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(54) **METHOD AND MACHINE FOR PRODUCING AN EXHAUST TERMINAL FOR BURNT GAS EVACUATION SYSTEMS OF INTERNAL COMBUSTION ENGINES**

(57) A method and a machine for cold-forming a metal tubular element(1) for producing an exhaust terminal for burnt gas evacuation systems of internal-combustion engines, by first reducing the diameter of the tubular element (1) at one end and increasing it at the other end and then by using a press having a punch (3) and a die (2), the punch consisting of an inner cylinder (31) and of an outer sleeve (32) coaxial to each other and separated by a space (33) and the die (2) consisting of a cylindrical hollow.

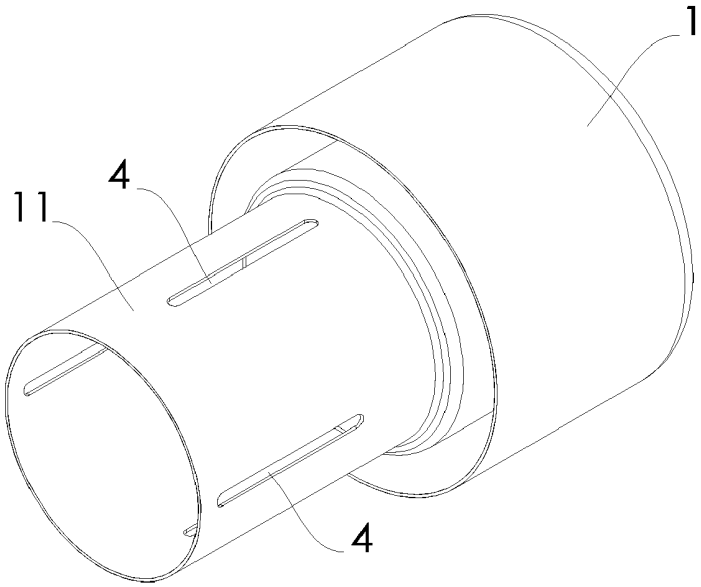

FIG. 1

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Description

Technical field

[0001] The present invention belongs to the sector of the metal cold-forming processes and in particular to the sector of the production of exhaust terminals for burnt gas evacuation systems of internal-combustion engines.

Status of the art

[0002] In the sector of the motor vehicles components industry, a specially important field is represented by the production of special components for customizing his/her own vehicle. The customized components and accessories sector for motor vehicles includes a very high number of different products, all aiming at improving the performances of the vehicles and/or basically improving their appearance.

[0003] In this sector, a particularly popular and appreciated accessory is the so-called "tail pipe", i.e. the exhaust terminal that is applied to the terminal section of the burnt gas evacuation system of an engine.

[0004] The main purpose of such accessory is that of improving the appearance of a vehicle and secondly that of amplifying the sound produced when the engine is running.

[0005] Having stated that the function of a "tail pipe" is substantially aesthetic, it is extremely important, when manufacturing it, to impart a high quality surface finishing level thereto.

[0006] In the past, the "tail pipes" were obtained starting from a parallelepiped metal sheet, by progressively folding said sheet up to making the opposite sides thereof match, which subsequently were welded together to form a substantially cylindrical and internally hollow body.

[0007] The method described here above is very little advantageous in that it requires a number of different operations to obtain an exhaust terminal, hence this process is rather slow and consequently expensive.

[0008] Furthermore, the presence of a "visible" weld negatively affects the appearance of the finished product, besides entailing risks of formation of rust.

[0009] This is the reason why the modern "tail pipes" are manufactured starting from a semi-finished metal tubular element in one piece, which is plastically modeled up to obtaining the desired shape for the exhaust terminal.

[0010] A feature that is common to most "tail pipes" presently marketed is in that the "free" end of the terminal, i.e. that end which slightly projects from the back side of the vehicle, presents a double wall, for both aesthetic reasons and structural reinforcement reasons.

