Dec. 8, 1964 | H. T. HALL | 3,159,876

HIGH PRESSURE PRESS

Originally Filed Nov. 9, 1959 | *4 Sheets-Sheet 1*

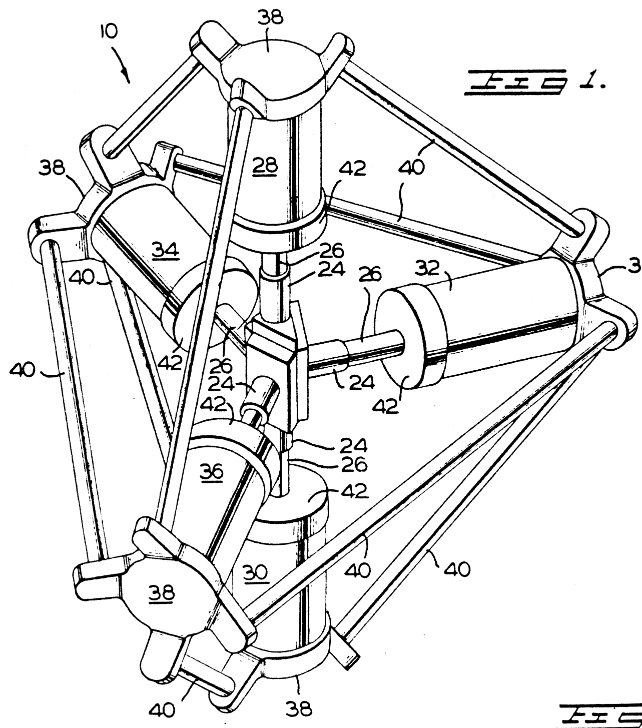

FIG. 1.

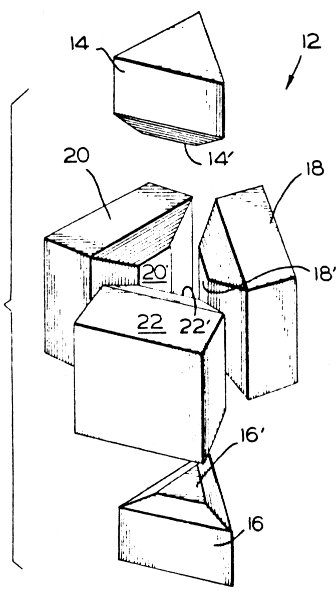

FIG. 2.

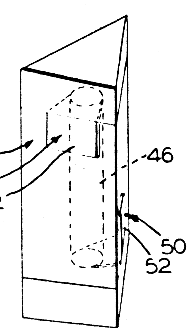

FIG. 3.

Inventor
Howard T. Hall

By Harold T. Stowell
Attorneys

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FIG. 4.

