray Diffraction Press

and associated electronic
equipment for research
on phase-changes at elevated
pressures and temperatures
(1963)



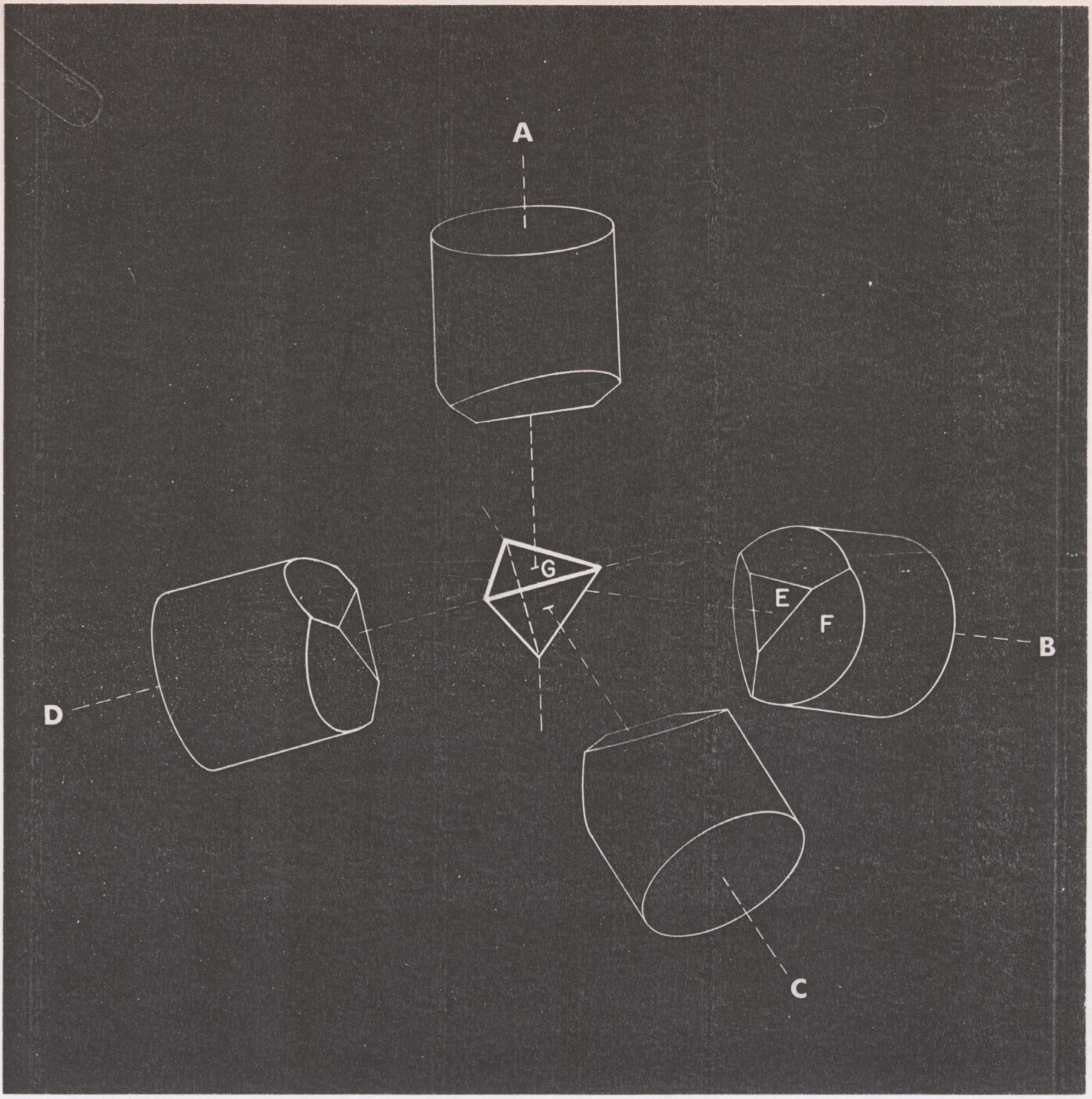
#194

↑ up

H. Tracy Hall

Press for French A.E.C.
Installed near Paris in 1964
built by McCartney

"Red" Robinson at controls



TETRAHEDRAL ANVILS AND REACTION CELL

The drawing shows the tetrahedral axes **A, B, C** , and **D** .

