United States Patent

Larker et al.

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[45] **Nov. 14, 1972**

[54] **PRESS FOR HOT HYDROSTATIC EXTRUSION**

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[73] Assignee: **Allmanna Svenska Elektriska Aktiebolaget,** Vasteras, Sweden

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[21] Appl. No.: **118,682**

[52] **U.S. Cl.**.....**72/60,** 72/272

[51] **Int. Cl.**.....**B21c 23/08**

[58] **Field of Search**.....72/60, 272

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Primary Examiner—Richard J. Herbst
Attorney—Jennings Bailey, Jr.

[57] **ABSTRACT**

For hydrostatic extrusion, a press is provided having a yoke. One of the end pieces of the yoke carries a die receiving block having an extrusion passage therethrough. A pressure cylinder is mounted within the yoke for movement towards and from the die receiving block. Slidable in the cylinder of the high pressure cylinder is a billet holder which divides the space within the cylinder into two parts. The billet holder has a spring controlled valve which prevents passage of pressure fluid therethrough until a predetermined pressure differential exists between the chambers. A punch is provided for sliding into and out of the high pressure cylinder on the opposite side thereof from the die.

The die and billet are first positioned between the high pressure cylinder and the die receiving block, after which the high pressure cylinder is moved to enclose the billet. Then pressure is applied in the high pressure cylinder on the side of the punch to move the billet holder against the billet and move the billet into engagement with the die. Then the pressure behind the the billet holder is increased so that the fluid passes through the billet holder and thereafter further increased by advancing the punch into the high pressure cylinder so that the fluid exerts sufficient pressure on the billet to extrude it.

Before opening the high pressure cylinder, the punch is withdrawn and cool pressure fluid is admitted into the end of the cylinder remote from the punch.

10 Claims, 16 Drawing Figures

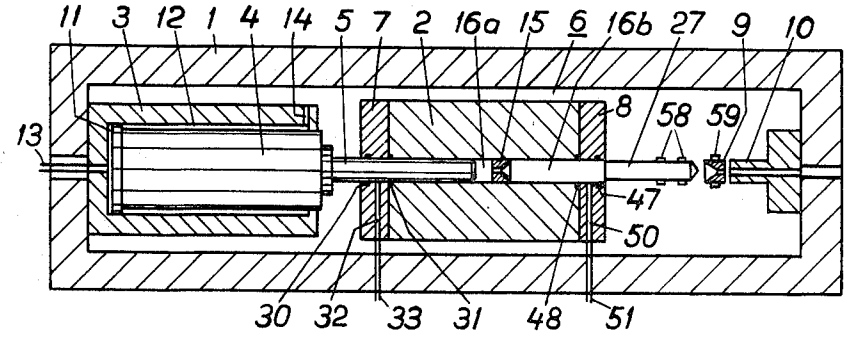
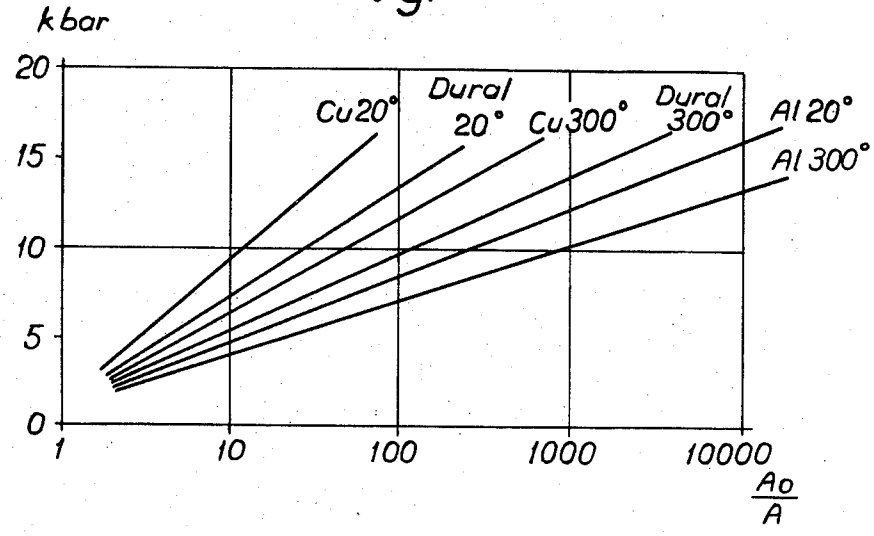


