

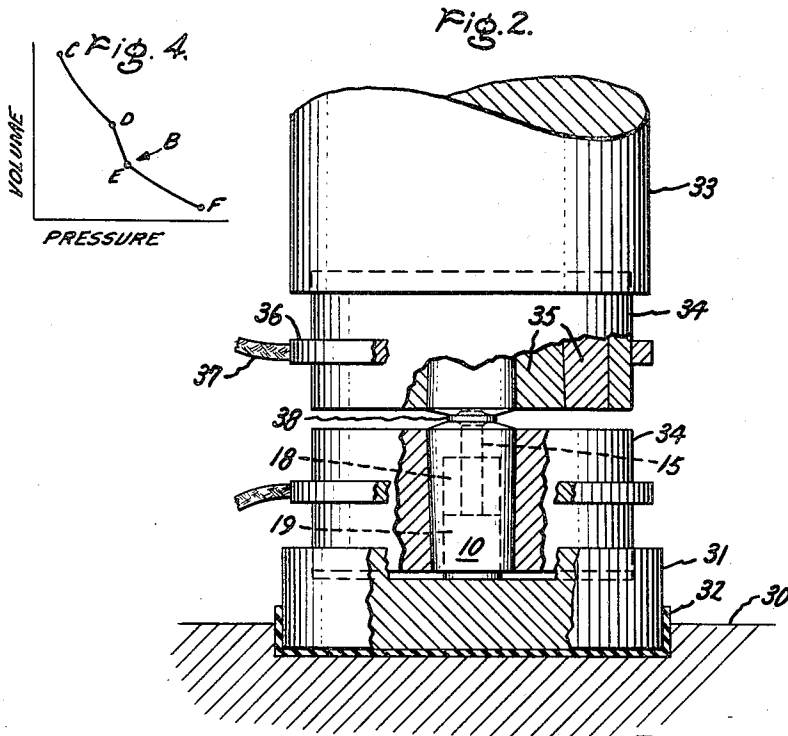
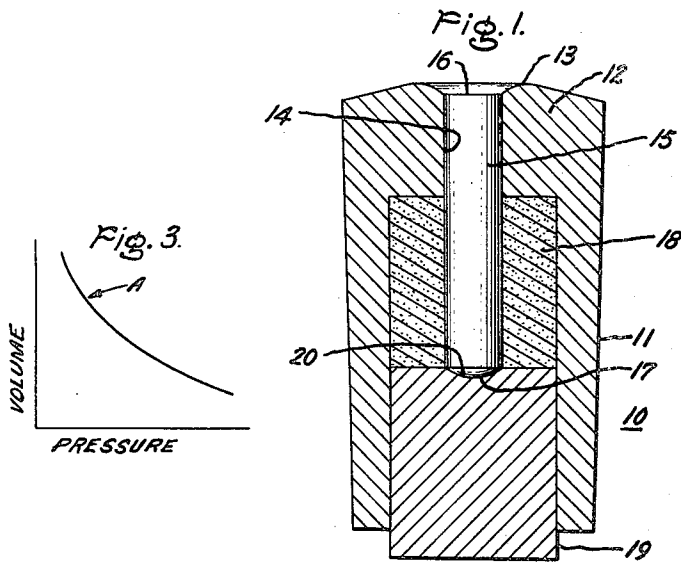
June 21, 1960

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2,941,245

DIE

Filed Oct. 20, 1955



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2,941,245

DIE

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Filed Oct. 20, 1955, Ser. No. 541,722

5 Claims. (Cl. 18—16.5)

This invention relates to dies and more particularly to such dies which are employed in high temperature high pressure apparatus.

In a copending application of Francis P. Bundy, Serial No. 488,042, filed February 14, 1955, and assigned to the same assignee as the present application, an apparatus is described and claimed to effect and control reactions which occur at temperatures of the order of several thousand degrees Centigrade and pressures of 20,000 to 40,000 atmospheres for long time intervals. Such apparatus comprises a reaction vessel which is positioned between a pair of opposed, recessed dies with annular lips to provide a specimen chamber to be subjected to temperatures and pressures of the order mentioned.