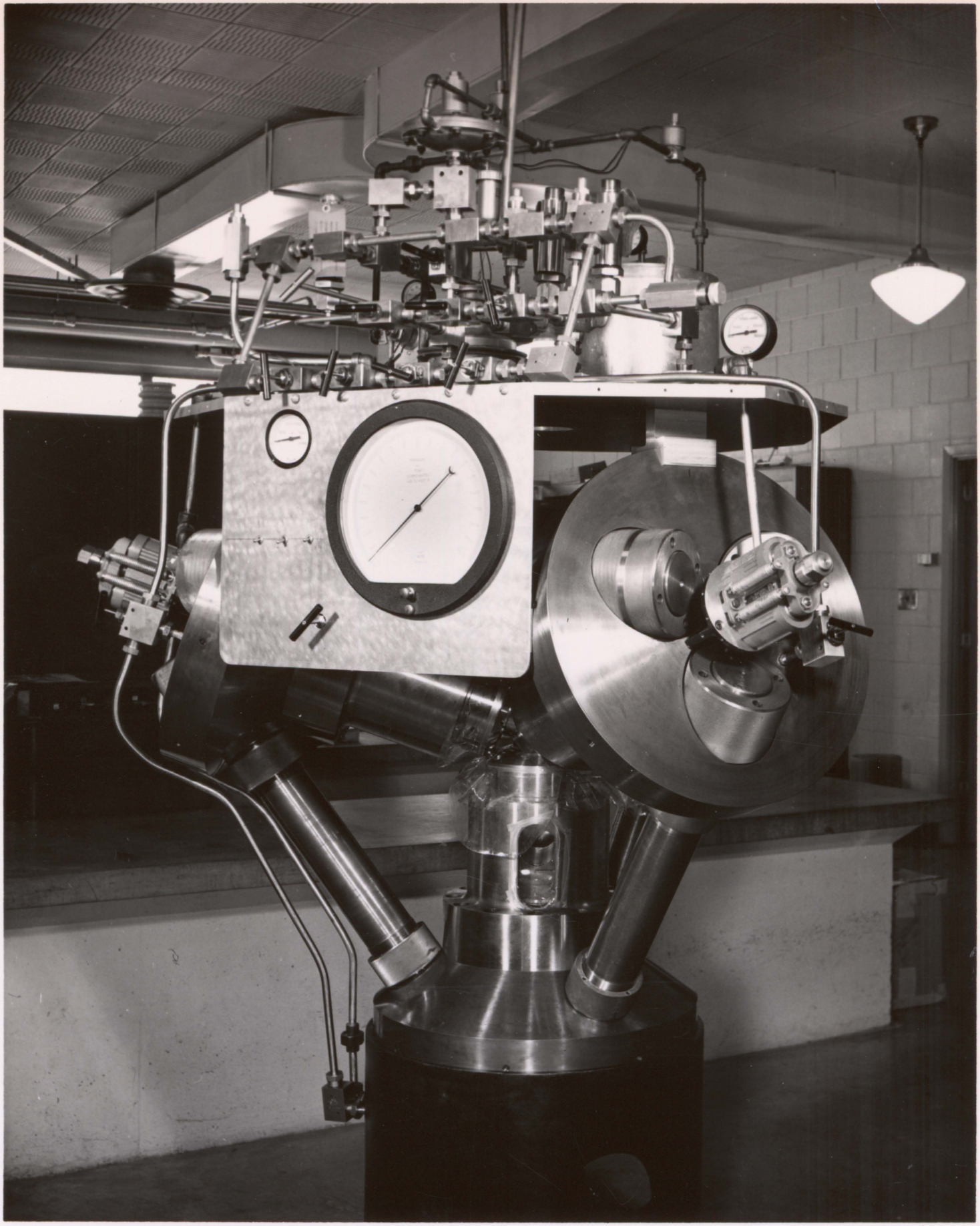
E indicates the triangular shaped face of the anvils.

F indicates the sloping faces of the anvils.