Fig.1



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Fig. 2

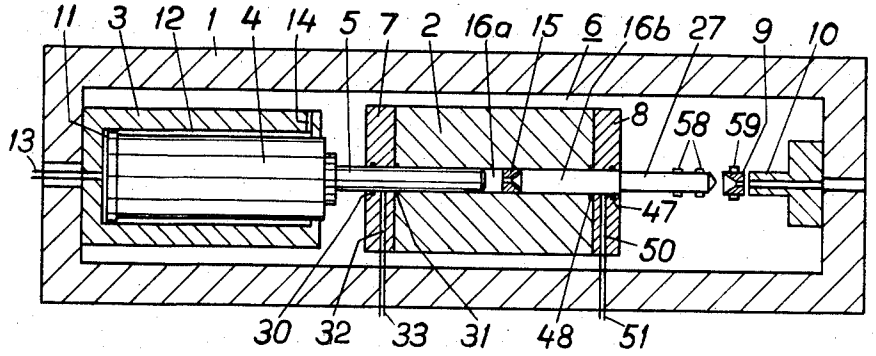


Fig. 3

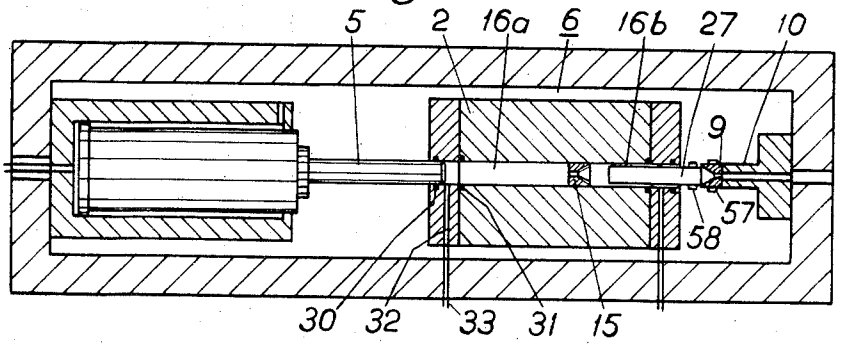
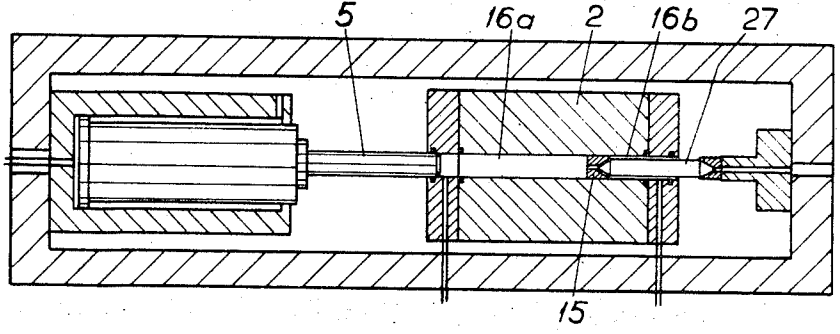


