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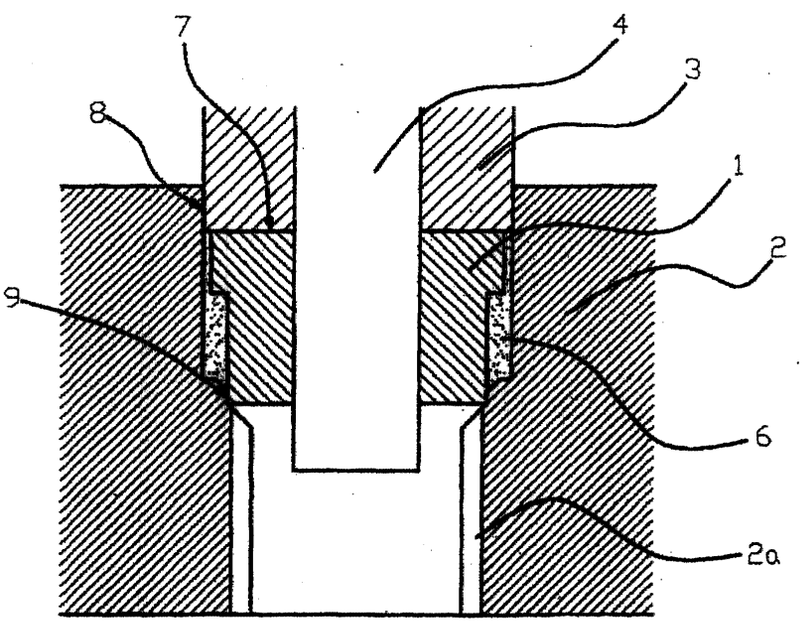
(54) Pressure controlled fluid pressure extrusion method

(57) The lower part of a material blank to be molded forms a lower seal (9) with a die (2). A punch (3) applying a molding force to the material forms an upper seal (7) with the perimeter of the die. The space between the upper and lower seals (9) forms a pressure chamber (6) that is filled with a fluid. As the punch descends into the die, the fluid is pressurized. The lower seal (9) is a complete seal to prevent leakage of fluid into the die. The upper seal is given a clearance with the die that permits controlled leakage of fluid therepast at a rate that limits the maximum pressure in the pressure chamber while permitting the development of an adequate pressure on the material being molded.

Fig. 2



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Description

[0001] The present invention relates to a pressure controlled fluid pressure extrusion method. The term "fluid pressure extrusion method" defines a method in which extrusion is conducted under the action of fluid pressure. Pressure control describes the adjustment of this fluid pressure in order to conduct proper extrusion. These extrusions can be used to make parts for automobiles such as helical gears and the like.

[0002] Examples of the prior art include forward extrusion methods as shown in Figure 1 of Japanese Laid-Open patent Publication Number 11-254082 and Figure 3 of Japanese Laid-Open Patent Publication Number 7-308729.

[0003] Referring to Figures 3(A)-3(D), steps of these prior art methods are schematically shown in order to compare these prior art methods with the present invention. A material blank 11 progresses through the steps of 3(A), 3(B), 3(C) and 3(D) to produce a manufactured product 15. In the example shown the manufactured product 15 comprises a throughbore. The blank material 11 also comprises a throughbore for receiving a mandrel in the metal mold.

[0004] Referring to Figure 3(A), the outer diameter of the material blank 11 is approximately the same size as the inner diameter of a container part 12b of a die 12. Referring to Figure 3(C), when the material blank 11 is extruded into the die 12 and molded by a punch 13, a large frictional force is generated between the outer diameter of the material blank and the container. Furthermore, when molding a helical gear part 15a of the manufactured product 15 with a helical gear part 12a of the die 12, the product 15 rotates as it advances along the die. This rotation generates a large additional frictional force in the direction of rotation as well as the frictional force which is generated in the axial direction as described above. As a result, the working load is increased, and there are negative effects on the product precision and on the die life. With this method, the outer diameter part of the material blank must be straight. If the outer diameter is tiered, that is to say, the material blank comprises one or more different diameter parts, the smaller diameter part could become deformed and could expand during molding such that the specified molding is not achieved.

