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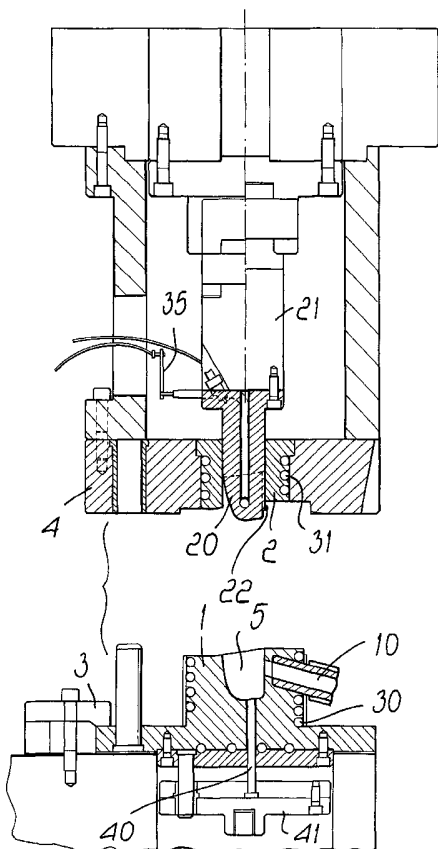
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(54) Title: APPARATUS AND METHOD FOR PRODUCING TOE CAPS FOR SAFETY SHOES

(57) Abstract: An apparatus for producing toe caps for safety shoes and the like made of aluminum, aluminum alloys and light alloys in general, comprising a bottom die and a top die which can be associated with respective platens and can be mated so as to form at least one impression. The apparatus further comprises at least one male plug that can be inserted in the impression in order to form the shape of the part being formed and is suitable to act as a flow control element for the duct for introducing the liquid metal in the impression.



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APPARATUS AND METHOD FOR PRODUCING TOE CAPS FOR SAFETY SHOES

Technical Field

The present invention relates to an apparatus for manufacturing toe caps,
5 for safety shoes and the like, made of aluminum, aluminum alloys and light
alloys in general, and to the method of manufacturing toe caps.

Background Art

It is known that the toe caps currently used in safety shoes or working
shoes are usually made of steel and have a substantially constant thickness,
10 since they are mostly manufactured by pressing metal plate.

Steel toe caps suffer the drawback that they are relatively heavy and are
magnetic.

Attempts made to manufacture toe caps by using composite materials,
such as fiberglass-reinforced plastics and carbon fibers, have failed to yield
15 satisfactory results, since they have an extremely high cost and great
thickness, which significantly impairs the aesthetics of the shoe.

Production by casting or pressing aluminum has failed to yield good
results, because it has not been possible to produce a toe cap capable of
withstanding the 200-joule impact test required by the standards.

20 Disclosure of the Invention

The aim of the present invention is to eliminate the drawbacks noted
above, by providing an apparatus for producing toe caps for safety shoes
made of aluminum, aluminum alloys and light alloys in general that allows
to obtain a toe cap capable of withstanding impact tests and is considerably
25 lighter than corresponding steel toe caps.

Within this aim, an object of the invention is to provide a toe cap whose
internal structure is practically free from gas with particularly closely
arranged molecules, so as to achieve high mechanical strength properties.

Another object of the present invention is to provide an apparatus that

allows to form the part and in practice to forge it in the plastic state without sprue.

Another object of the present invention is to provide an apparatus that allows to obtain a toe cap which, in addition to being nonmagnetic and
5 lightweight, has a low cost.

This aim and these and other objects that will become better apparent hereinafter are achieved by an apparatus for producing toe caps for safety shoes and the like, made of aluminum, aluminum alloys and light alloys in general, according to the invention, which comprises a bottom die and a top
10 die which can be associated with respective platens and can be mated so as to form at least one impression, characterized in that it comprises at least one male plug that can be inserted in said impression in order to form the shape of the part being formed and is suitable to act as a flow control element for the duct for introducing the liquid metal in said impression.