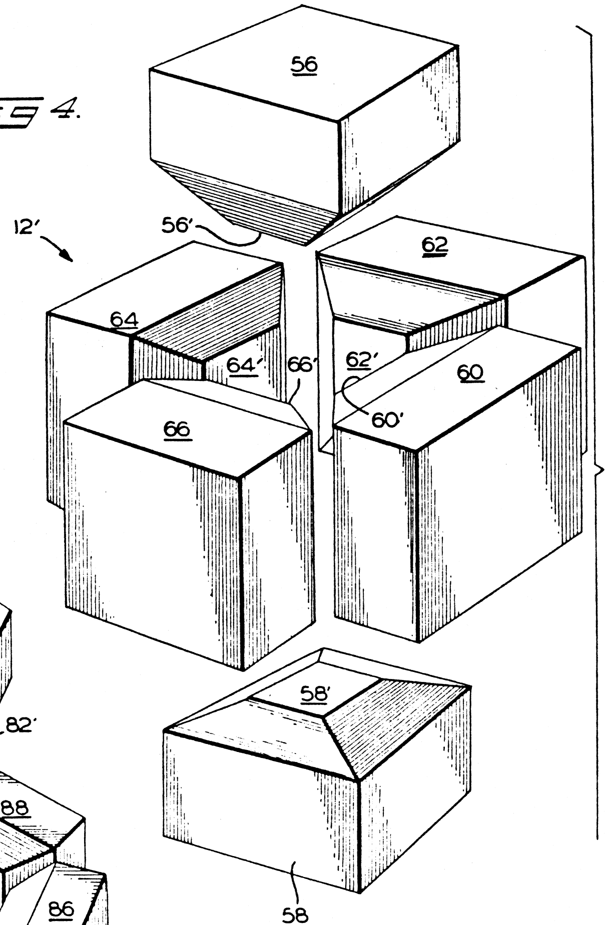
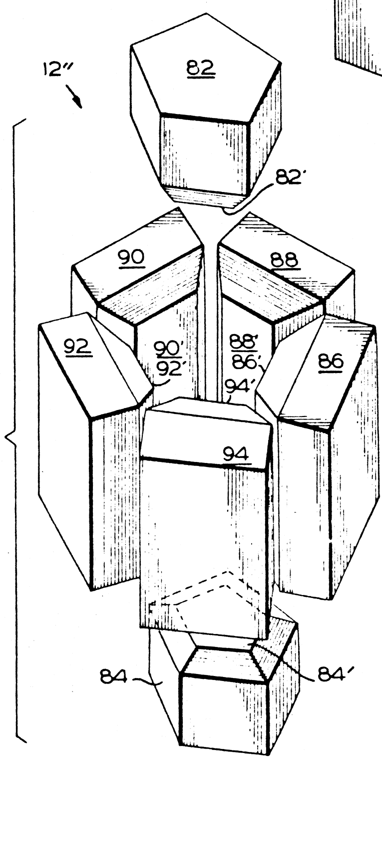


FIG. 7.



Inventor
Howard T. Hall

By *Harold T. Stowell*

Attorneys

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FIG. 7.

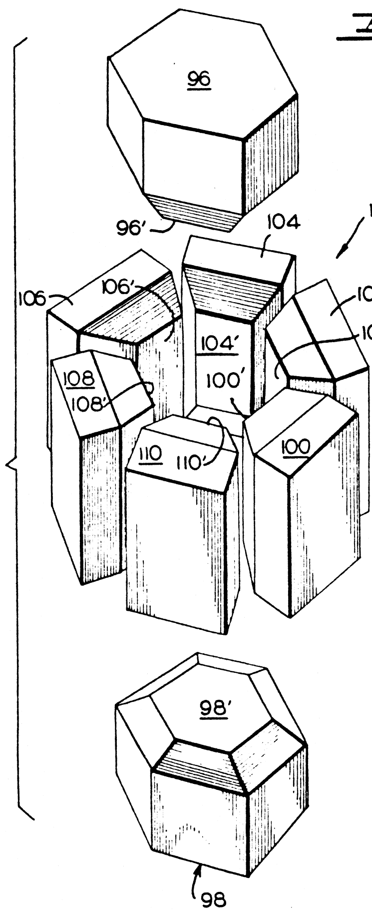


FIG. 8.

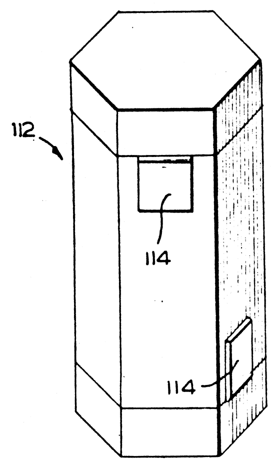


FIG. 6.

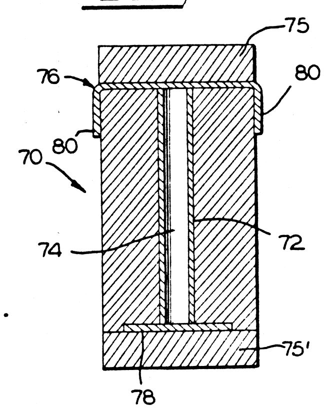
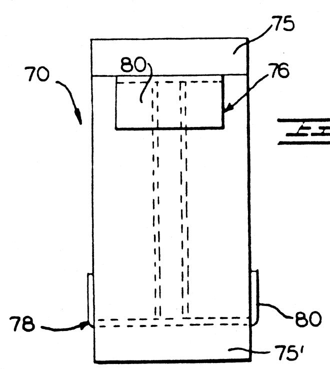


FIG. 5.