Fig. 4



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Fig. 5

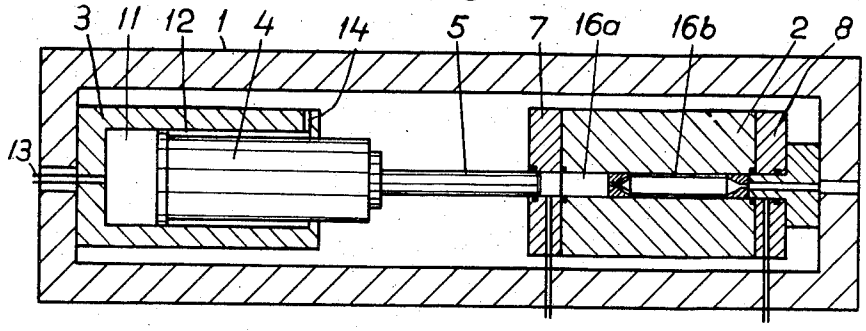


Fig. 6

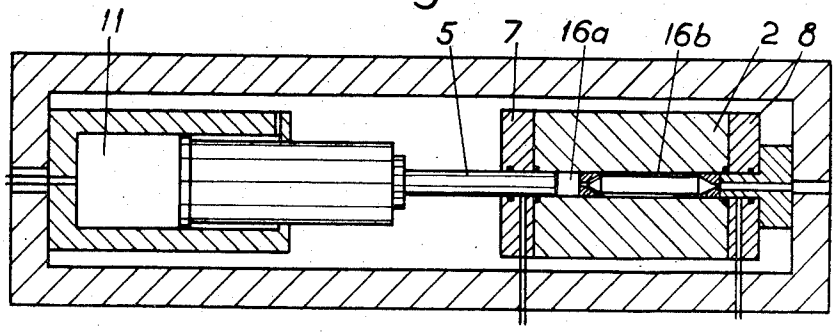
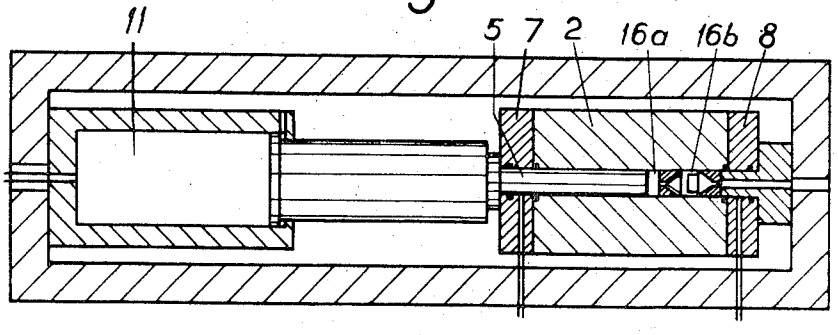


Fig. 7



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Fig. 8

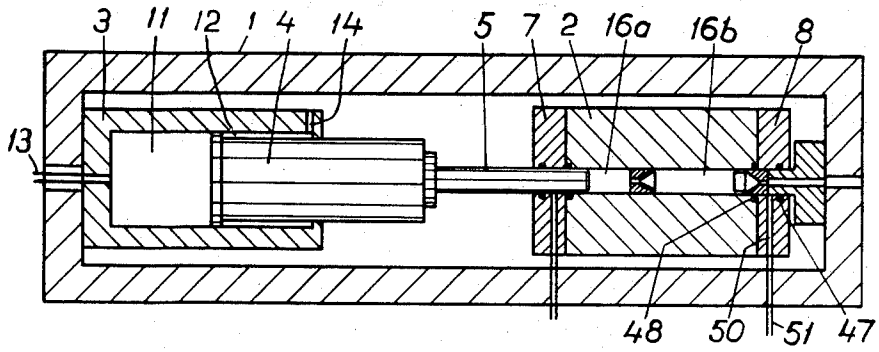
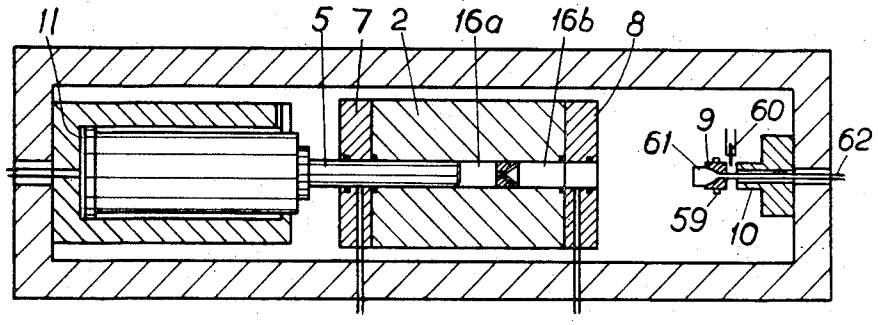