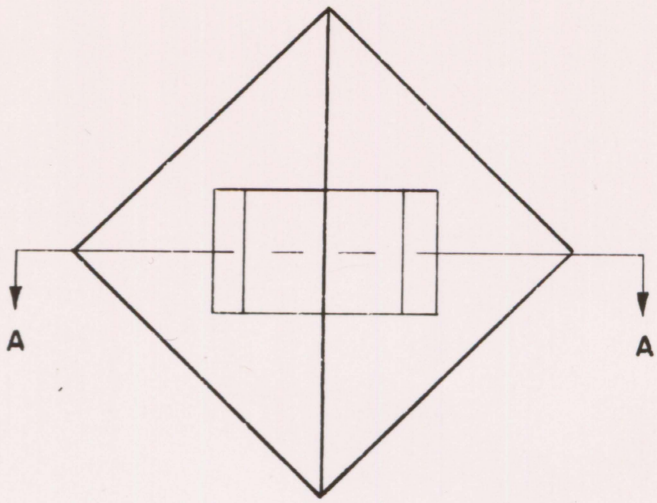
G indicates the tetrahedron that encompasses the internal reaction cell components.

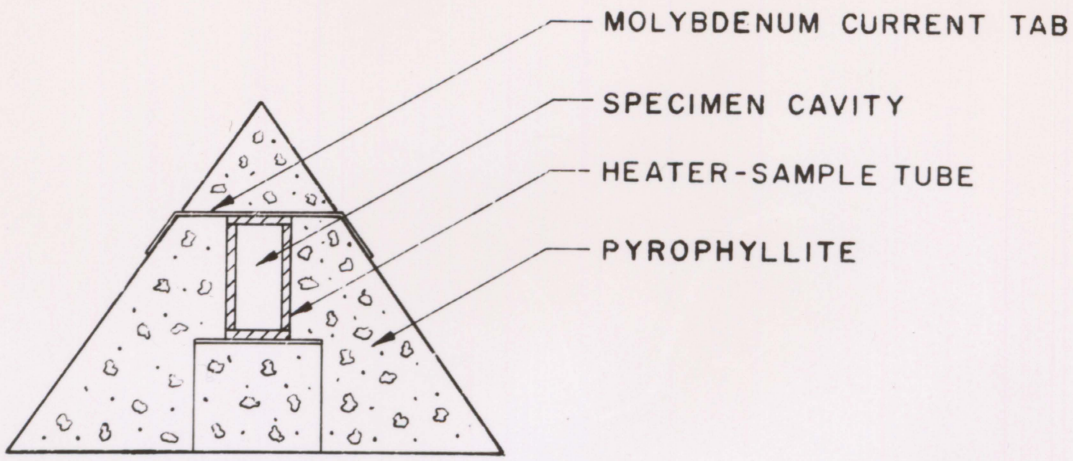
A 300 T0N CAPACITY INVERTED TETRAHEDRAL PRESS