[0011] The plastic modeling process is rapid and cost-effective nor does it require any hot machinings like welding.

[0012] An example of such production process is shown in EP0882530 and in DE553403, or in US3266822 even though, in the latter case, the process is related to pipings in general, not expressly to the production of exhaust terminals for vehicles.

[0013] In particular, as far as EP0882530 is concerned, the semi-finished tube is inserted into a press equipped with a radial punch: an end of the tube is firmly secured to the bed of the press, while the radial punch exerts a thrust onto the free end of the tube.

[0014] The head of the punch features an annular cavity whose cross section is substantially equal to a semicircle; the free end of the tube is forced against the curved wall of said annular cavity and is deformed following the profile of the annular cavity itself, partially folding onto itself and thus forming a section of wall parallel to the lateral surface of the tube. In practice, the free end of the tube is folded onto itself, so as to form a kind of flap.

[0015] In such kind of machining, the deformation of the tubular element takes place thanks to the direct contact between the outer surface of the tubular element with the surface of the annular cavity of the radial punch; the high force of friction due to the two surfaces in contact rubbing one against the other can damage the surface of the outer wall of the tubular element.

[0016] Any scratches or scores resulting from such type of machining are not acceptable, given the substantially aesthetic function committed to the exhaust terminal.

[0017] This is the reason why, after the modeling operation step described here above, it is often necessary to further trim the surface of the terminal, which unavoidably results in increased manufacturing costs and times.

Purposes and summary of the invention

[0018] A purpose of the present invention is to provide an innovative method for producing exhaust terminals for exhaust pipes of internal combustion motor vehicles, capable of reducing production costs and times, while preventing the drawbacks that are typical of the methods known in the present status of the art.

[0019] Such result is achieved by using a specifically modified press, comprising a special punch consisting of an inner cylinder and an outer sleeve, coaxial to and spaced from each other.

[0020] The method described in the present patent application comprises a preliminary step whereby the diameter of an end of the tubular element is reduced and that of the opposite end is widened.

[0021] Then the tubular element is placed in the press, where the action exerted by the punch progressively deforms it so as to force it to assume the shape of the lateral surface of the sleeve.

[0022] The special punch's action is exclusively exerted onto the inner wall of the tubular element's wall, whereas the outer wall thereof remains unchanged.

[0023] In this way it is not necessary to resort to a final surface trimming of the product.

[0024] Conveniently an exhaust terminal manufac-

tured according to the method disclosed in the present patent application comprises means for coupling with the exhaust pipe of the engine, so as to prevent the terminal from getting broken in the case of accidental shocks.

Brief description of the drawings

[0025]

Fig. 1 shows an axonometric view of a tubular element (1) realized by using the method according to the present patent application, wherein four slots (4) have been cut for coupling with the exhaust system of the engine.

Fig. 2 shows an axonometric view of the fixture used to form the exhaust terminal according to the present invention, wherein a base plate with a matrix die (2) and an upper plate which a special punch (3) projects from, are visible.

Fig. 3 shows a cross-sectional view according to the sectioning plane passing through the axis of the matrix die (2) and parallel to the longer side of the base plate of said fixture, at the conclusion of the press operating step (d), but before starting the deformation step (e) on the tubular element (1); in this figure, the tubular element (1) placed inside the fixture has already been subjected to operating step (a) whereby the inner end (11) is reduced and operating step (b) whereby the outer end (12) is widened. The figure also shows an enlarged detail of the matrix die (2) on the upper edge (21) of which rests the annular wall (15) radiusing the outer end (12) to the undeformed section of the tubular element(1).

Fig. 4 shows a cross-sectional view of the fixture and of the tubular element, according to the same sectioning plane as with previous figure 3, at the conclusion of the deformation (e). The figure also shows an enlarged detail of the tubular element (1) deformed by the action exerted by the punch (3) up to assuming the shape of the sleeve (32).