Fig. 9



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Fig. 10

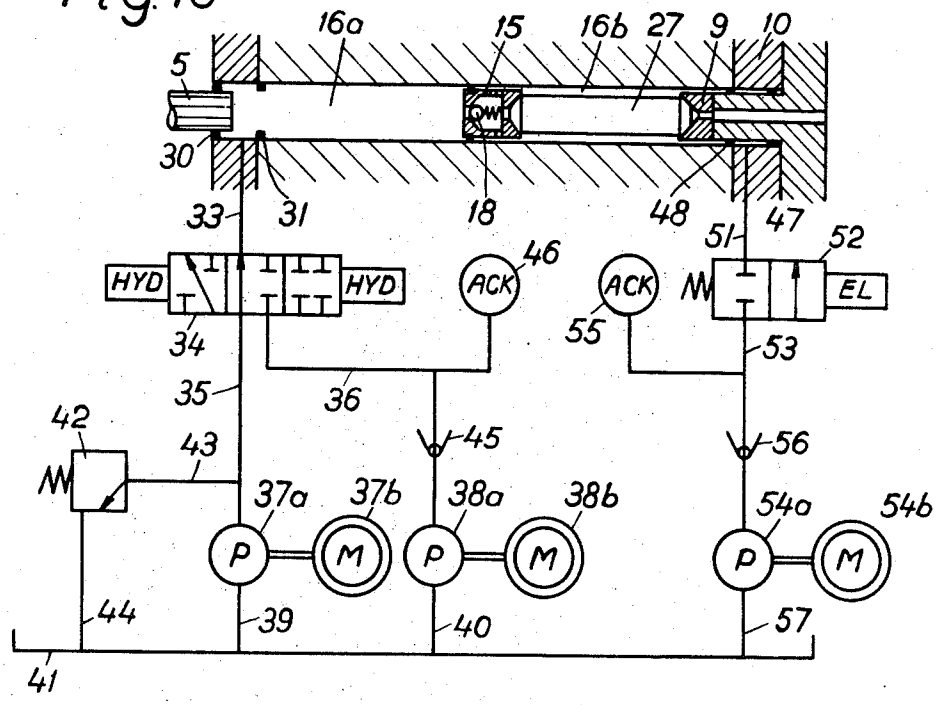


Fig. 11

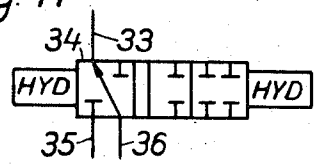


Fig. 12

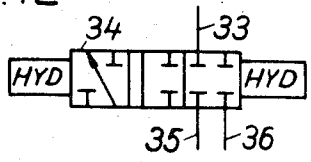


Fig. 13

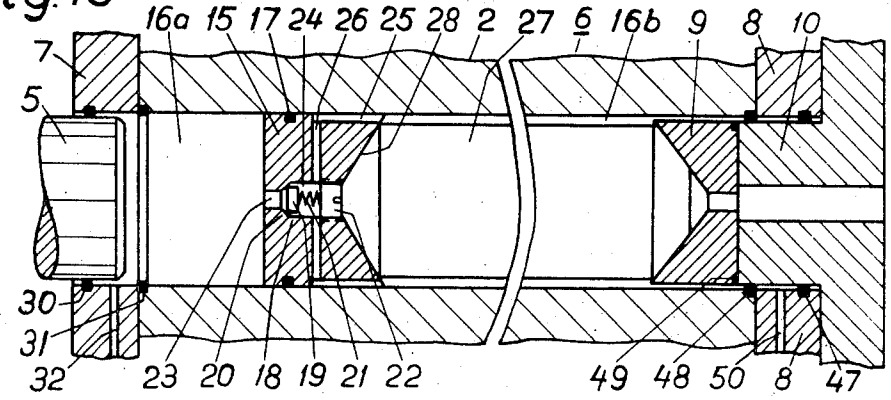


Fig. 14

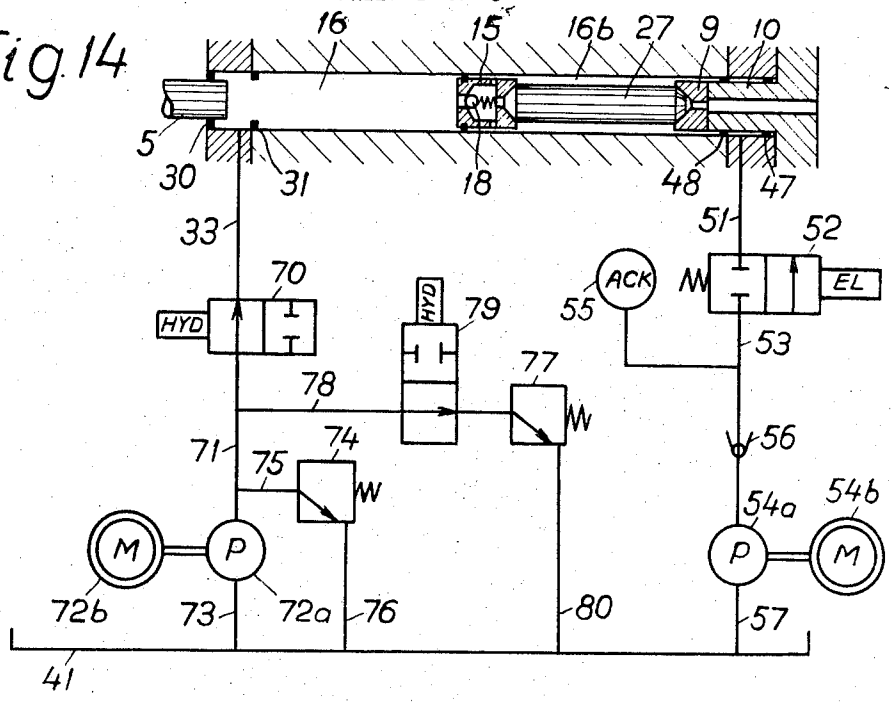


Fig. 15

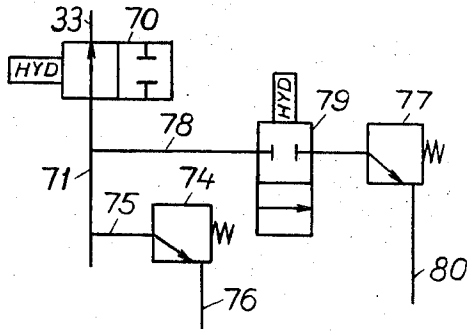
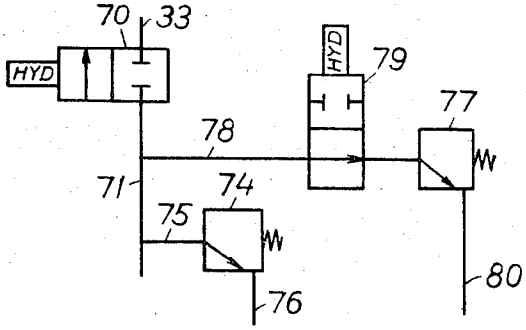


Fig. 16



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PRESS FOR HOT HYDROSTATIC EXTRUSION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a press, preferably a horizontal press, for hot hydrostatic extrusion, particularly extrusion at increased temperatures, implying that the billet to be extruded has a temperature considerably above ambient temperature.

2. The Prior Art

For hydrostatic extrusion a billet is inserted in a pressure chamber formed by a cylinder, a die with an opening having the cross-section desired in the finished product, and a pressure-generating punch which, when moved into the cylinder, generates a pressure in a pressure medium surrounding the billet, thus effecting uniform pressure from all sides on it. The ratio between the cross-sectional area of a billet and the cross-sectional area of the product formed in the die is called the area reduction ratio in hydrostatic extrusion. Normally a high value is desired for the area reduction radio. Whether the method is economical or not depends to a great extent, on the area reduction ratio since this limits the cross-section of the billet and thus the quantity produced per working cycle. The size of the area reduction ratio is dependent on material and temperature. For copper the area reduction ratio at 15 kb pressure is about 50 at ambient temperature and about 800 at 300°C.

The area reduction ratio thus increases sharply with increased temperature. Hot extrusion thus offers a way of considerably increasing production and decreasing the cost of hydrostatic extrusion when such material, equipment and dimensions of the product extruded are used that the area reduction ratio and the operating pressure of the press limit the billet size so that the volume of the pressure chamber is poorly exploited.

During hydrostatic extrusion a liquid pressure medium comes into direct contact with the heated billet to be pressed. This causes many problems, for example boiling of the pressure medium.

RELATED APPLICATION

The hot hydrostatic extrusion method utilizing the press shown herein is claimed in an application filed herewith in the names of the same inventors for "-Method for Hot Hydrostatic Extrusion."