[0005] In one aspect of the present invention, a fluid pressure is disposed between the die and the material blank. When molding the material blank, a suitable fluid pressure acts upon the material blank.

[0006] Briefly stated, an aspect of the present invention provides a fluid pressure molding method in which the lower part of a material to be molded forms a lower seal with a die. A punch applying a molding force to the material forms an upper seal with the perimeter of the die. The space between the upper and lower seals forms a pressure chamber that is filled with a fluid. As the punch descends into the die, the fluid is pressurized. The lower seal is a complete seal to prevent leakage of fluid into the die. The upper seal is given a clearance with the die that permits controlled leakage of fluid therepast at a rate that limits the maximum pressure in the pressure chamber while permitting the development of an adequate pressure on the material being molded.

[0007] Preferably, a suitable fluid pressure acts on the outer perimeter surface of a material. The material is pushed directly by a punch into die for molding, whereby the material is molded into a desired shape.

[0008] Preferably, the fluid is suitably sealed by the material, the die, and the punch. The action of the die and the punch pressurizes the fluid. The fluid pressure acts on the material to form the product.

[0009] In preferred embodiments, the fluid pressure is adjusted by a clearance of the die and the punch.

[0010] The invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figures 1(A) through 1(D) are schematic representations of the steps in a process according to an arrangement of the invention;
Figure 2 is an expanded view of the principal part of Figure 1(B); and,
Figures 3 (A) through 3(D) are schematic representations illustrating the method of the prior art.

[0011] Referring to Figures 1(A)-1(D), the process of molding a material blank 1 into a molded product 5 is shown. A metal mold 100 is constructed from a die 2, a punch 3, and a mandrel 4. The metal mold 100 is set into a conventional press (not shown). The metal mold 100 is actuated by the ascending and descending motion of a slide of the press.

[0012] Referring to Figure 1(A), the die 2 includes a cavity 10 having the shape of the desired molded product. In the illustrated arrangement, the molded product is a helical gear. Teeth 2a are formed on the lower part of a cavity 10, that is to say towards the bottom of the mold 100 in the drawings of Figures 1(A) to 1(D). Teeth 5a of the molded product 5 are formed by teeth 2a.

[0013] Referring to Figure 1(B) and Figure 2, the material blank 1 is supplied to die 2. The material blank 1 is transported to die 2 by a transport device (not shown) and is inserted into a cavity 10 of the die 2. After inserting the material blank 1 into the cavity 10, the mandrel 4 is inserted into a central throughbore in the material blank 1. A fluid is supplied to cavity 10. In the present arrangement, oil is used as the fluid.

[0014] Next, the punch 3 is lowered into cavity 10. The lower end surface of the punch 3 contacts the upper surface of the material blank 1. As the punch 3 descends further, a fluid pressure chamber 6 is defined and sealed between the punch 3 and the lower portion of the material blank 1. With further descent of the punch 3 the fluid inside cavity 10 is pressurised. In other words, the fluid is sealed by a first seal 7 at the contact surface between

material 1 and punch 3, a second seal 8 at the insertion surface between die 2 and punch 3, and a third seal 9 at the insertion surface between die 2 and the lower end of material blank 1.

[0015] The seal 9 must completely seal to prevent leakage of fluid from the fluid pressure chamber 6 to the portion of the die 2 containing the teeth 2a. If the pressurized fluid from fluid pressure chamber 6 penetrates into teeth 2a, the presence of the material 1 may produce partial depressions in teeth 5a of molded product 5. This would prevent achieving the desired shape.