Fig. 5 represents a longitudinal cross-section of the tubular element (1) before subjecting it to the diameter reduction step (a).

Fig. 6 shows a longitudinal cross-section of the tubular element (1) after the diameter reduction step (a) at the inner end (11) and the diameter enlargement step (b) at the outer end (12).

Fig. 7 shows a longitudinal cross-section of the tubular element (1) at the conclusion of the plastic deformation step (e).

Fig. 8 represents a longitudinal cross-section of the tubular element (1) after the cutting step (h) performed at the outer end (12).

Detailed description of an embodiment of the invention

[0026] The present invention concerns an innovative process whereby a semi-finished metal tubular element is modeled for manufacturing an improved-appearance exhaust terminal for exhaust pipes of burnt gas evacuation systems of internal combustion engines.

[0027] The method according to the present invention specifically concerns the manufacturing of an exhaust terminal of the double-walled type, obtained starting from a preferably cylindrical metal tubular element (1).

[0028] The tubular element (1) comprises an inner end (11) suitable for being coupled with the burnt gas exhaust system of the engine and an outer end (12) opposed with respect to said inner end (11).

[0029] In the method according to the present invention, the inner and outer diameters of the inner end (11) of the tubular element (1) are preliminarily reduced.

[0030] Diameter reduction is accomplished by using a pipe-narrowing machine or a taper swaging machine or any other similar machines known in the present art.

[0031] Preferably are one or several progressive and successive diameter reduction operations carried out in this operating step.

[0032] Then the outer end (12) of the tubular element (1), opposite with respect to the inner end (11), is inserted into a pipe-widening machine or the like and its inner and outer diameters are enlarged.

[0033] The just described operation results in an annulus defining an annular wall (15) which joins the outer end (12) to the undeformed section of the tubular element (1). Said annular wall lays in a plane orthogonal with respect to the axis of the tubular element (1).

[0034] Preferably are one or several progressive and successive diameter widening operations carried out at the outer end (12) in this operating step.

[0035] Then the tubular element (1) is placed in a fixture mounted in a specifically modified press in order for it to be modeled up to forming the exhaust terminal according to the present invention.

[0036] Said fixture comprises a base plate and an upper plate, said base plate presenting a matrix die (2), whereas a special punch (3) coaxial to said matrix die (2) projects from said upper plate.

[0037] The matrix die (2) consists of a cylindrical hollow whose outer diameter equals the inner diameter of the outer end (12) of the tubular element (1).

[0038] The special punch (3) consists of an inner cylinder (31) and an outer sleeve (32), coaxial to each other and separated by a space (33); the outer diameter of the cylinder (31) equals the inner diameter of the inner end (11) of the tubular element (1), whereas the inner diameter of the sleeve (32) equals the diameter of the undeformed section of the tubular element (1).

[0039] The tubular element (1) is placed into the press coaxially with respect to the matrix die (2) and to the punch (3), this way making the annular wall (15) rest on the upper edge (21) of the matrix die (2); the inner wall of the outer end (12) of the tube adheres to the outer wall of the matrix die (2).

[0040] The press is operated and the special punch (3)

starts progressively descending; the inner end (11) of the tubular element (1) little by little inserts into the space (33) comprised between the cylinder (31) and the sleeve (32) of said punch (3).

[0041] The movement of the punch (3) continues and the lower edge (321) of the sleeve (32) gets in contact with the annular wall (15) of the tubular element (1); as the punch goes on in its own descent, the wall of the tubular element (1) is forced to assume the shape of the sleeve (32), by deforming in the plastic range. In this operating step, the outer end (12) of the tubular element (1) remains permanently adherent to the outer wall of the matrix die (2).

[0042] Upon reaching its end of stroke position, the punch (3) is lifted up to making the tubular element (1) completely clear the space (33) between the cylinder (31) and the sleeve (32); at this point the tubular element (1) can be taken out from the press.