SUMMARY OF THE INVENTION

By the present invention, the boiling problem has been solved upon insertion of the billet in the pressure chamber by preventing the pressure medium from coming into contact with the billet before the pressure chamber has been sealed.

A press according to the invention has a press stand and a high pressure cylinder having a pressure chamber therein. The high pressure cylinder is mounted for movement longitudinally and within the press stand. The press stand has a pair of yokes at opposite ends, and a die receiving member is mounted on one of said yokes opposite the opening of the pressure cylinder and is provided with an extrusion passage therethrough. A die is movable into a position opposite the die receiving member, the die having an opening therethrough adapted to be aligned with the opening in the die

receiving member. The high pressure cylinder is movable a sufficient distance away from the die receiving member to permit the insertion of a die and a billet to be extruded therebetween. A pressure generating punch is movably mounted on the opposite side of the pressure cylinder from the die receiving member for movement within the high pressure cylinder. A billet holder is mounted within the high pressure cylinder and is axially movable therein, the billet holder dividing said pressure chamber into first space between the billet holder and the punch and a second space between the billet holder and the other end of the pressure chamber. The billet holder has valve means therein for preventing flow of pressure fluid from the first space to the second space when the pressure difference between the fluids in the first and second spaces is less than a predetermined amount. Means are provided to move said high pressure cylinder towards the die receiving member to engage over a billet placed between the die and the high pressure cylinder. Thereafter fluid under pressure is admitted into the first chamber at a pressure lower than such predetermined pressure to move the billet holder towards the billet and thereby to force the die against the die receiving member. Thereafter the high pressure cylinder is advanced until it engages over the die. Then fluid is supplied to the first space at a pressure greater than said predetermined pressure whereby to introduce pressure fluid into the second space around the billet. The punch is then moved into the first chamber to increase the pressure therein and the pressure in the second chamber to extrusion pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described with reference to the accompanying drawings.