15 Brief Description of the Drawings

Further characteristics and advantages of the invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment of an apparatus for manufacturing toe caps for safety shoes and the like, made of aluminum, aluminum alloys and light alloys in
20 general, illustrated by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a schematic view of the apparatus according to the invention, with the dies in the open position;

Figure 2 is a view of the apparatus with the dies closed during the step for
25 introducing the liquid metal;

Figure 3 is a view of the apparatus during formation of the part by descent of the male plug;

Figure 4 is a view of the apparatus during the step of extracting the part from the bottom die;

Figure 5 is a view of the apparatus during separation of the part from the male plug;

Figure 6 is a schematic view of the resulting part.

Ways of carrying out the Invention

5 With reference to the figures, the apparatus for manufacturing toe caps for safety shoes and the like, made of aluminum, aluminum alloys and light alloys in general, according to the invention, comprises a bottom die 1 and a top die 2, which are respectively associable with a lower platen 3 and with an upper platen 4.

10 The dies can be mutually mated, by way of the relative motion of the platens and preferably by way of the descent of the upper platen, so as to form an impression 5.

The particularity of the invention consists in that at the impression 5 there is a duct for introducing the liquid metal 10, which is connected to an
15 assembly for feeding the molten metal 11, which is temperature-controlled and allows to introduce in the impression 5 pre-dosed quantities of liquid aluminum or aluminum alloys.

At the top die 2 there is a male plug 20, which is associated with a movable part 21 of the upper platen 4 constituting motion means for the
20 male plug able to provide, after the introduction of the molten metal inside the impression 5, the introduction of the male plug forming the exact shape of the part being manufactured; further, the male plug 20 achieves the closure of the inflow duct 10 by means of a flat portion 22 that closes the passage of the duct 10 and allows to form a sprueless part.

25 The male plug 20 defines in practice a flow control element for the duct 10 and also applies a pressure between 500 and 1300 kg/cm² so as to perform in practice a forging of the liquid metal, which achieves a plastic deformation of the material before it solidifies and, by applying pressure, more favorable conditions as regards solidification.

Moreover, the application of pressure during solidification allows to substantially eliminate gas in the structure of the casting and to move closer the molecules, which in practice are packed more tightly and allow to provide a particularly compact structure.

5 This technique is certainly innovative with respect to conventional methods, which entailed, in the case of introduction of liquid metal, the introduction of the material from above, with an excessive time before closing the die, with the possibility of partial solidifications of the liquid metal and considerable difficulties in die temperature control; moreover,
10 pressure was difficult to adjust and was due in each instance to the specific characteristics of the material.

In the specific solution, the bottom die 1 is provided with lower heating resistors 30 and correspondingly the top die 2 is provided with upper heating resistors 31, which allow optimum temperature control, together with the
15 presence of thermocouples 35 that perform temperature control of the male plug 20, wherein appropriate heating resistors are provided.

In performing die-casting, the difference between the temperature of the metal before formation and the temperature of the dies that form the impression is preferably as low as possible and is between 150 and 250 °C,
20 preferably 200 °C.

It should be added to the above that at the impression 5 there is an ejector 40, which can be actuated by an ejector piston 41 associated with the lower platen, which is preset to facilitate the release of the produced part after the solidification period, in order to remove it from the impression of the bottom
25 die.

In the practical use of the apparatus according to the invention, the dies are heated to a preset temperature by means of the electric resistors 30 and 31, and the metal in the furnace is brought to the required temperature.

In order to start the cycle, the upper movable platen descends rapidly

until the bottom die and the top die are mutually closed, keeping the male plug 20 partially extracted from the impression 5.

Once the coupling of the dies has been performed, the dosage system for the liquid metal, constituted by aluminum and aluminum alloys, is activated in order to introduce a quantity of dosed liquid metal in the impression 5 by means of the inflow duct 10.

Once dosage has ended, the descent of the male plug 20 is activated, under the actuation of the cylinder 21, which performs a descent at a preset speed and applies a preset pressure.

10 It is considerably important that the descent of the piston 20 automatically also closes the inflow duct 10 for the liquid metal.

Once the descent of the male plug 20 has ended, the solidification time begins; during this time, the pressure rises according to a preset criterion in order to forge the part, designated by the reference letter P, which is still in the plastic state.