[0016] The seal 7 may have some leakage without producing any problems. In the present arrangement, because teeth 2a are a helical gear, while molding, material 1 rotates with respect to punch 3. As punch 3 advances, a film of fluid penetrates between the teeth 2a and the teeth 5a being formed. The resulting lubrication reduces the frictional force that accompanies this rotation.

[0017] With the seal 8, the pressurized fluid must be actively released. If the fluid pressure in the fluid pressure chamber 6 rises without limit, problems such as rupture of members such as die 2 and the like can occur. However, if a large amount of fluid in fluid pressure chamber 6 leaks from seal 8, material 1 expands radially. This can cause problems such an incomplete molding action of the material blank 1. Taking these points into account, it is necessary to determine the clearance for the restriction of seal 8. In this way, the seal 8 acts as a pressure relief valve.

[0018] As described above, the clearance of seal 8 is determined so that an optimal fluid pressure in the fluid pressure chamber 6 is achieved.

[0019] Referring to Figure 1(C), while the fluid pressure from fluid pressure chamber 6 is applied to the material blank 1, the material blank 1 is pushed by punch 3 to become molded into the molded product 5. In this situation, because the fluid in fluid pressure chamber 6 is disposed between the die 2 and the material blank 1, frictional forces between the die and the blank material are not generated. Therefore, the material blank 1 is molded with only the molding pressure that is needed for molding. In the present arrangement, because teeth 2a of die 2 form a helical gear, the material blank 1 is rotated while being pushed into die 2. However, due to the action of the above fluid, frictional resistance associated with the rotation is not generated.

[0020] Referring to Figure 1(D), the molded product 5 inside die 2 is impelled from below by a knockout device (not shown) and is removed from above the die 2. In other words, the molded product is lifted to the top of die 2 by a rotatable lifting member (not shown).

[0021] In the present arrangement, a tiered material blank is used, but the present invention can be used for a straight or constant diameter material blank as well. Although there is a throughbore in the center of the molded product, the present invention does not require a throughbore to be provided. In the present arrangement, the molded product is a helical gear, but the present invention can be used for molded parts with super gears or with no gears as well.

[0022] According to the present invention, because there is no associated frictional force, the load needed for molding is reduced. As a result, the stress on the die is reduced, and product precision is improved. There are advantages such as having a die with a long life and conserving energy. Furthermore, even if there is a space between the die and the material blank, there is no deformation of the material blank and extrusion of tiered material blanks becomes possible. As a result, the cross-section reduction rate for the extrusion is small, and the molding load is further reduced.

[0023] The fluid pressure in fluid pressure chamber 6 is controlled by the clearance of seal 8. As a result, control is easy and stable. In this regard, the method of the present invention permits molding of parts that have heretofore been considered difficult to process.

[0024] Having described preferred arrangements of the invention with reference to the accompanying drawings it is to be understood that the invention is not limited to those precise arrangements, and that the various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention as defined in the appended claims.

Claims

1. A pressure controlled fluid pressure extrusion method comprising:

   placing a material blank (1) to be molded in a die (2);
   applying a fluid pressure to an outer perimeter surface of the said material blank; and
   pushing said material blank directly by a punch (3) into the said die for molding, whereby the said material blank is molded into a desired shape.

2. A pressure controlled fluid pressure extrusion method according to Claim 1, further comprising the steps of;

   sealing the said fluid by seals (7, 8, 9) formed of contact between the said material, the said die, and the said punch; and
   movement of the said punch with respect to the said fluid by the said die.

3. A pressure controlled fluid pressure extrusion method according to claim 2, wherein the step of applying fluid pressure includes the step of adjusting a clearance between said die and said punch, the said clearance controlling the said fluid pressure.

4. A pressure controlled fluid pressure extrusion method according to Claim 2, wherein the step of sealing includes completely sealing the said material blank with respect to the said die, whereby leakage of the said fluid therepast is prevented.