[0043] The just described operating step is followed by another one whereby the outer end (12) of the tubular element (1) is cut off; such cutting off is carried out by using known techniques, for instance by using a lathe.

[0044] According to a particularly complete embodiment of the present method, in the inner end (11) of the tubular element (1) one or several slots (4) are cut to make it possible to couple the exhaust terminal with the exhaust pipe of an engine.

[0045] Conveniently is the major axis of said one or several slots (4) parallel to the axis of the exhaust terminal and are the means for coupling with the exhaust pipe such as to allow an axial shift of the terminal with respect to the exhaust pipe, in the case of big shocks or axial stresses onto the terminal itself.

[0046] In a preferred embodiment, the vertical stroke of the punch (3) is adjusted in such a way that when the punch (3) reaches the lowest point of its own movement, the joining area (15) between the undeformed section of the tubular element (1) and the inner end (11) is substantially at the same height as the upper edge (21) of the matrix die (2).

Claims

1. A method to cold-form a semi-finished metal tubular element (1) to produce an exhaust terminal for burnt gas evacuation systems of internal-combustion engines, said tubular element (1) comprising an inner end (11) suitable for being coupled with said gas exhaust system and an outer end (12) opposite to said inner end (11), **characterized in that** it comprises the following operating steps:

   a. reducing the diameter of an extreme section of said tubular element (1) to form the inner end (11) of the exhaust terminal;
   b. increasing the diameter of the opposite extreme section of said tubular element (1) to form the outer end (12) of the exhaust terminal, so as to determine an annulus which forms an annular wall (15) joining said outer end (12) to the not-deformed tubular element (1), said annular wall (15) laying on a plane orthogonal to the axis of the tubular element (1);
   c. placing the tubular element (1) in a fixture located in a press, said fixture comprising a base plate and an upper plate, said base plate presenting a matrix die consisting of a cylindrical hollow (2) featuring an outer diameter equal to the inner diameter of the outer end (12) of the tubular element (1), whereas a special punch (3) projects from said upper plate, said special punch being coaxial to said matrix die (2) and consisting of an inner cylinder (31) and an outer sleeve (32) coaxial to each other and separated by a space (33), said cylinder (31) featuring an outer diameter equal to the inner diameter of the inner end (11) of the tubular element (1), and said sleeve (32) featuring an inner diameter equal to the diameter of the tubular element (1) in its not-deformed section; the tubular element (1) being placed in the press coaxially to said matrix die (2) and to said punch (3), so that the annular wall (15) rests on the upper edge (21) of said matrix die (2), whereas the outer end (12) of the tubular element (1) externally adheres to the matrix die (2) ;
   d. operating the press and starting the downward movement of the special punch (3), in this operating step the tubular element (1) progressively inserting into the space (33) determined inside said punch (3);
   e. causing the plastic deformation of the wall of the tubular element (1) thanks to the stress exerted by the lower edge (321) of the sleeve (32) onto the wall of the tubular element (1), which is thus forced to assume the shape of the lateral surface of the sleeve (32); this way the outer end (12) of the tubular element (1) remaining adherent to the outer wall of the matrix die (2) ;
   f. lifting the punch (3), after the latter reaches its end-of-stroke position;
   g. taking the tubular element (1) out of the press;
   h. cutting the outer end (12) of the tubular element (1).

2. A method to produce exhaust terminals according to the previous claim, **characterized in that** after the operating step (h), during which the outer end (12) of the tubular element is removed, one or several slots (4) are cut in the inner end (11) of the tubular element (1).

3. A method to produce exhaust terminals according to one or several of the previous claims, **characterized in that** whenever the punch (3) reaches the

lowest point of its own movement, the joining area (15) between the undeformed section of the tubular element (1) and the inner end (11) is basically at the same height as the upper edge (21) of the matrix die (2).