Once the solidification time has ended, the ejector piston 41 is actuated and acts on the ejector 40 with an upward motion at a preset speed, simultaneously with the actuation for the rise of the upper platen of the press, male plug 20, up to a preset level.

20 Once the preset upper level of the upper platen has been reached, the rise of the male plug 20 is actuated, consequently releasing the resulting part.

The thicknesses of the resulting part can vary from point to point according to the requirements of mechanical strength of the part, a feature that was not obtainable with conventional methods, which instead started from the pressing of a plate.

25 The possibility to vary the thickness of the part according to contingent requirements provides a further possibility to reduce the weight of the resulting part without thereby reducing mechanical strength.

From the above description it is thus evident that the invention achieves

the intended aim and objects, and in particular the fact is stressed that an apparatus and a method are provided which are definitely innovative in that, in practice, a liquid forging is provided, with the possibility to control the part solidification step, always achieving optimum conditions.

5 The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

All the details may further be replaced with other technically equivalent elements.

10 In practice, the materials used, as well as the contingent shapes and dimensions, may be any according to requirements.

The disclosures in Italian Patent Application No. MI2001A000949 from which this application claims priority are incorporated herein by reference.

CLAIMS

1. An apparatus for producing toe caps for safety shoes and the like, made of aluminum, aluminum alloys and light alloys in general, comprising a bottom die (1) and a top die (2) which can be associated with respective platens (3,4) and can be mated so as to form at least one impression (5),
5 characterized in that it comprises at least one male plug (20) that can be inserted in said impression (5) in order to form the shape of the part (P) being formed and is adapted to act as a flow control element for the duct (10) for introducing the liquid metal in said impression (5).
- 10 2. The apparatus according to claim 1, characterized in that said liquid metal inflow duct (10) is formed at said bottom die (1).
3. The apparatus according to the preceding claims, characterized in that said male plug (20) is supported by said top die (2) and is connected to means (21) for translational motion with respect to said top die (2).
- 15 4. The apparatus according to one or more of the preceding claims, characterized in that said male plug (20) has a flattened portion (22) for closing the passage connecting said liquid metal inflow duct (10) and said impression (5).
5. The apparatus according to one or more of the preceding claims,
20 characterized in that said male plug (20) is adapted to apply a pressure between 500 and 1300 kg/cm² to the liquid metal that is present in said impression (5).
6. The apparatus according to one or more of the preceding claims, characterized in that it comprises lower heating resistors (30) at said bottom die (1), upper heating resistors (31) at said top die (2), and male plug heating
25 resistors.
7. The apparatus according to one or more of the preceding claims, characterized in that the difference between the temperature of the liquid metal before casting and the temperature of said dies (1,2) is between 150

and 250 °C, preferably 200 °C.

8. The apparatus according to one or more of the preceding claims, characterized in that it comprises an ejector (40), which is provided on the bottom of said impression (5) and connected to an ejector piston (41) for the
5 release of the solidified part (P) from said impression (5).

9. A method for producing toe caps for safety shoes and the like made of aluminum, aluminum alloys and light alloys in general, characterized in that it consists in introducing dosed liquid metal in an impression formed by a bottom die and a top die, in introducing in said impression a male plug
10 adapted to apply a preset pressure to said metal and to prevent connection to the liquid metal inflow duct, in performing the solidification of the part under pressure for a preset time, in performing the ejection of the part with respect to the impression, and in removing the male plug from the part.

10. The method according to claim 9, characterized in that the difference
15 in temperature between the liquid metal and the dies that form said impression is between 150 and 250 °C, preferably 200 °C.

11. The method according to one or more of the preceding claims, characterized in that said male plug applies a pressure between 500 and 1300 kg/cm² during the solidification of the part.

20 12. A toe cap for safety shoes and the like, made with the apparatus of claim 1 and according to the method of claim 9, characterized in that it comprises a body formed by casting liquid aluminum, aluminum alloys and light alloys in general, said body having a differentiated thickness in its various points and being sprueless.