Used primarily for scientific research

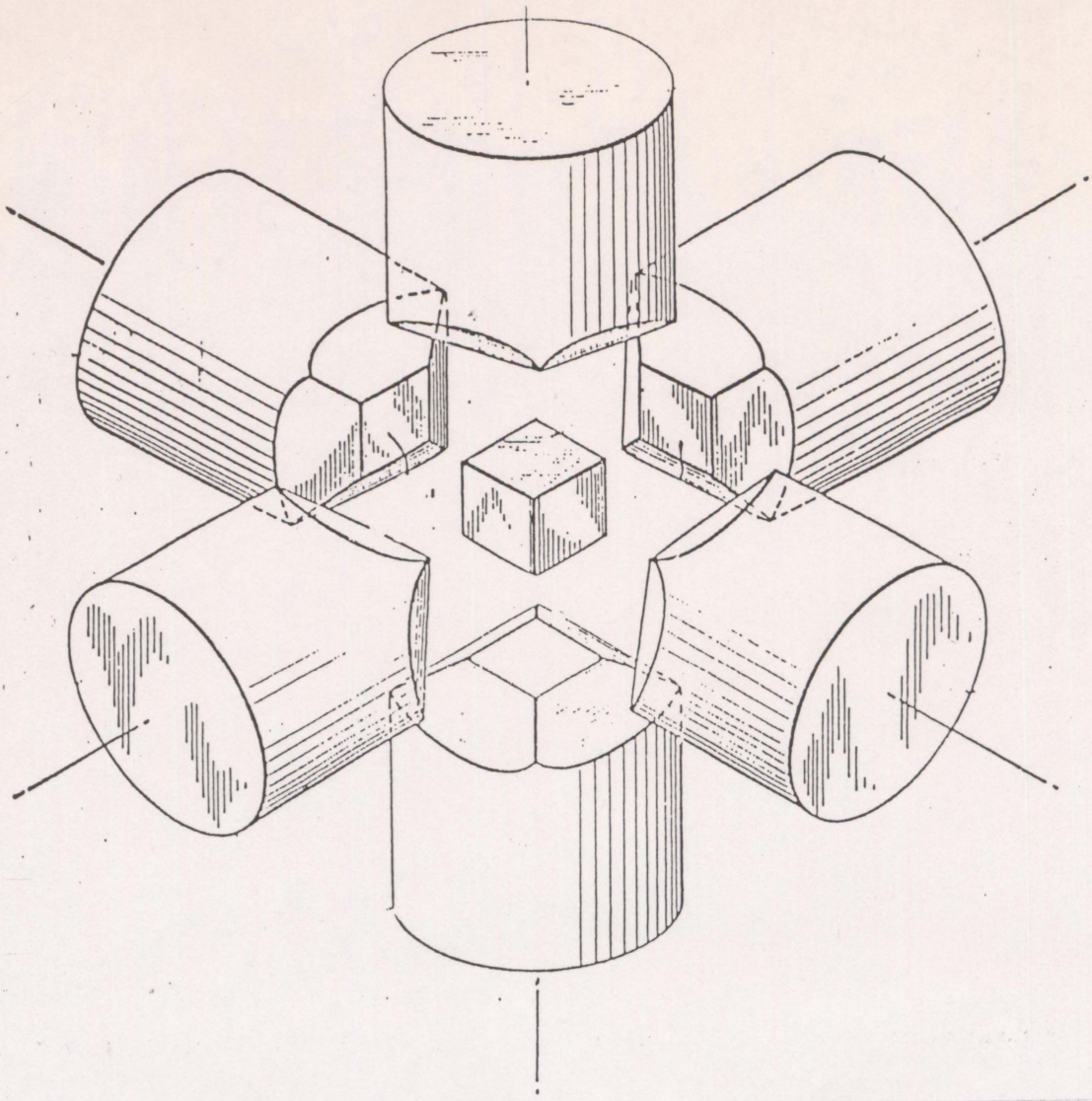


TETRAHEDRAL CELL





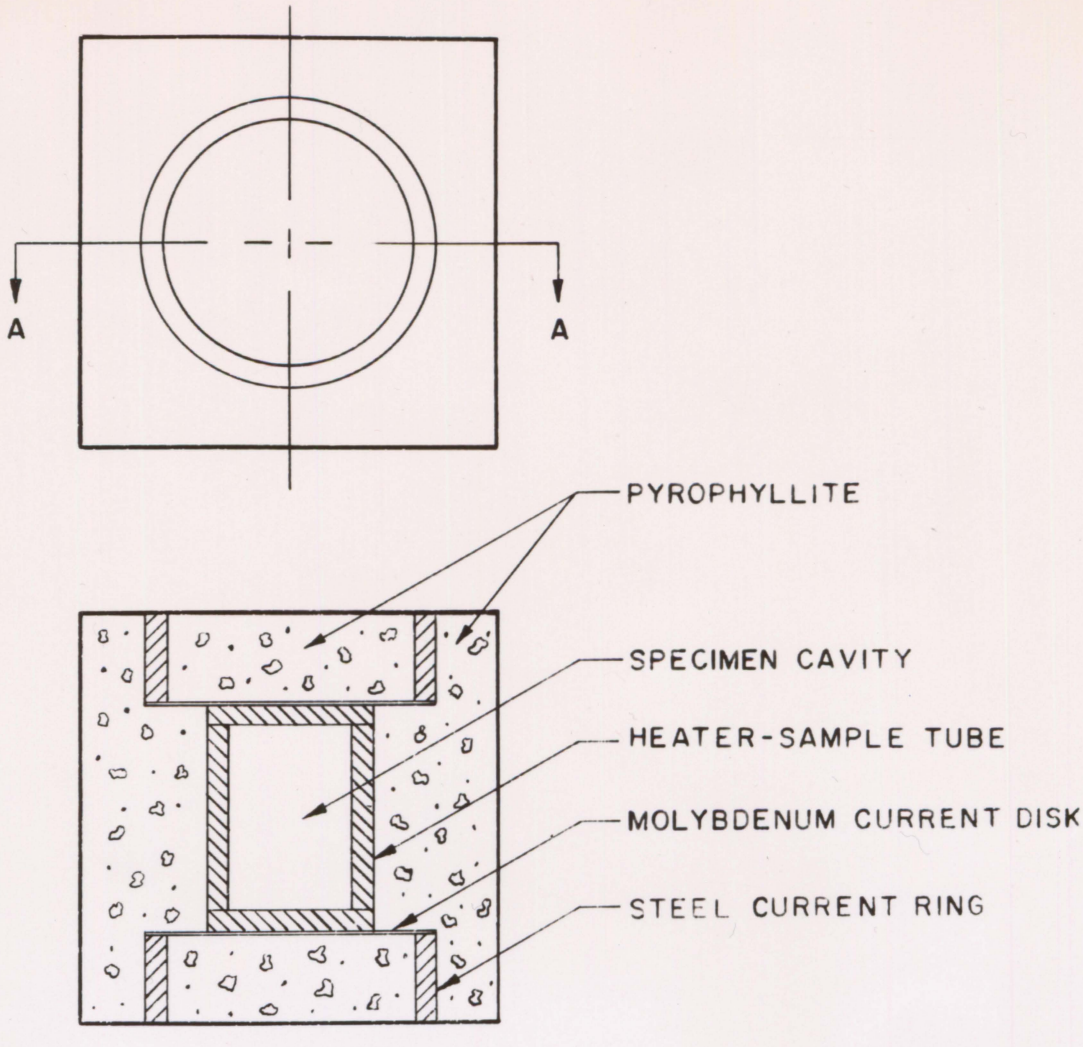
SECTION A-A



CUBIC ANVIL PRESS ARRANGEMENTS

The six anvils are aligned along the axes of an x-y-z cartesian coordinate system. The area of the faces of the reaction cell is 50% larger than the corresponding area of each anvil face. This allows for extrusion and compression of the pyrophillite to take place between adjoining anvils and build up the pressure inside.