4. A method to produce exhaust terminals according to one or several of the previous claims, **characterized in that** the diameter of the inner end (11) of the tubular element (1) is reduced by using a pipe-narrowing machine or by another similar machine whose technology is known, by progressively performing one or several diameter reduction operations.

5. A method to produce exhaust terminals according to one or several of the previous claims, **characterized in that** the diameter of the outer end (12) of the tubular element (1) is widened by using a pipe-widening machine or by another similar machine whose technology is known, via one or several successive and progressive operations.

6. A method to produce exhaust terminals according to one or several of the previous claims, **characterized in that** the outer end (12) of the tubular element (1) is cut by way of chip removal, for instance by way of lathe machining or another known technique.

7. A machine to produce an exhaust terminal for burnt gas evacuation systems of internal-combustion engines, by way of the cold forming of a semi-finished metal tubular element (1), comprising an inner end (11) suitable for being coupled with said gas exhaust system and an outer end (12) opposite to said inner end (11), **characterized in that** it comprises a fixture located in a press, said fixture comprising a base plate and an upper plate, said base plate presenting a matrix die consisting of a cylindrical hollow (2) featuring an outer diameter equal to the inner diameter of the outer end (12) of the tubular element (1), whereas a special punch (3) projects from said upper plate, said special punch being coaxial to said matrix die (2) and consisting of an inner cylinder (31) and an outer sleeve (32) coaxial to each other and separated by a space (33), said cylinder (31) featuring an outer diameter equal to the inner diameter of the inner end (11) of the tubular element (1), and said sleeve (32) featuring an inner diameter equal to the diameter of the tubular element (1) in its not-deformed section.