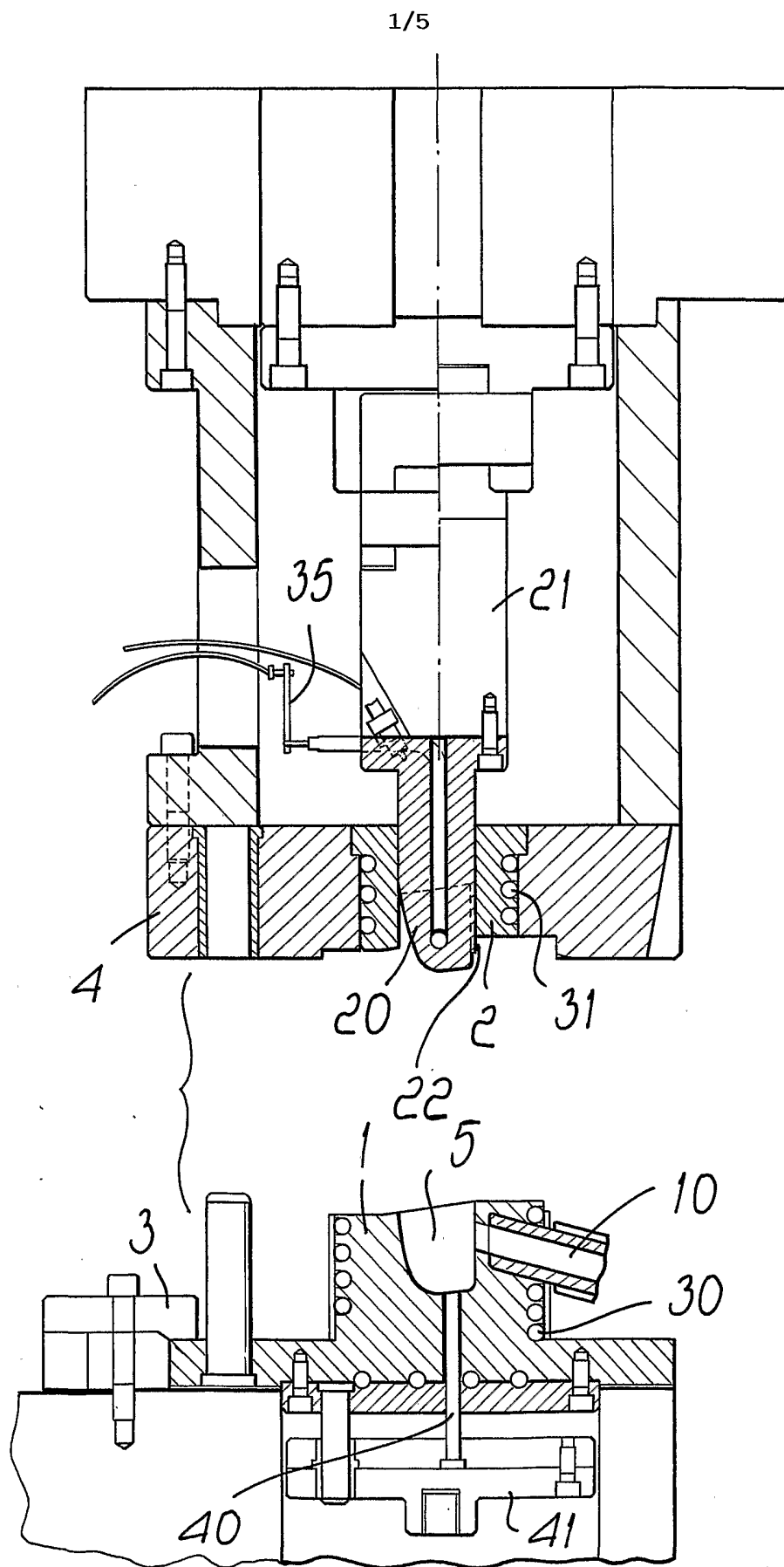