FIG. 1 shows the relationship between pressure and area reduction ratio during hydrostatic extrusion.

FIGS. 2–9 show schematically a press according to the invention at eight different moments during an operating cycle.

FIG. 10 shows a system for supplying the pressure chamber with pressure medium.

FIGS. 11 and 12 show alternative positions of an operating valve in the system according to FIG. 10.

FIG. 13 shows the pressure chamber itself in more detail.

FIG. 14 shows yet another system for supplying the pressure chamber with pressure medium.

FIGS. 15 and 16 show alternative positions for the operating valves in this latter system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 the relationship is shown between the area reduction ratio Ao/A and the pressure for copper, duralumin and pure aluminum at ambient temperature and at increased temperature. The area reduction ratio, which is defined as the ratio between the cross-sectional area of the billet and the cross-sectional area of the extruded product, is represented by the abscissae.

In the drawings 1 designates a press stand. A horizontal high-pressure cylinder 2 is axially displaceable in this stand by hydraulic cylinders (not shown). At one end of the stand is an operating cylinder 3 with an

operating piston 4 shaped as a differential piston and connected to a pressure-generating punch 5 which penetrates into the high pressure cylinder 2 and generates the pressure necessary for the extrusion in the pressure chamber 6 which is formed by the cylinder 2, end pieces 7 and 8, punch 5, a die 9 positioned in the opposite end of the cylinder and a die support 10. The pressure-generating punch is operated by a pressure medium supplied from a source, not shown, to one of the spaces 11 or 12 formed between the cylinder 3 and piston 4. The supply conduits are designated 13 and 14. In the pressure chamber is a billet holder 15 which is shaped as a piston freely movable within the cylinder. The billet holder is of the type described previously in U.S. Pat. No. 3,531,965. The billet holder divides the space 16 into two separate spaces 16*a* and 16*b*, separated by the holder 15. The billet holder 15 is provided with a sealing ring 17 (FIG. 13) which seals against the bore in the cylinder 2 and with an overflow valve 18 with a valve cone 19 which seals against a valve seat 20 and is pressed against this seat by a spring 21, the tension of which can be adjusted with the help of a screw 22. Between the space 16*a* and the valve is a channel 23. Between the space 24 on the outlet side of the valve and slots 25 at the periphery of the billet holder are channels 26 so that pressure medium can flow to the space 16*b*. The side of the billet holder facing the billet 27 is shaped as a cone 28, so that the billet is centered. The end pieces 7 and 8 are connected to the ends of the cylinder 2 by means of bolts or connecting rods. At the two ends of the pressure chamber are two seals, slightly spaced from each other. The seals 30 and 31 seal between the pressure-generating punch 5 and the end piece 7 and cylinder 2, respectively. The seal 31 is a high pressure seal. In the end piece 7 is a channel 32 which opens out between the seals 30 and 31.

The channel 32 can be placed in communication with pressure medium sources 37*a* and 38*a* (FIG. 10) by way of the conduit 33, valve 34 and conduits 35, 36, the pressure medium sources being connected to a pressure medium container 41 by conduits 39 and 40. The pressure medium sources consist of pumps driven by motors 37*b* and 38*b* connected to these pumps. A pressure-limiting overflow valve 42 is connected by conduit 43 to the conduit 35. Between the valve 42 and the container 41 is a drainage pipe 44. Between the valve 34 and a non-return valve 45 an accumulator 46 is connected.

Seals 47 and 48 seal between the die support 10 and the end piece 8 and cylinder 2, respectively. Between the die 9 and the die support 10 is a seal 49. In the end piece 8 is a channel 50 which opens out between the seals 47 and 48. The channel 50, by means of the conduit 51 and valve 52 and the conduit 53, can be placed in communication with a pressure medium source comprising a pump 54*a* and a motor 54*b*. A pressure accumulator 55 is connected to the conduit 53 between the valve 52 and a non-return valve 56. A conduit 57 connects the pressure medium source 54 with the pressure medium container 41.

The billet 27 and the die 9 are inserted into the press by a manipulator. Only the gripping means 58 and 59 of the manipulator are shown. In the press is a cutting wheel 60 to separate an extruded product 62 from the remainder of the billet 61 which is left in the die after an extrusion operation.