Inventor
Howard T. Hall

By Harold T. Stowell

Attorneys

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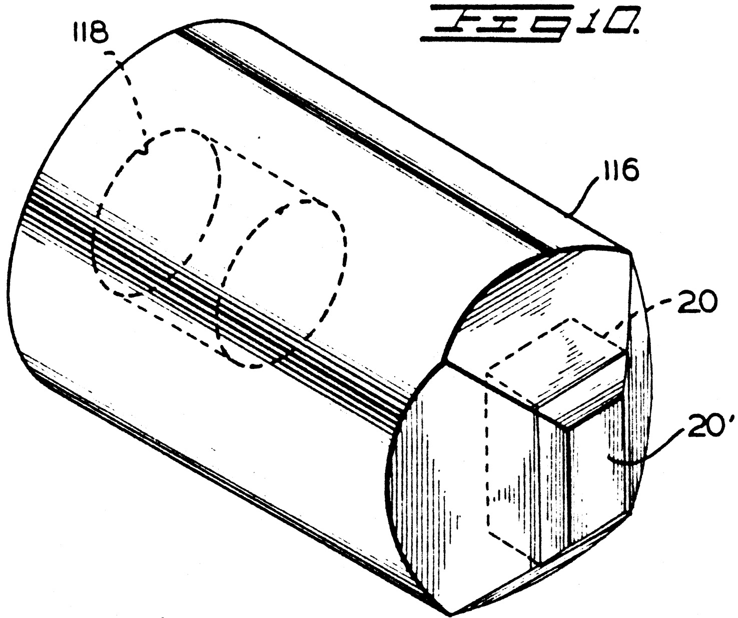
FIG. 10.



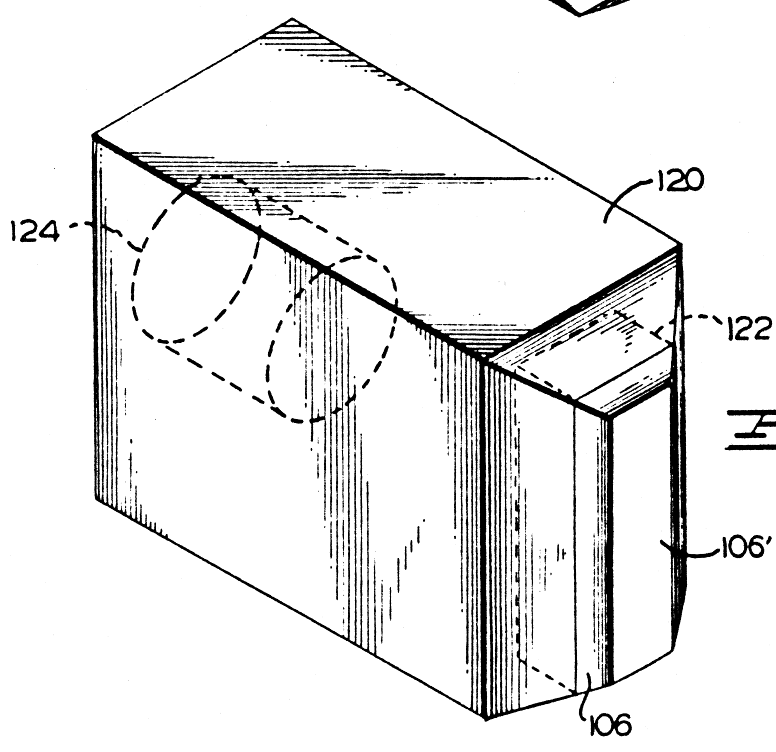


FIG. 11.