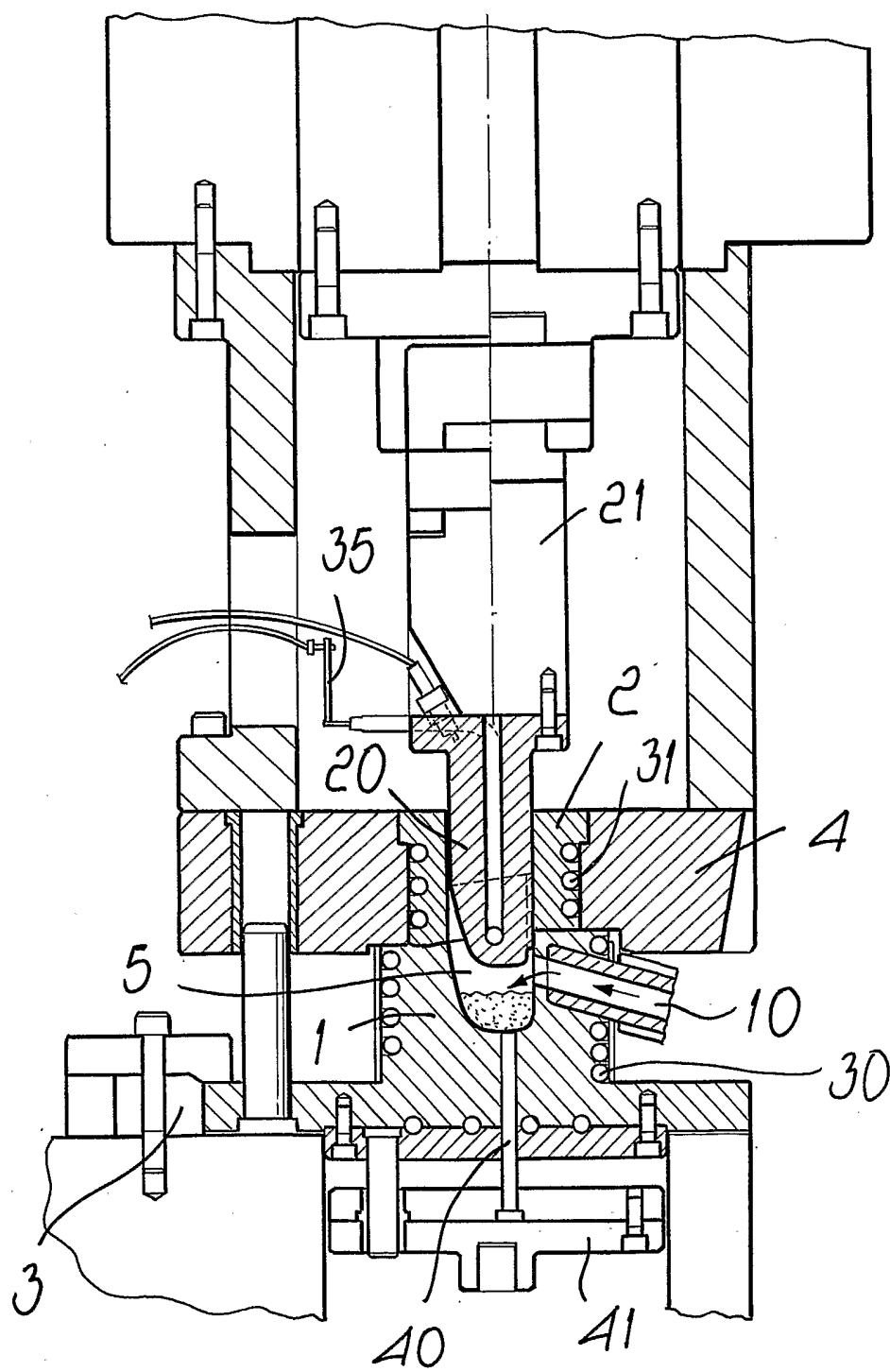