The press operates in the following way. At the start of an operating cycle the high pressure chamber and pressure-generating punch 5 are in the position shown in FIG. 2 and a heated billet 27 and die 9 have been inserted in front of the pressure chamber by the manipulator to a position opposite the opening in the end piece 8 and held in this position by the gripping means 58 and 59 of the manipulator. The valve 34 is in the position shown in FIG. 12. The cylinder 2 and pressure-generating punch are in the positions shown in FIG. 2. The cylinder 2 is now displaced to the right by the hydraulic cylinders to engage over the billet 27 until it reaches the position shown in FIG. 3. The valve 34 is then shifted from the position shown in FIG. 12 to that shown in FIG. 10. Since the end surface of the pressure-generating punch 5 is between the seals 30 and 31, there is free communication between the space 16*a* and the pressure medium source 37 by the channel 32, conduit 33, valve 34 and conduit 35. Pressure medium having a pressure less than the opening pressure of the overflow valve 18 in the billet holder 15 is supplied to the space 16*a* so that this piston-shaped billet holder 15 is forced by the pressure medium against the billet 27 and presses the billet and the die 9 against the die support 10. The pressure is prevented from increasing above the opening pressure of the valve 18 by the overflow valve connected to the conduit 35. Billet 27 and die 9 are now held in place by the force of the billet holder 15 as shown in FIG. 4 and the gripping members 58 and 59 of the manipulator can be withdrawn and the cylinder 2 moved further over the billet 27, the die 9 and over the die support 10 so that the pressure chamber 6 is completely closed as shown in FIG. 5. During this stage the pressure in the space 16*a* is kept constant. The valve 34 is moved from the position shown in FIG. 10 to that shown in FIG. 11. The space 16*a* is thus placed in communication with the pressure medium source 38*a* where the pressure is high. The pressure of the medium in the space 16*a* is now considerably increased to a level substantially above the opening pressure of the valve 18 in the billet holder 15 so that the valve opens and pressure medium flows into the space 16*b* and fills the space around the billet 27.

The air in the space 16*b* is compressed at a sufficiently high pressure so that its volume is small and it does not noticeably affect the insertion distance of the pressure-generating punch 5 when the pressure is increased, see FIG. 6, to extrusion level. During the entire process of closing the pressure chamber, therefore, the hot billet is surrounded by air and is therefore not noticeably cooled. Furthermore, the development of steam and smoke is avoided, which complicates servicing of the press and may cause a risk of damage to personnel and material.

FIG. 7 shows the press at the moment when the extrusion is completed. The pressure-generating punch is thereafter returned to the left so that the pressure is decreased in the pressure chamber and the cylinder 2 is also moved to the left to the position shown in FIG. 8. When the end surface of the die is between the seals 47 and 48 there is free communication between the space 16b and the valve 52 through the channel 50 and conduit 51. By changing the position of the valve 52 com-

munication is opened to a pressure medium source consisting of a pump **54** and an accumulator **55** in which the pressure is relatively high. It should considerably exceed the vapor pressure of the pressure medium in the space **16***b*. The pressure should be 25 bar or more. By spraying cold pressure medium into the space **16**b the pressure medium situated therein and heated by the billet is cooled so that hot or boiling liquid does not flow out when the pressure chamber is completely opened. Hot pressure medium is also prevented from coming into contact with the high pressure seal, thus essentially decreasing the strain on this sensitive seal. Furthermore, the remainder of the billet and the die are also cooled so that cutting of the extruded product and handling of the die **9** and the remainder of the billet **61** are facilitated as seen in FIG. **9**.

In the embodiment according to FIGS. **14** to **16**, instead of utilizing two sources of pressure fluid for the chamber **16***a*, there is a single pump **72***a* drawing pressure fluid through line **73** and driven by motor **72***b*. A line **71** connects the outlet of the pump to valve **70** and line **33**. Lines **75** and **78** lead respectively from line **73** through overflow valves **74** and **77** and lines **76** and **80** to reservoir **41**. Overflow valve **74** is set for a substantially higher pressure than overflow valve **77**.

During the first part of the process, when fluid under low pressure is to be supplied to chamber **16***a*, valve **79** is kept open so that valve **77** limits the pressure to a low value. When extrusion is to take place, valve **79** is closed and the pressure rises to that permitted by valve **74**, which is a pressure high enough to pass through the spring valve **18** into chamber **16**b. Thereafter, valve **70** is closed and the punch **5** is advanced for extrusion.