Inventor
Howard T. Hall

By Harold T. Stowell
Harold T. Stowell
Attorneys

United States Patent Office

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HIGH PRESSURE PRESS

Howard T. Hall, Provo, Utah, assignor to Research Corporation, New York, N.Y., a corporation of New York
Continuation of application Ser. No. 851,855, Nov. 9, 1959. This application May 23, 1962, Ser. No. 199,558
5 Claims. (Cl. 18-16) 1

This invention relates to new and improved presses and, more particularly, to presses wherein the materials within the press may be subjected to very high pressures and, where desired, simultaneously heated to relatively high temperatures.

In my co-pending application, Serial No. 731,543, filed April 28, 1958, issued as Patent No. 2,918,699, December 29, 1959, there is disclosed a tetrahedral anvil type press which is capable of extremely high pressures without failure of the anvil members. The faces of the anvil devices of such a tetrahedral press define when closed a regular tetrahedron.

The present invention is particularly directed to an improved high pressure press wherein the faces of the anvil devices of the press form, when closed, a polyhedral prism whereby it is possible to press long thin materials without making the overall dimensions of the press cell disproportionately large.

A further object is to provide such a press which may be employed with a solid pressure transmitting medium wherein the solid pressure transmitting medium also serves as a thermal and electrical insulation and provides the necessary compressible gasket for the device.

A further object is to provide such a press that is relatively simple in form and dependable in use wherein materials, liquid, solid, granular, or the like, in nature may be subjected to controlled high pressures and, when desired, simultaneously heated to relatively high temperatures whereby high pressure, or high pressure and temperature, reactions may be carried out or the effect of high pressure or high pressures and high temperatures on materials may be conveniently studied.

These and other objects and advantages are provided in a press generally comprising a pair of anvil devices having similar opposed equal faces mounted for rectilinear movement along a common axis, at least three anvil devices mounted for rectilinear movement along axes normal to the faces thereof and positioned in a common plane normal to the common axis of said pair of anvil devices and converging to a common intersection located in said common axis, the faces of said anvil devices forming a a closed polyhedral prism in their position of contact.

The invention will be more fully described with reference to the illustrative embodiment shown in the drawings wherein:

FIG. 1 is a perspective view of a press embodying the principles of the present invention;

FIG. 2 is a diagrammatic exploded view of the anvil devices of the press shown in FIG. 1;

FIG. 3 is a perspective view of a solid pressure transmitting sample carrier for the press illustrated in FIGS. 1 and 2;

FIG. 4 is a perspective exploded view of a modified form of anvil devices forming another form of closed polyhedral prism;

FIG. 5 is a side elevational view of a solid pressure transmitting sample carrier for a press having anvil members as disclosed in FIG. 4;

FIG. 6 is a vertical section through the solid pressure transmitting sample carrier illustrated in FIG. 5;

FIG. 7 is an exploded perspective view of another form of anvil devices forming a closed polyhedral prism in their position of contact;

FIG. 8 is an exploded perspective view of a further form of anvil devices forming a closed polyhedral prism in their position of contact;

FIG. 9 is a perspective view of a solid pressure transmitting sample carrier for a press having anvil devices such as illustrated in FIG. 8;

FIG. 10 is a perspective view of one of the anvil devices shown in FIGS. 1 and 2, having a cylindrical carrier to provide lateral mechanical support for the press anvil; and

FIG. 11 is a perspective view of one anvil member of the anvil assembly illustrated in FIG. 8, illustrating means for providing lateral mechanical support therefor.

Referring to the drawings and, in particular, to FIGS. 1 through 3 thereof, 10 generally designates a press having a plurality of anvil devices generally designated 12 forming a closed polyhedral prism in their position of contact. In FIG. 2, the polyhedral prism forming the press section of press 10 is composed of five anvil devices. Two of the anvil devices 14 and 16 have faces 14' and 16' called bases, which lie in parallel planes. Each of the remaining anvil devices 18, 20 and 22 have, respectively, faces 18', 20' and 22'. Faces 14' and 16' are similar equilateral triangles while faces 18', 20' and 22' are regular parallelograms.