Fig. 1

*Fig. 2*

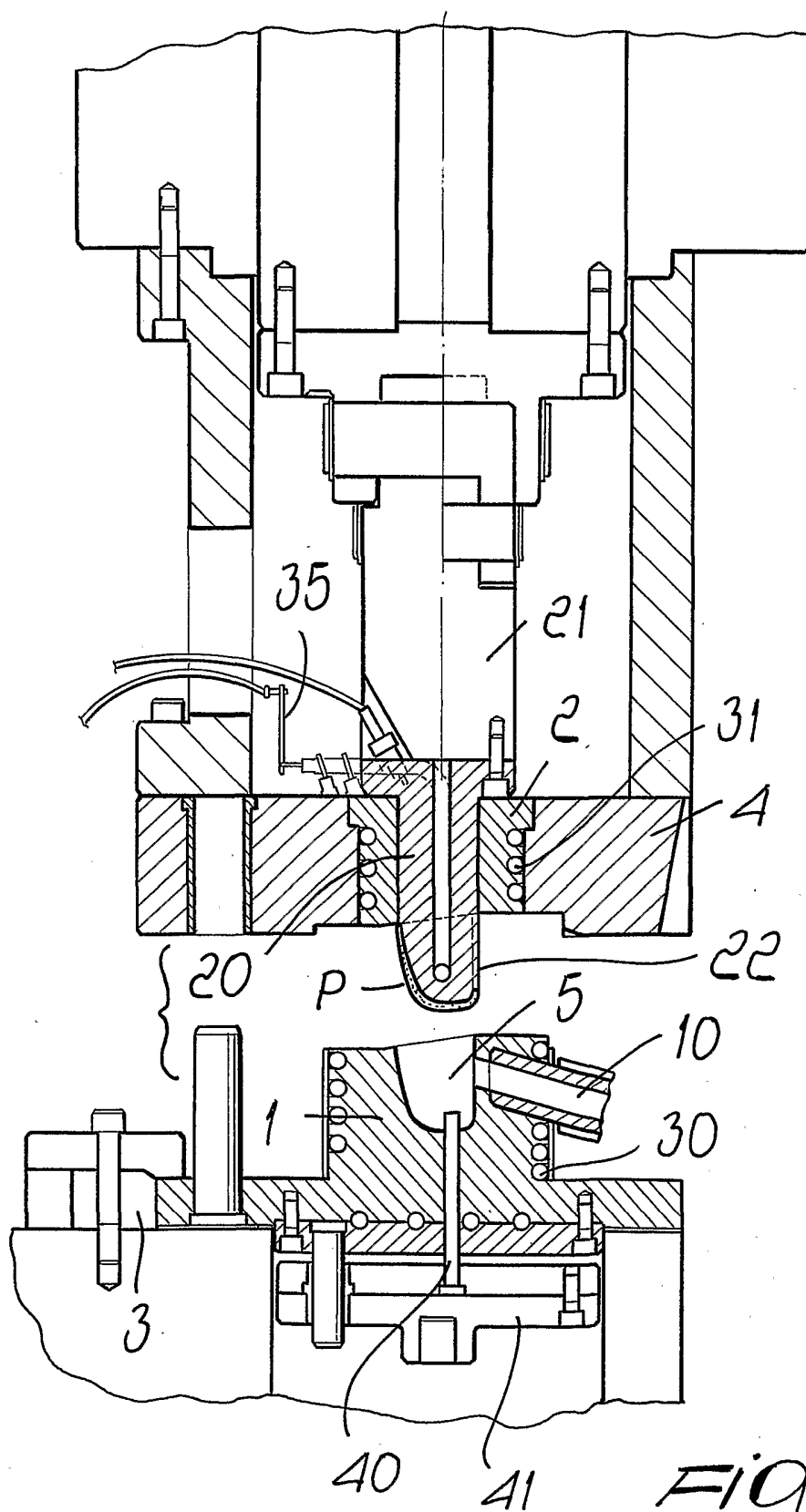


FIG. 4