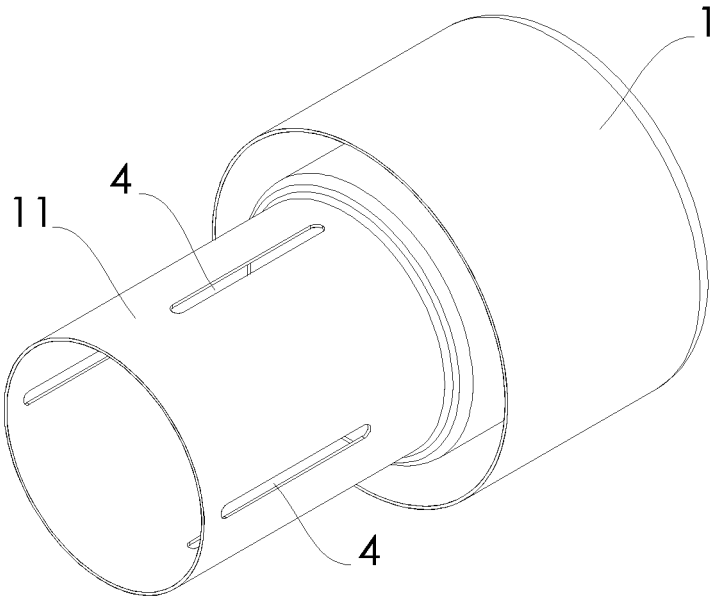

FIG. 1

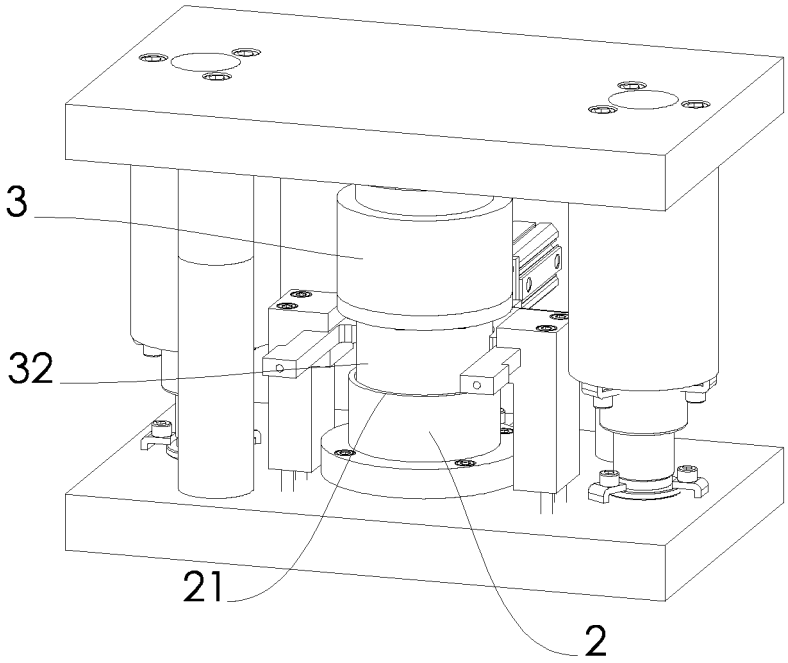

FIG. 2

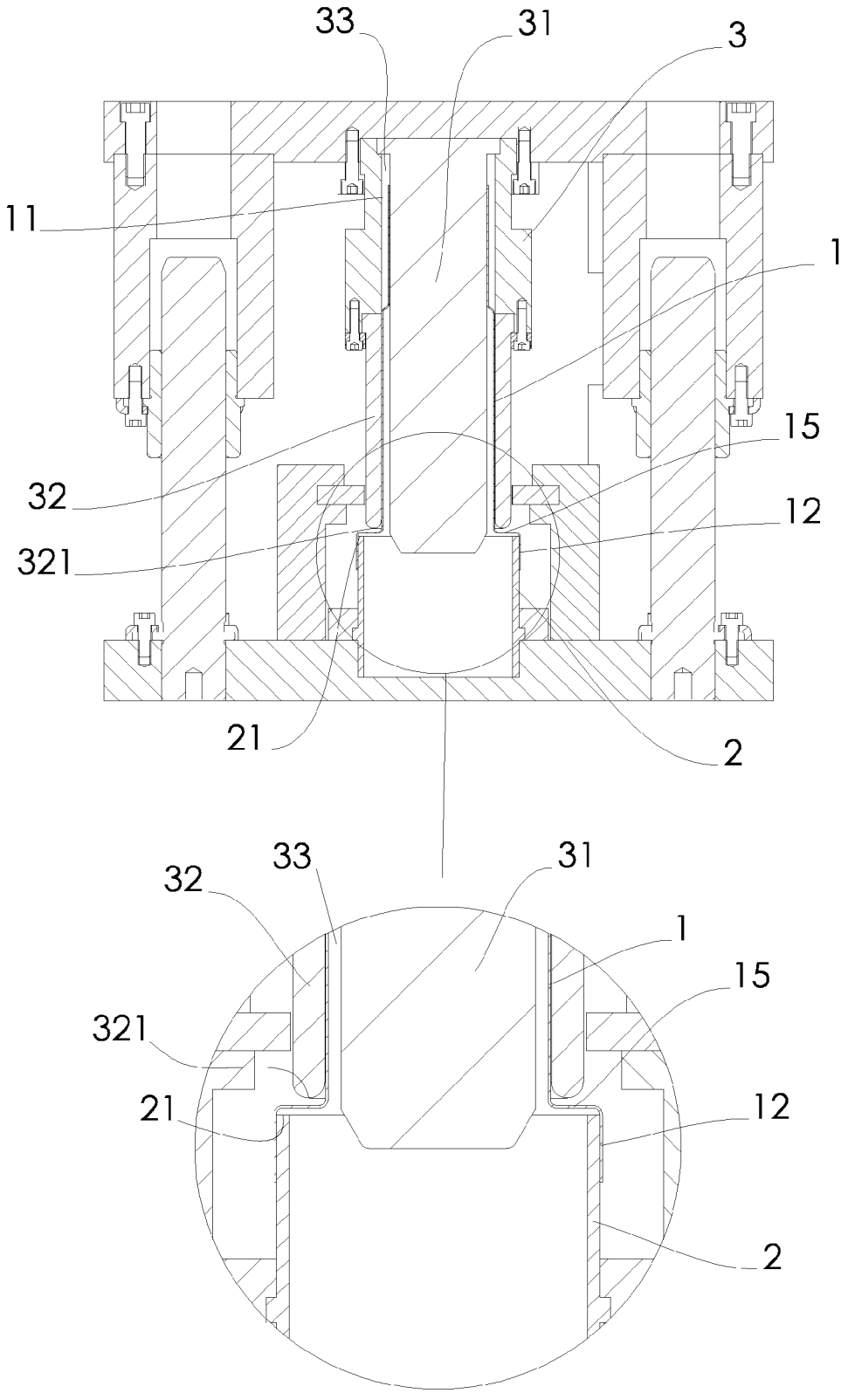

FIG. 3

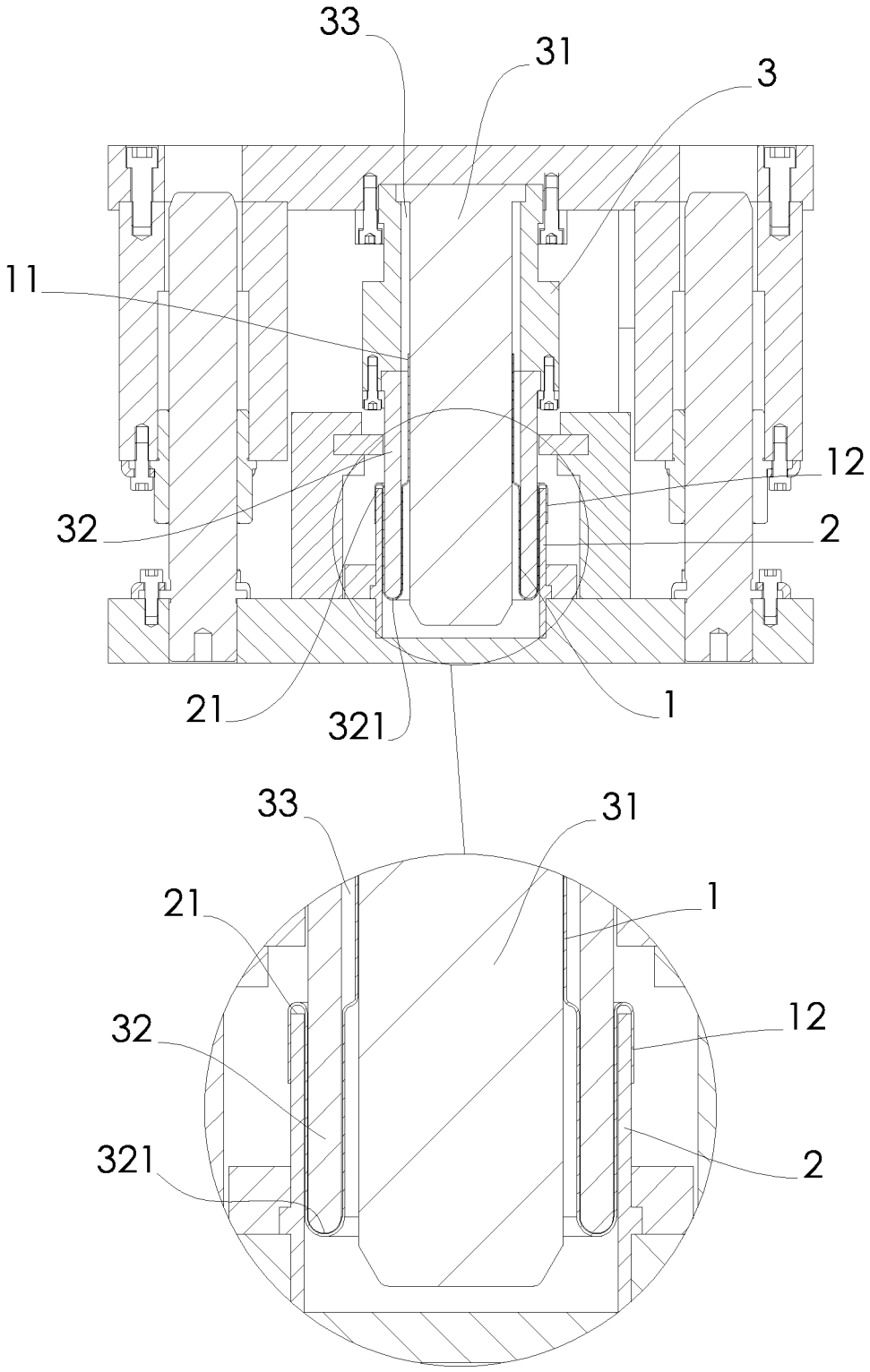

FIG. 4

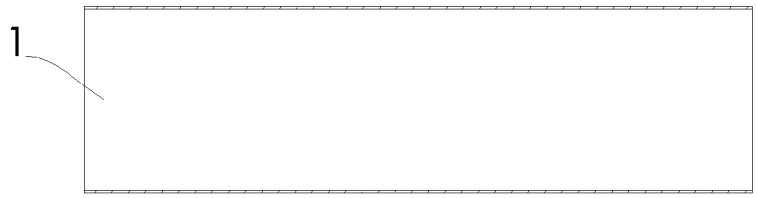