On presses designed for operation at atmospheres not substantially greater than 35,000 atmospheres, the anvil members 12 may be constructed of hardened steel such as AISI Nos. 4140, 4340, or similar steels. Where substantially higher pressures are to be developed in the press, cemented tungsten carbide is preferably employed for the anvil members 12. It will also be apparent to those skilled in the art that other materials having suitably high compressive strength may be used, such as, cemented cubic boron nitride. Each of the anvil members 12 is carried by a mounting ring member generally designated 24 which receives at its base and the extended end of one of the piston rods 26 of pressure developing means illustrated in FIG. 1 as hydraulic rams 28, 30, 32, 34 and 36. Hydraulic rams 28 and 30 are mounted in opposed relationship so that their respective piston rods move in a rectilinear path along a common axis.

Hydraulic rams 32, 34 and 36 are mounted so that their piston rods 26 have rectilinear movement along axes normal to the faces 18', 20' and 22' of their respective anvil members. Further, each of the hydraulic rams 32, 34 and 36 are mounted so that the piston rods 26 thereof are positioned in a common plane normal to the common axes of the piston rods of hydraulic cylinders 28 and 30 so that the piston rods 26 of the plural hydraulic rams converge to a common intersection.

In order to provide support for each of the hydraulic rams, there is provided at the base end of each of the cylinders 28, 30, 32, 34 and 36 a plate member 38. Each plate member is interconnected, by screw-type connecting rods designated 40, to the plate member of each of the other of the hydraulic rams to provide rigid interconnections between the hydraulic rams of the press. Further, the head ends 42 of the hydraulic rams may be similarly interconnected to prevent movement of the cylinders and to insure that during operation of the press there is no askew movement of the anvil devices 12.

Each of the hydraulic rams is connected to a source of pressure fluid through conduits, not shown in the drawings, whereby the piston rods 26 thereof are moved toward and away from a point of common intersection.

In operation of the press hereinabove described, the material to be placed under pressure is positioned in a pressure transmitting and sealing carrier substance of larger dimensions than the polyhedral prism defined by the five faces of the anvil members when the edges of the faces are in abutting arrangement. Preferably the pressure transmitting substance is a fine grained compact solid material having good thermal and electrical insulating properties. A number of compact powders and fibers meet these requirements and an excellent readily machinable material which has been successfully employed is pyrophyllite, a naturally occurring hydrous aluminum silicate often called Tennessee Grade A Lava.

Pyrophyllite melts to a glassy substance at temperatures about 1500* C. at pressures of a few thousand atmospheres. Its melting point is increased considerably at very high pressures. When it is melted at high pressures, molecular holes are squeezed out and the material is very viscous and does not flow readily. At very high pressures the upward limit of temperature usefulness for pyrophyllite as a pressure transmitting medium has not been established. It has been found, however, when the material is confined, to be a useful holder for materials to be placed under pressures at temperatures to 10,000* C. and at pressures of about 15,000 atmospheres.

Referring to FIG. 3, a pyrophyllite prism 44 is constructed with edges about 25% larger than the corresponding edges of the corresponding faces 14', 16', 18', 20' and 22' of the anvil members 12. The pyrophyllite serves as a pressure transmitting medium and as thermal and electrical insulation, and provides the necessary compressible gasket for the system. The pyrophyllite prism is bored as at 46 to provide an opening for a material container running axially through the pyrophyllite prism from opposite bases.

The material container is preferably tubular in form and may be constructed of metal or graphite where the material is to be heated while under pressure. Where the material is not to be heated, the entire space formed by the bore 46 may be filled with material to be compressed.

Where the material to be placed under pressure is also to be heated, the pyrophyllite prism sample holder is cut to receive metal conductors 43 and 50. Where the sample container within the bore 46 is metal, the electrical conductors 48 and 50 may be spot welded to the ends of the container.

The tabs 52 of each conductor 43 and 50 make electrical contact with the faces of a pair of the anvil devices 12, which bring in the electrical heating current. The heating of the material is effected by the electrical resistance of the sample container on the passage of current therethrough. The pyrophyllite material holder provides electrical insulation between the opposed faces of the anvil devices during actual operation of the press, while electrical insulation between the anvil supporting structures may be provided by insulators between tire rings 24 and the piston rods 26 of the rams which insulation may comprise thin fiberboard.