FIGS. **15** and **16** show the different positions of the valves **70** and **79** as described above.

We claim:

1. Press for hydrostatic extrusion comprising a press stand, a pressure chamber comprising a high pressure cylinder axially displaceable in the press stand, a die engageable in the cylinder and a pressure-generating punch at the opposite end of the cylinder from the die which, when moved into the cylinder, generates a pressure in a pressure medium enclosed in the pressure chamber and surrounding a billet inserted in the chamber sufficient for extruding said billet through the die, a billet holder axially displaceable in the cylinder which divides the pressure chamber into first and second spaces and has valve means therein for creating a pressure difference between the spaces and permitting pressure medium to flow from the first space between the punch and the billet holder to the second space between the billet holder and the die at a certain pressure difference between the two spaces, which comprises means for selectively furnishing to the first space a pressure medium at a pressure below such pressure difference so that there is substantially no flow of the pressure medium past the billet holder, and thereafter at a pressure sufficient to cause flow of the pressure medium past the holder so that the second space is filled with pressure medium.

2. Press according to claim **1**, in which the pressure medium source comprises a pump for pressure medium and a conduit connecting said source to first space of the pressure chamber, and at least one pressure-limiting overflow valve connected to said conduit between said first space in the pressure chamber and the pressure medium source.

3. Press according to claim **1**, having two sources of pressure medium which deliver pressure medium under different pressures, and valve means for alternately connecting said sources to the first space in the pressure chamber.

4. Press according to claim **3**, having a pressure-limiting overflow valve connected to the connection between said valve means and the pressure medium source delivering the least pressure.

5. Press according to claim **1**, in which conduit connects said first space in the pressure chamber with the pressure-chamber source into a space at the end of the pressure chamber which is axially limited by a high-pressure seal between the pressure chamber and the punch and a seal within the second space in a part surrounding the pressure-generating punch.

6. Press according to claim **1**, in which the second space in the pressure chamber between the piston and the die communicates during part of the opening period following extrusion with a pressure medium source from which the space is supplied with pressure medium to cool remnants of the billet and heated pressure medium.

7. Press for hydrostatic extrusion comprising a press stand, a high pressure cylinder having a pressure chamber therein, means mounting said high pressure cylinder for movement longitudinally thereof within the press stand, said press stand having a pair of yokes at opposite ends, a die receiving member mounted on one of said yokes opposite the opening of the pressure diameter and having an extrusion passage therethrough, a die movable into a position opposite said die receiving member and having an opening therethrough adapted to be aligned with the opening in the die receiving member, said high pressure cylinder being movable a sufficient distance away from said die receiving member to permit the insertion of a die and a billet to be extruded therebetween, a pressure generating punch means on the opposite side of the pressure cylinder from the die receiving member mounted for movement within the high pressure cylinder, a billet holder mounted within said high pressure cylinder and axially movable therein, said billet holder dividing said pressure chamber into first space between the billet holder and the punch and a second space between the billet holder and the other end of the pressure chamber, said billet holder having valve means therein for preventing flow of pressure fluid from the first space to the second space when the pressure difference between the fluids in the first space and the s second space is less than a predetermined amount, means to move said high pressure cylinder towards said die receiving member to engage over a billet placed between the die and the high pressure cylinder, means for thereafter admitting fluid under pressure into said first space at a pressure lower than such predetermined pressure to move said billet holder towards the billet and thereby to force the die against the die receiving member, means for thereafter advancing the high pressure cylinder until it engages over the die, means for thereafter supplying fluid to said first space at a pressure greater than said predetermined pressure whereby

to introduce pressure fluid into said second space around the billet, and means for thereafter moving said punch into the first space to increase the pressure therein and the pressure in said second space to extrusion pressure.

8. In a press as claimed in claim 7, said means for admitting pressure fluid to said first space comprising a passage opening thereinto adjacent the end thereof into which the punch enters, said punch closing said passage when it is advanced to raise the pressure to extruding pressure.

9. A device as claimed in claim 7, said means for supplying pressure fluid comprising a first source of low pressure fluid and a second source of high pressure fluid and means for selectively connecting said first and second source to said passage.

10. In a press as claimed in claim 7, a passage opening into said pressure chamber edge the end thereof facing said die holding member, said die receiving member being sufficiently long to extend into said pressure chamber when the cylinder is moved to engage over the billet, said die receiving member extending into the high pressure cylinder to a sufficient degree to close said passage, and means to supply fluid pressure to said passage so as to introduce cool fluid into the second space when the high pressure cylinder is withdrawn from the die receiving member.

* * * * *