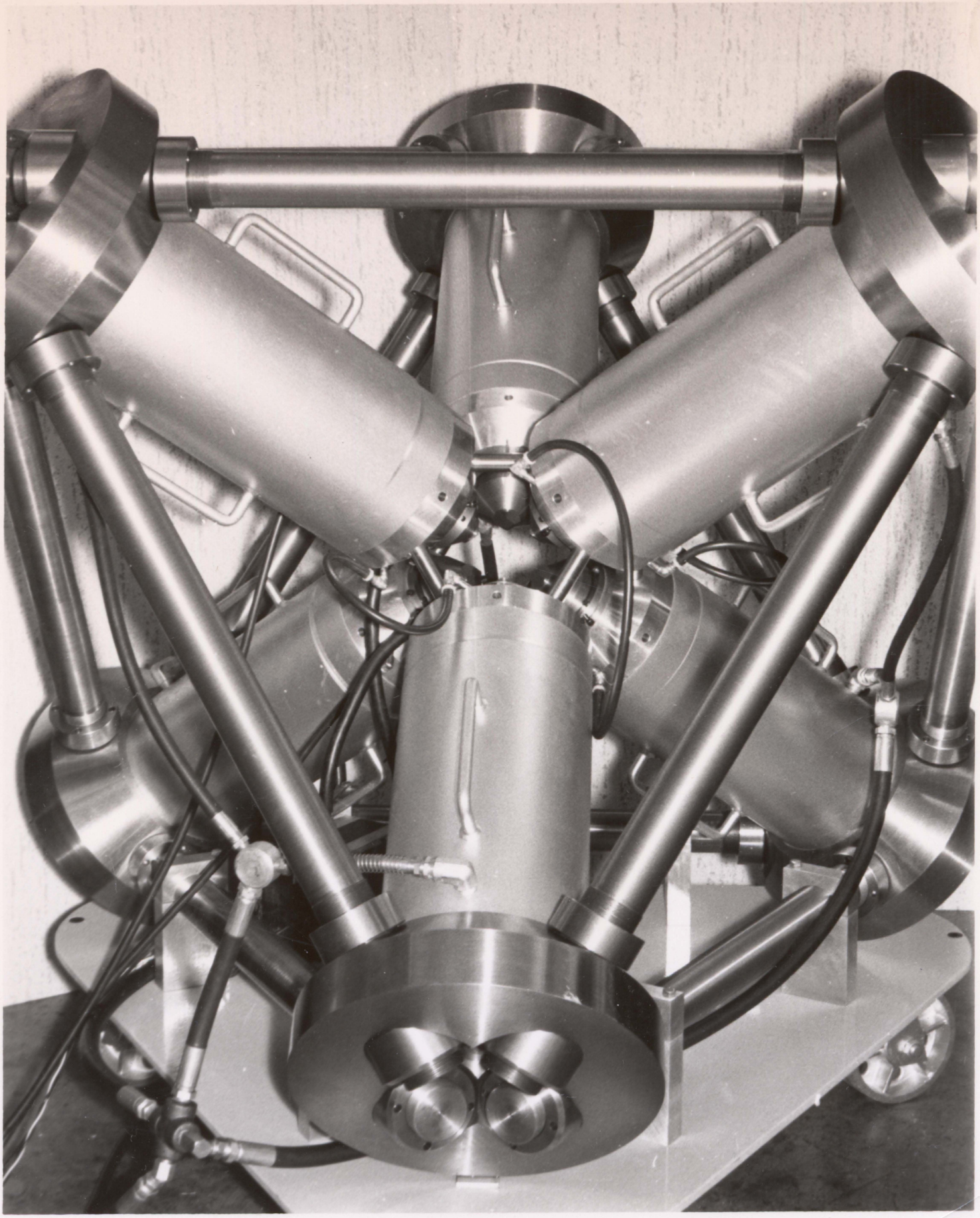
CUBIC CELL



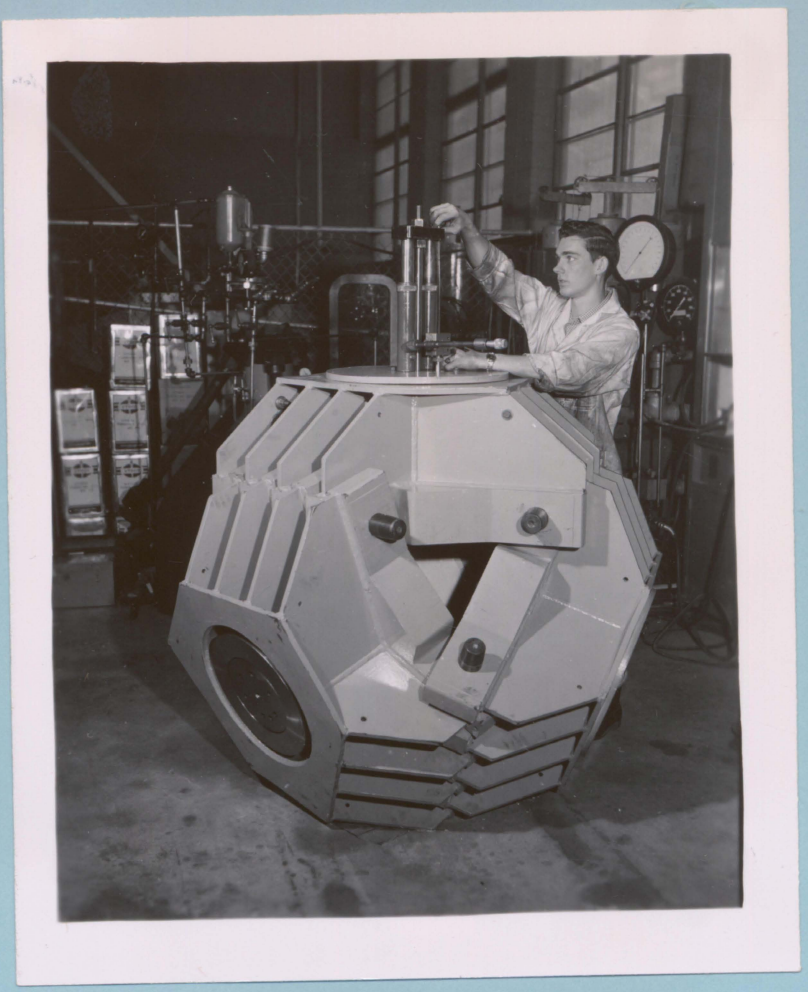
SECTION A-A

A 200 T0N CAPACITY CUBIC PRESS

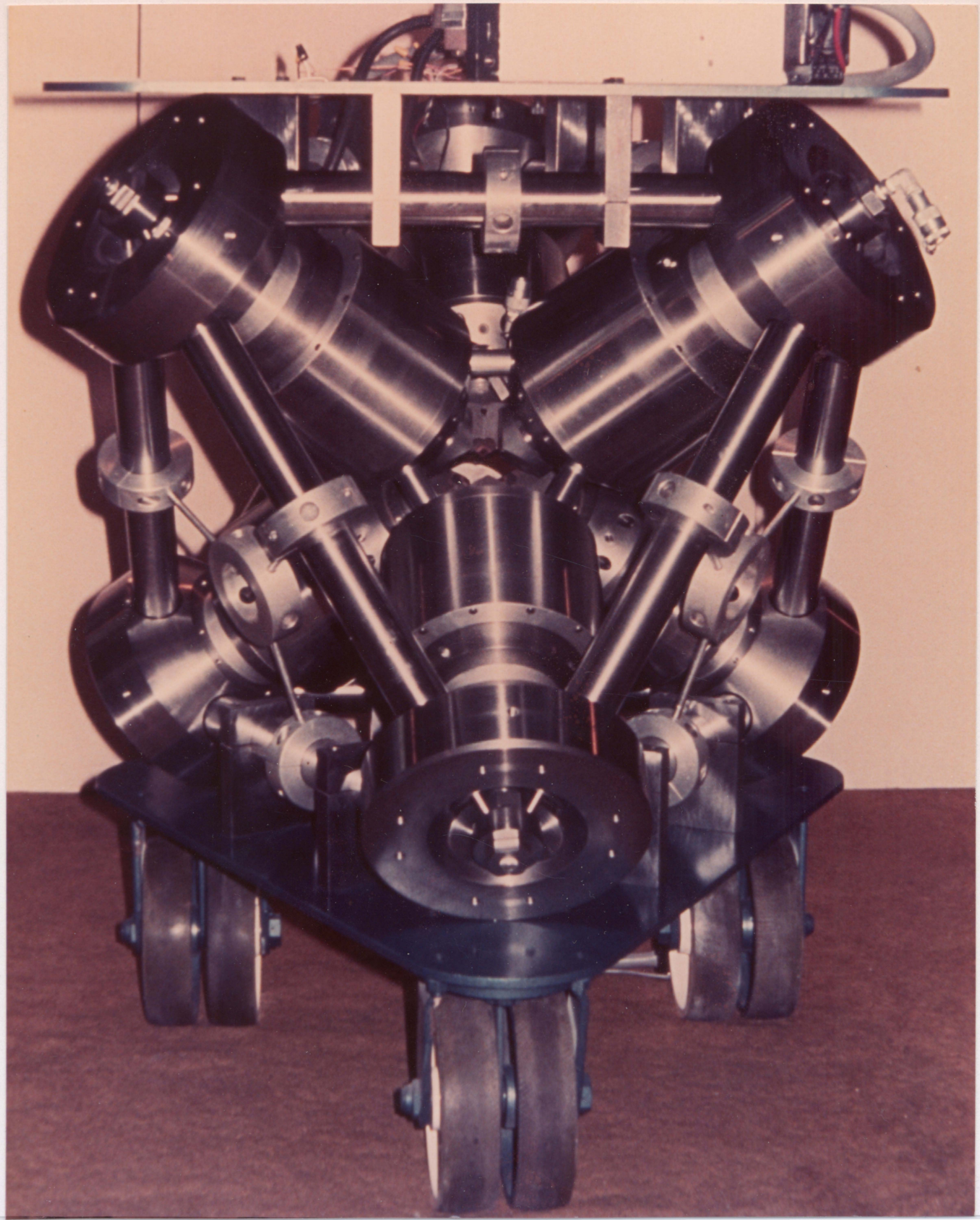