In previous apparatus, die stroke was limited by opposing die lips which were necessary to prevent lateral extrusion of the reaction vessel. The problem was overcome partially by a gasket assembly which increased the size of the reaction vessel to produce a more effective die stroke. However, the invention of the present application provides a novel die having additional stroke which eliminates such a special gasket assembly.

Accordingly, it is an object of my invention to provide a new and improved die.

It is another object of the invention to provide an improved die for high pressure high temperature apparatus.

It is another object of the invention to provide an improved die which produces higher pressures by increasing the effective die stroke.

It is a further object of the invention to provide an improved die which operates as a two-stage die in a single stage press.

In carrying out my invention in one form, a hollow casing has an apertured die face at one end and a slidable force block within the other end to enclose a central core surrounded by a volumetric transitional material to provide a die.

These and various other objects, features and advantages of the invention will be better understood from the following description taken in connection with the accompanying drawing is which:

Fig. 1 is a sectional view of a die which embodies my invention; and

Fig. 2 is a partial sectional view of a high pressure high temperature apparatus which employs the die of Fig. 1.

In Fig. 1 of the drawing, a die 10 is shown which comprises a generally hollow casing, such as, a cylinder 11 with an integral closure 12 at one end. The outer face of closure 12 is tapered outwardly toward the longitudinal axes of the closure 12 and the cylinder 11 and then tapers inwardly toward aperture 14 thus forming an annular lip 13 which surrounds a central aperture 14 in closure 12. A core or pin 15, which has a flat face 16 and hemispherical face 17, is positioned partially within aperture 14. Flat face 16 is positioned normally at the base of lip 13 within aperture 14. A washer 18 of volumetric transitional material is positioned between core 15 and

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the inner wall of cylinder 11 to surround partially the core. A material of this type undergoes a phase transition which reduces its volume when the pressure reaches and exceeds its critical value. A force block or piston 19 with a recess 20 on its inner surface slidably fits partially within the open end of cylinder 11. Recess 20 seats face 17 of core 15 while a portion of block 19 projects beyond the outer edge of cylinder 11.

When a force is applied to a die by a pressure source, such as, a hydraulic press, the die will transmit this force against a specific object. If it is desired to increase the force which is applied against the object, it is necessary to increase proportionally the press load. However, I have found that the force can be increased without a similar increase in press load when a two-stage die is employed which has a washer of volumetric transitional material between its face and its force block.

Volumetric transition contemplates or includes a sharp and distinct volume change of a material undergoing compression. For the purpose of explanation, an exaggerated curve is shown, in Fig. 3, of a material which will not undergo such a transition. In Fig. 3, the curve for material A undergoing compression, shows a generally proportional reduction in volume for increases in pressure. In Fig. 4, there is shown a material B, which undergoes a volumetric transition. A curve for material B discloses a partial generally proportional reduction in volume from the points C to D. At the point D, however, an increase in pressure results in a sharp reduction in volume to the point E, and thereafter, an additional proportional volume reduction to the point F. The part of the curve represented by the points D and E is the volumetric transition as defined for the purposes of this invention. The process is generally reversible in that the material will also follow the curve from points F to C.

A number of materials undergo volumetric transitions at elevated pressures whereby the material occupies a smaller volume at and above this point. While it may be seen that numerous volumetric transitional materials may be employed in this invention, more satisfactory results are obtained from solids rather than liquids or gases. Examples of suitable materials which can be used for washer 18 of the present invention are calcium carbonate (CaCO_3), cuprous iodide (Cu_2I_2), potassium cyanide (KCN), lead iodide (PbI_2), ammonium formate (HCO_2NH_4), and urea (CH_4ON_2). The diameter of washer 18 determines the press load which is necessary to cause the volumetric transition while the thickness of the washer determines the amount of additional stroke available.