5. A pressure controlled fluid pressure extrusion method according to Claim 4, wherein the step of sealing includes providing a clearance between the said punch and the said die effective to permit leakage of said fluid therepast at a rate which produces the desired fluid pressure.

6. A pressure controlled fluid pressure extrusion method comprising:

placing a material blank to be molded in a die (2);
completely sealing a lower portion of the said material blank with respect to the said die;
adding a fluid to a space (6) above a lower seal (9) between a perimeter of the said material blank and the said die;
urging a punch (3) into the said die;
the said punch forming an upper seal (8) with said die;
a space between the said lower portion and the said upper seal defining a pressure chamber (6);
advancing the said punch into the said die to mold the said material blank into a product;
the step of advancing being effective to pressurise the said fluid; and
providing a fit between the said punch and the said die at the upper seal that is effective to permit an amount of leakage that produces a desired level of fluid pressurisation in the said pressure chamber.

7. An extrusion method comprising the steps of:

positioning a material blank (1) to be molded in a die (2);
pressing the said material blank in the said die to mold the said material blank into a desired molded shape;
characterised in that the said method includes the step of applying fluid pressure between at least one surface of the said material blank and an adjacent surface of the said die.

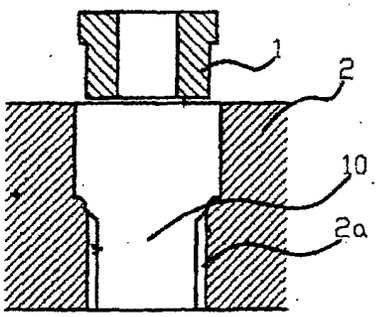


Fig. 1(A)

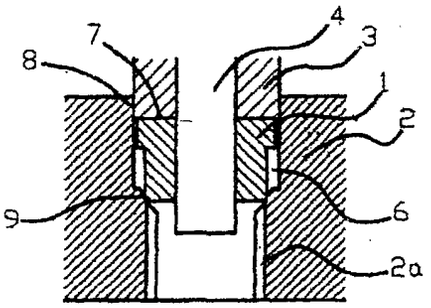


Fig. 1(B)

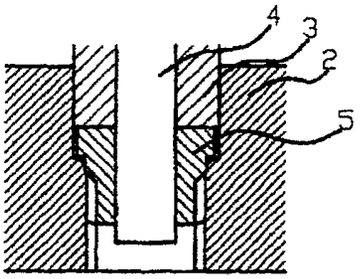


Fig. 1(C)