FIG. 5

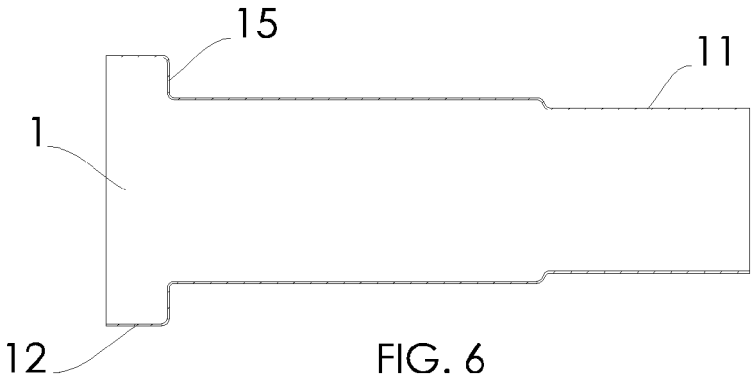

FIG. 6

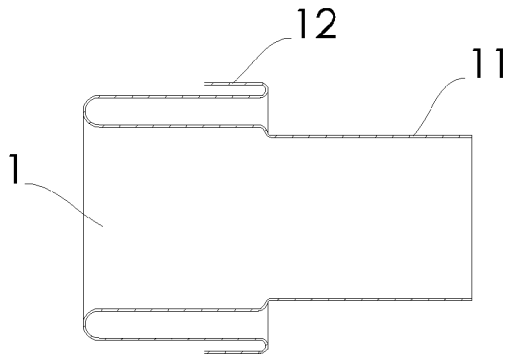

FIG. 7

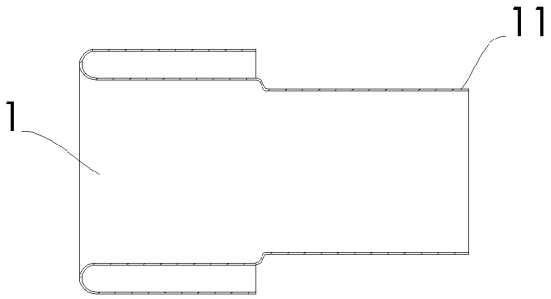

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 2381

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC) B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 November 2015	Pieracci, Andrea

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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