Die 10 is assembled by inserting core 15 into aperture 14 of closure 12 so that core face 16 is positioned at the base of lip 13. A washer 18 of volumetric transitional material which has a central aperture is positioned around core 15 to fit against the inner wall of cylinder 11. Force block 19 is then positioned within the opposite end of cylinder 11 to seat core face 17 in recess 20. A portion of force block 19 projects beyond the outer edge of cylinder 11 to provide a member against which pressure is applied. When initial force is applied against block 19, this force is transmitted to closure 12 by washer 18 and to core 15 directly. After the transition point of washer 18 has been reached, this material undergoes a volumetric decrease which permits block 19 to concentrate additional force against core 15. A longer pressure stroke is secured by this volume change since core 15 is pushed through aperture 14 in closure 12 to provide a second pressure stage against the object or specimen to be pressed. Thus, die 10 provides a two stage pressure action when it is actuated by only a single stage pressure source, such as, a hydraulic press.

In Fig. 2, die 10 is shown in a high temperature high

pressure apparatus such as that disclosed in the above-mentioned application of Francis P. Bundy. Press bed 30 of a hydraulic press (not shown) is recessed to have a platen 31 seated therein. A layer of electrical insulation 32 is provided between platen 31 and bed 30 to prevent conduction of electric current through the press. A ram 33, which is positioned in axial alignment with platen 31, is actuated by an associated piston (not shown). Both platen 31 and ram 33 are recessed to partially position members 34 therein each of which comprises a central die with surrounding binding rings 35. While die 10 is shown only in lower member 34, a pair of such dies can be employed in the apparatus. An annular conducting ring 36 with a connector 37 is positioned around the periphery of each outer binding ring to supply electric current from a source of power (not shown) through rings 35 and the dies to a reaction vessel 38 which is located between opposed faces of the dies.

In the operation of the high temperature high pressure apparatus shown in Fig. 2, each member 34 with associated conducting ring 36 and connector 37 is positioned partially within the recess of its associated platen 31 and ram 33 in the press. Reaction vessel 38 which is to be subjected to a high temperature high pressure environment is positioned between opposed die faces. Pressure which is supplied by a piston (not shown) through its associated ram 33 and member 34 is applied to reaction vessel 38 by the opposed dies. At the same time, electric current is supplied from one electrical connector, such as upper connector 37 to upper conducting ring 36, binding rings 35, and the die to generate heat in reaction vessel 38. The current path continues from vessel 38 through die 10, binding rings 35, conducting ring 36, and connector 37 to the electrical source.

When force applied to the dies exceeds the transition point of washer 18 in lower die 10, this material undergoes a volumetric change which reduces the volume it occupies. Block 19 concentrates additional force against core 15 to increase the force at its face 16 and provides a longer pressure stroke since core 15 is moved through aperture 14 against the object to be pressed. In other words, with respect to Fig. 2, it may be seen that movement of the opposed dies proceeds until the annular lips substantially compress the vessel 38 to such a degree that no further movement of the die is obtainable. In this situation, there is no further increase in pressure without additional stroke. Therefore, in order to increase the pressure on the vessel 38, the material 18 is chosen to undergo volumetric transition at this pressure and consequently force is transmitted to the core or pin 15 to move the pin 15 against the vessel 38 for additional force or pressure. If it is desired, reaction vessel 38 may also be subjected to high pressures alone.

As will be apparent to those skilled in the art, the objects of my invention are attained by the use of a hollow casing with an apertured die face at one end and a slidable force block within the other end which encloses a central core surrounded by a volumetric transitional material to provide a die.

While other modifications of this invention and variations of apparatus have not been described, the invention is intended to include all such as may be embraced within the following claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A multiple stage die comprising a hollow casing, a closure for one end of said casing, said closure having a central aperture therethrough, a core positioned within said aperture and said casing to be moved through said aperture to project from said closure, a washer of volumetric transitional material surrounding said core and engaging said core and said casing, and a force block slidably fitting in the opposite end of said casing against one end of said core and said washer to impose a force

on said closure and said core dependent upon the transition of said volumetric transitional material.