In addition, when desired, a thermocouple may be inserted in the pyrophyllite prism for temperature measurements with fine wires from the thermocouple passing through fine bores provided for that purpose in the material holder. Further, when desired, pressure indicators may also be provided in the device as is known in the art.

In operation, the pyrophyllite prism is centered on the triangular face of anvil device 16, after the anvil faces of the devices have been painted with rouge to increase friction. The anvils are then simultaneously forced together and since the faces of the pyrophyllite prism are larger than the faces of the anvil devices, some of the pyrophyllite is forced between the sloping sides of the anvils and a sealing gasket is automatically formed. Continued motion of the anvils compresses the gasket and pyrophyllite prism holder. The pressure on the pyrophyllite prism holder is transmitted to the material contained therein.

In FIG. 4 of the drawings, the anvil devices 12' are six in number and when in the closed position, the six faces thereof define a regular four-sided prism. The six anvil members comprise a pair of anvil devices 56 and 58 having similar opposed equal rectangular faces 56' and 58', respectively. The anvil devices 56 and 58 are mounted for rectilinear movement along a common axis and correspond to anvil devices 14 and 16 of the form of the invention shown in FIGS. 1 and 2. The other four anvil devices 60, 62, 64 and 66 each has a face 60', 62', 64' and 66', respectively. Each of the anvil devices 60, 62, 64 and 66 is mounted for rectilinear movement along an axis normal to its face portion and the anvil devices 60, 62, 64 and 66 move in a common plane normal to the common axis of anvil devices 56 and 58 and converge to a common intersection located on the common axis of anvil devices 56 and 58.

In FIGS. 5 and 6, a material holding device 70 for the anvil devices illustrated in FIG. 4 is shown. Referring to FIGS. 5 and 6, the material holder may be formed of pyrophyllite and is preferably bored as at 72 along its major axis with the bore receiving a metallic tubular sample holder 74. The upper and lower ends 75 and 75' of the sample bolder rest on or are secured to a pair of electrical conductive strips 76 and 78 which strips have their extended ends bent to form tabs 80 for conducting a sample heating current from a pair of anvil faces to the metallic sample holder 74.

A modified form of anvil devices is illustrated in FIG. 7 wherein the polyhedral prism formed by the anvil devices 12" are seven in number and include prism bases 82 and 84 having faces 82' and 84', respectively. The sides of the prism comprise five anvil members 86, 88, 90, 92 and 94 having faces 86', 88', 90', 92' and 94', respectively. The pair of prism bases 82 and 84 have similar opposed equal faces and are mounted for rectilinear movement along a common axis. The five anvil devices 86, 88, 90, 92 and 94, forming the sides of the prism are each mounted for rectilinear movement along an axis normal to their respective faces and in a common plane normal to the axis of anvil devices 82 and 84. When the faces of each of the anvil devices illustrated in FIG. 7 are in edge-to-edge contact, there is formed a pentagonal prism in which is received a compressible pressure transmitting and scaling carrier of larger dimensions than the pentagonal prism defined by the seven anvil members.

Another form of the device of the present invention is illustrated in FIG. 8 wherein anvil devices 12''' are eight in number and comprise anvil members 96 and 98 having six-sided faces 96' and 98'. Each of the faces 96' and 98' of the bases 96 and 98 are the same size and the pair of anvil members are mounted in opposed relationship for rectilinear movement along a common axis. The sides of the prism forming the press cell are six in number and generally designated 100, 102, 104, 106, 108 and 110 having rectangular faces 100', 102', 104', 106', 108' and 110'. Anvil members forming the sides of the prism illustrated in FIG. 8 are also mounted to the end of, for example, hydraulic rams for movement along a line perpendicular to the common axis of prism base members 96 and 98 so that when the edges of the anvils forming the prism are in contact, a closed press cell is formed.