Used primarily for scientific research

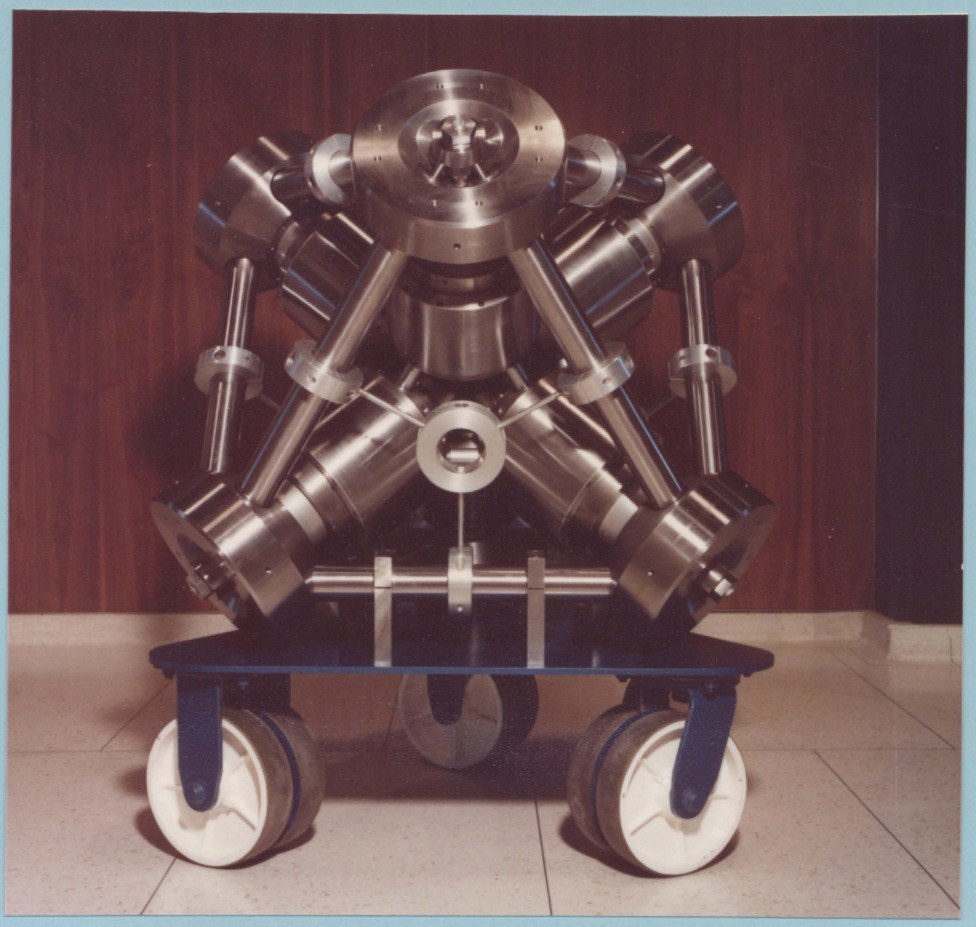


A 1,000 T0N CAPACITY TETRAHEDRAL PRESS
"CLAMSHELL DESIGN"
THIS DESIGN ELIMINATES THE USUAL TIE BARS



THREE VIEWS OF A PORTABLE 300 TON CAPACITY CUBIC PRESS





H. TRACY HALL AGE 35 AT THE TIME HE MADE THE FIRST DIAMONDS