2. A two stage die comprising a hollow casing, a closure for one end of said casing, said closure having a central aperture therethrough, the outer face of said closure tapering outwardly toward the longitudinal axes of said cylinder and said closure and thence inwardly toward said aperture to provide an annular lip surrounding said aperture, a core slidably positioned within said aperture and said casing to be moved through said aperture to project from said closure, one face of said core positioned normally at the base of said lip, a washer of volumetric transitional material surrounding said core and engaging said core and said casing, and a force block slidably fitting in the opposite end of said casing against said core and said washer, said force block projecting beyond the outer edge of said casing to impose a force on said closure and said core dependent upon the transition of said volumetric transitional material.

3. A two stage die comprising a hollow cylinder, a closure for one end of said cylinder, said closure having a central aperture therethrough, the outer face of said closure tapering outwardly toward the longitudinal axes of said cylinder and said closure and thence inwardly toward said aperture to provide an annular lip surrounding said aperture, a core slidably positioned within said aperture and said cylinder to be moved through said aperture to project from said closure, one face of said core positioned normally at the base of said lip, a washer of volumetric transitional material surrounding said core and engaging said core and said casing, said material fitting against the inner wall of said cylinder, and a force block slidably fitting in the opposite end of said cylinder against said washer, the inner face of said block having a recess, the other face of said core seated in said recess, said force block projecting beyond the outer edge of said cylinder to impose force on said closure and said core dependent upon the transition of said volumetric transitional material.

4. A two stage die comprising a hollow cylinder, a closure for one end of said cylinder, said closure having a central aperture therethrough, the outer face of said closure tapering outwardly toward the longitudinal axes of said cylinder and said closure and thence inwardly toward said aperture to provide an annular lip surrounding said aperture, a core slidably positioned within said aperture and said cylinder, said core having a flat face at one end and a hemispherical face at the opposite end, said flat face positioned normally at the base of said lip, a washer of volumetric transitional material surrounding said core, said material fitting against the inner wall of said cylinder, and a force block slidably fitting in the opposite end of said cylinder against said washer, the inner face of said block having a recess, the hemispherical face of said core seated in said recess, said force block projecting beyond the outer edge of said cylinder to impose force on said closure and said core dependent upon the transition of said volumetric transitional material.

5. A multiple stage pressure die which comprises in combination, a cylinder member, a closure member closing the uppermost portion of said cylinder and having a coaxial aperture therethrough, an axially movable pin positioned in said aperture and extending into said cylinder, a volumetric transitional material in said cylinder surrounding said pin and engaging said pin and said cylinder, a piston block in the open end of said cylinder, said block bearing against said pin and said volumetric transitional material on one end thereof and projecting from said cylinder at the other end, said die including two substantially successively acting pressure paths, one of said pressure paths being through said block, said volumetric transitional material and said closure, the other of said pressure paths being through said block and said pin.

References Cited in the file of this patent

UNITED STATES PATENTS

1,918,064	Taylor	July 11, 1933
2,122,960	Schwartzwalder	July 5, 1938
2,125,068	Dempey	July 26, 1938
2,127,994	Davis et al.	Aug. 23, 1938
2,195,297	Engle	Mar. 26, 1940
2,360,528	Talmage	Oct. 17, 1944
2,544,414	Bridgman et al.	Mar. 6, 1951
2,694,922	Vilella	Nov. 23, 1954

OTHER REFERENCES

Bridgman: "J. of Chem. Physics," vol. 15, pages 92-98, February 1947. (Copy in Scientific Library.) 23/209.1-D.

Bour et al.: "Zeitschrift fur Anorganische Chemie," vol. 92, pages 324-328 (1915). (Entire article includes pages 313-328.) Copy in Scientific Library.

Bridgman IV: "Review of Modern Physics," vol. 18, No. 1, pp. 1-9, 19-27, 32-38, 79-88, 1946. (Copy in Sci. Lib. QC1 R 45.)

Bridgman III: "Am. Acad. of Arts and Sciences, Proceedings," vol. 74, No. 3, pp. 21-28, October 1940. (Copy in Sci. Library, Q11 B7.)

Parsons: "Philosophical Transactions of the Royal Society," vol. 220, pages 67-71, 92-99, 1919, Series A. (Copy in Sci. Lib. 23/209.1-d.)