In FIG. 9 of the drawings, a pyrophyllite pressure transmitting and sealing carrier for the press cell illustrated in FIG. 8 is shown. The pressure transmitting carrier is generally designated 112 and the edges thereof are about 25% larger than the corresponding edges of the polyhedral prism formed by the eight anvil devices 12'''. As illustrated with reference to FIGS. 3, 5 and 6, the carrier 112 may also be provided with electrically conductive members having external tabs generally designated 114 whereby a sample heating current may be transmitted from predetermined anvil devices to the interior of the pyrophyllite carrier for heating the materials being subjected to high pressure.

While only a limited number of polyhedral prism press cells have been illustrated and specifically described herein, it will be apparent to those skilled in the art that many other forms of prisms may be satisfactorily employed in forming high pressure cells.

It will also be appreciated that the press cells illustrated herein could be subjected to higher pressures without failure where the anvil devices are provided with a tightly-fitting binding ring in order to give the anvil faces lateral mechanical support. Where the distance between the faces of the base members of the prism is not substantially greater than the spacing between substantially opposed anvil members forming the sides of the prism, each of the anvil devices may be surrounded by a tightly-fitting binding ring having a circular cross-section as illustrated in FIG. 10.

Referring specifically to FIG. 10, the anvil device 20 illustrated in FIG. 2 is provided with a tightly-fitting binding ring member 116. The binding ring 116 is bored as at 118 on the face remote from the face receiving the anvil member. The bore 118 receives the extended end of the piston rod of one of the hydraulic rams and the inner surface of the bore 118 may be provided with a thin insulating material to electrically insulate the mechanical portions of the improved press from each other where heating current is directed to the sample holder as hereinbefore described.

Where the distance between the faces of the base of the prism is substantially greater than the distance between opposed side faces thereof whereby the side faces of the anvil members forming the sides of the prism are elongated rectangles, it is not practical to provide cylindrical binding rings for the anvils. In such cases where it is desired to provide mechanical lateral support for the anvil members, the support may be provided by polyhedral members such as member 120 illustrated in FIG. 11. Member 120 shown in FIG. 11 is provided with an opening 122 at one end to receive an anvil device such as illustrated at 166 in FIG. 8, while the other end is bored as at 124 to receive the extended end of the piston rod which imparts rectilinear motion to the polyhedral support element 120 and, in turn, its anvil device 12''' carried at the opposite end.

While only one form of drive means for the plural anvil members has been specifically shown in the drawings, it is apparent that other forms of drive means may be effectively employed without departing from the scope of the present invention, For example, screw means may replace the hydraulic rams 23, 30, 32, 34 and 36 illustrated in FIG. 1 or combination screw means and hydraulic rams may be effectively employed.

It is further evident that various modifications may be made in other specific features of the press without departing from the principles of the present invention.

This application is a continuation of my co-pending application S.N. 851,855, filed November 9, 1959, now abandoned, for High Pressure Press.

I claim:

1. A high pressure press comprising a pair of anvil devices having similar opposed press faces, means for rectilinearly moving the pair of anvil devices along a common axis toward a common point, at least three anvil devices having similar equal press faces, further means for rectilinearly moving said at least three anvil devices along axes normal to the press faces thereof and positioned in a common plane normal to the common axis of said pair of anvil devices and converging to a common intersection located in said common axis, the press faces of the anvil devices forming a closed polyhedral prism in their position of contact and rigid tie means interconnecting the means for urging each of said anvil devices into a closed prism to provide an integral press unit whereby

the reaction of each of the anvil devices is transferred to the others.

2. The invention defined in claim 1 whereby the means for urging each of the anvil devices into a closed prism comprises a hydraulic ram and means connecting each of the hydraulic rams to a common source of hydraulic pressure.

3. The invention defined in claim 1 including a pressure transmitting member comprising a polyhedral prism having a pair of bases which lie in parallel plane and each of the remaining faces is bounded by a parallelogram, said pressure transmitting member being constructed of pyrophyllite with the edges thereof being larger than the corresponding edges of the polyhedral prism formed by the press faces of the anvil device.

4. The invention defined in claim 1 wherein the at least three anvil devices are three in number and all of the anvil devices form a closed triangue prism in the position of contact.

5. The invention defined in claim 1 wherein the at least three anvil devices are four in number and all of the anvil devices form a closed rectangular prism in their position of contact.

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