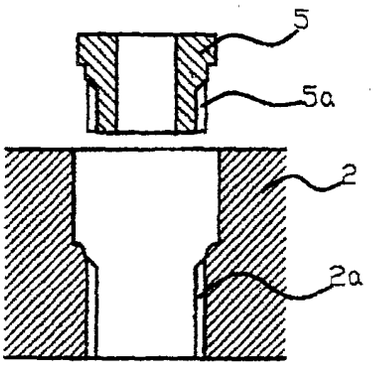
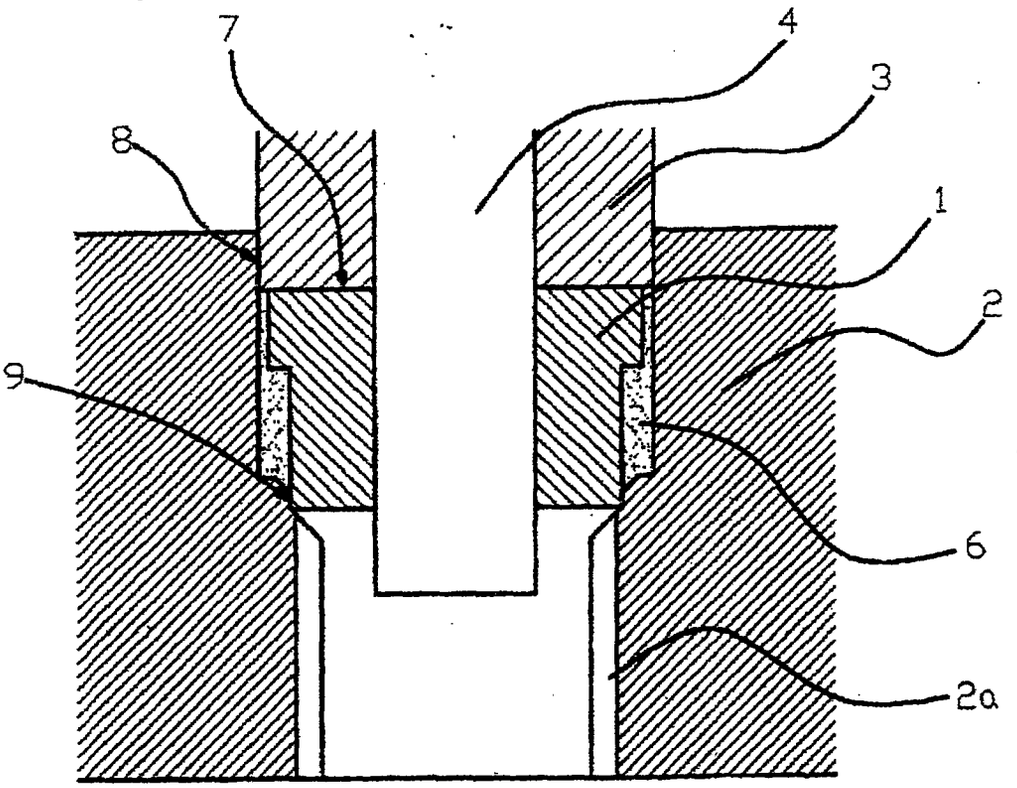
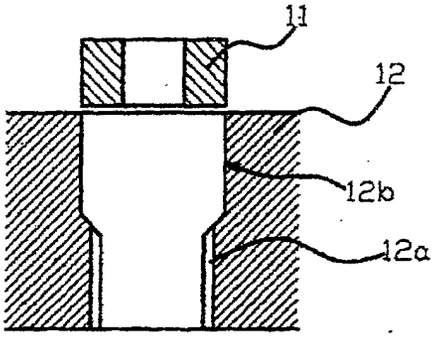


Fig. 1(D)

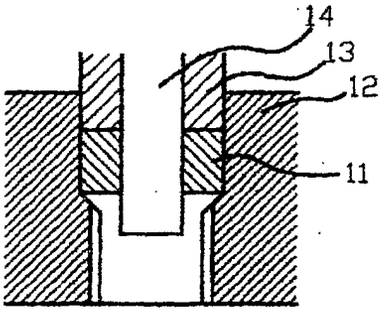
Fig. 2





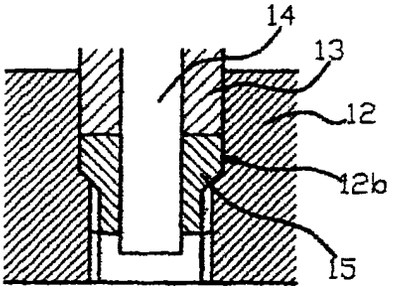
PRIOR ART

Fig. 3(A)



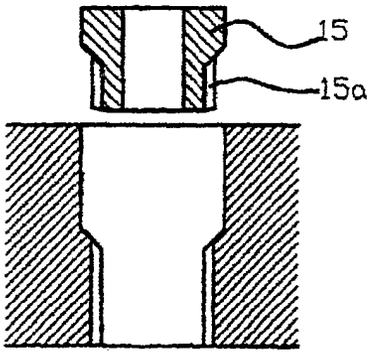
PRIOR ART

Fig. 3(B)



PRIOR ART

Fig. 3(C)



PRIOR ART

Fig. 3(D)