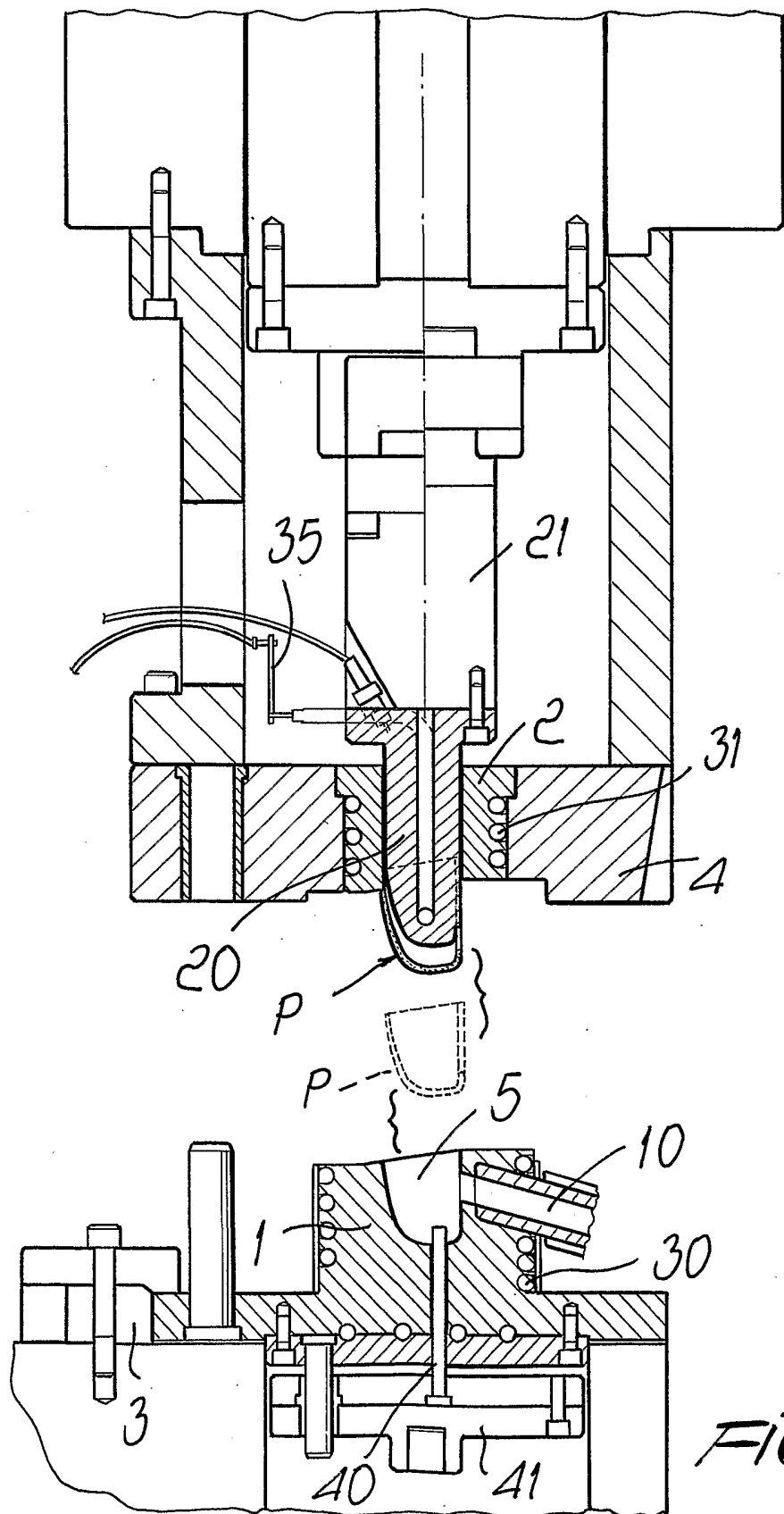


Fig. 5

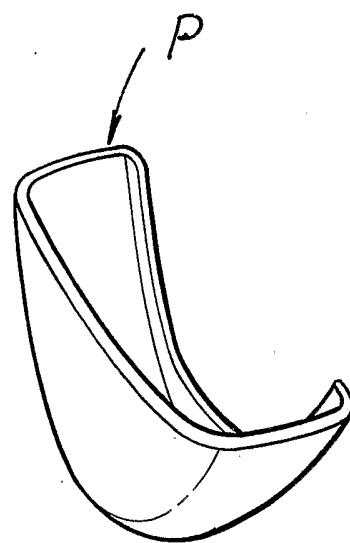


Fig. 6