US 20120241471A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2012/0241471 A1

(43) Pub. Date: Sep. 27, 2012

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(54) **PLASTIC CLOSURE COMPRISING A CUTTING AND PERFORATING DEVICE**

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(21) Appl. No.: **13/499,066**

(22) PCT Filed: **Sep. 15, 2010**

(86) PCT No.: **PCT/EP10/63560**

§ 371 (c)(1), (2), (4) Date: **Jun. 12, 2012**

(30) **Foreign Application Priority Data**

Sep. 29, 2009 (DE) 10 2009 045 124.2

Publication Classification

(51) **Int. Cl.**
B65D 5/74 (2006.01)

(52) **U.S. Cl.** **222/83**

(57) **ABSTRACT**

The invention relates to a closing device (**1**) consisting of a plastic material for applying to a closed container consisting of a plastic film material. Only two cutting teeth (**20**, **21**) of the same height are to be applied to the cylindrical perforator (**5**) of said device, said teeth being arranged in an angular region of between 70° and 120° of the circumference. In this way, the section of the subsequent tooth extends into the section of the previous tooth, enabling a secure opening, without the risk of cutting an entire rondelle out of the plastic film of the container. The creation of only two partial sections without producing an opening in the container is also prevented.

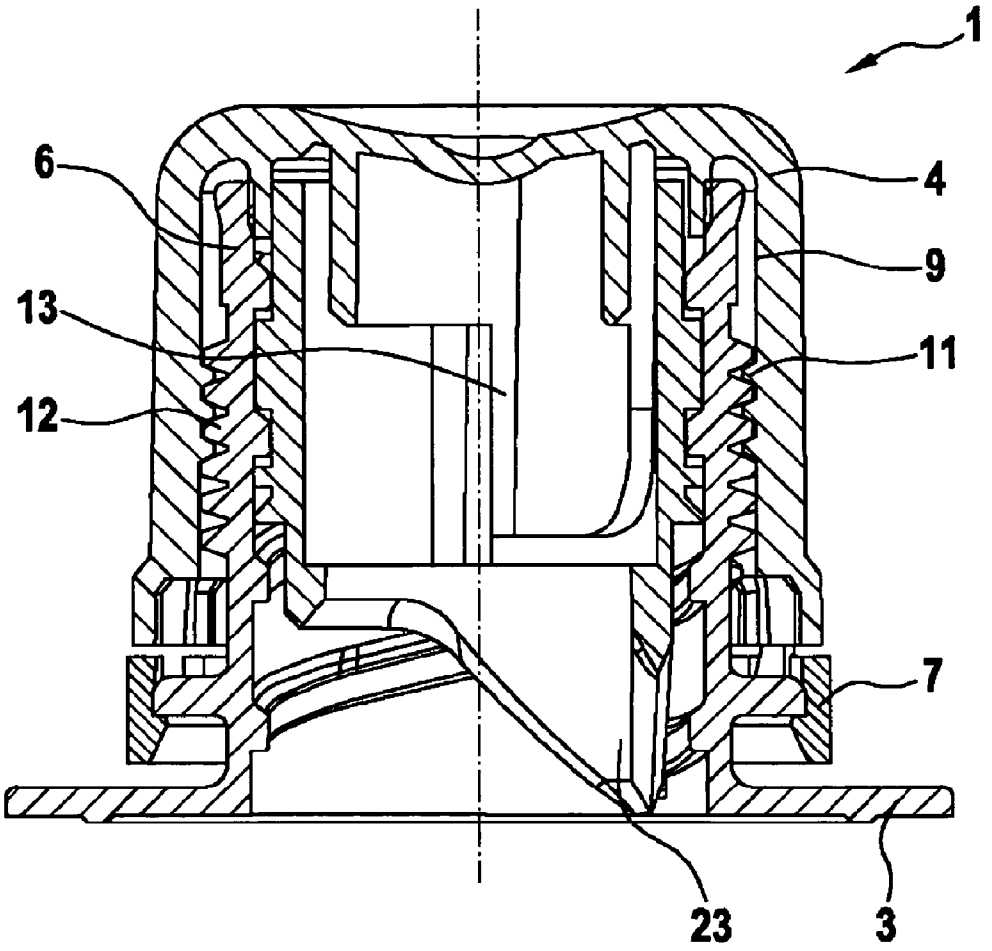


Fig. 1

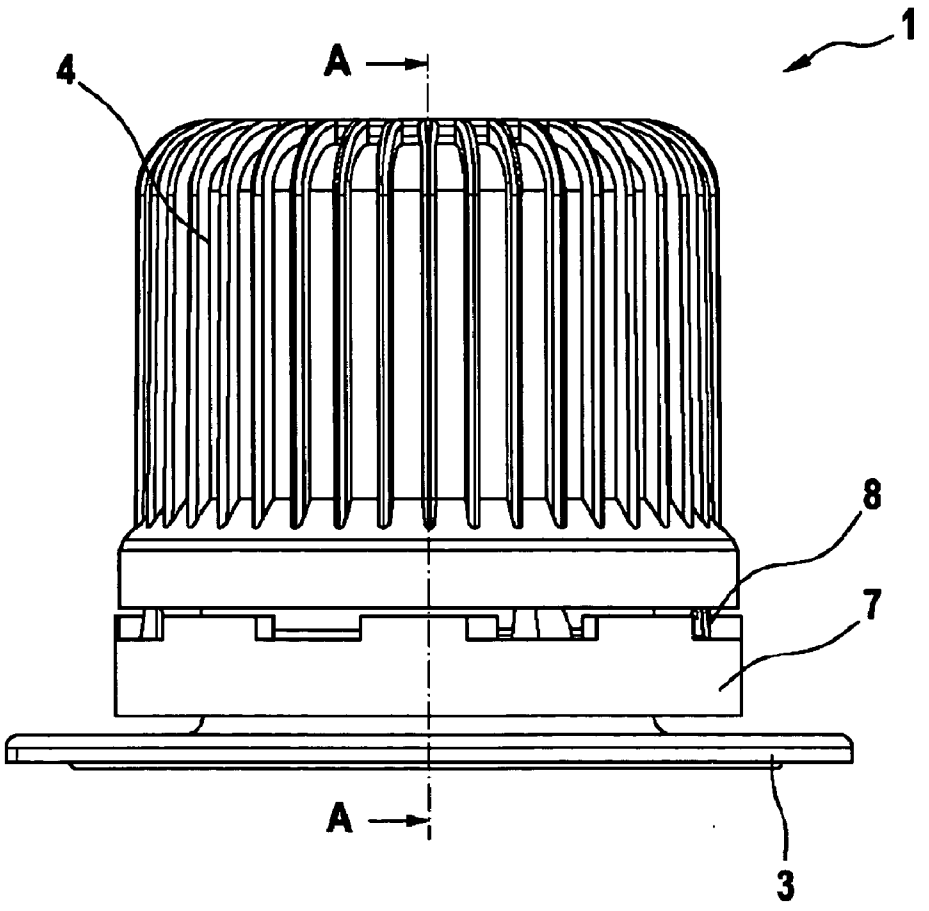


Fig. 2

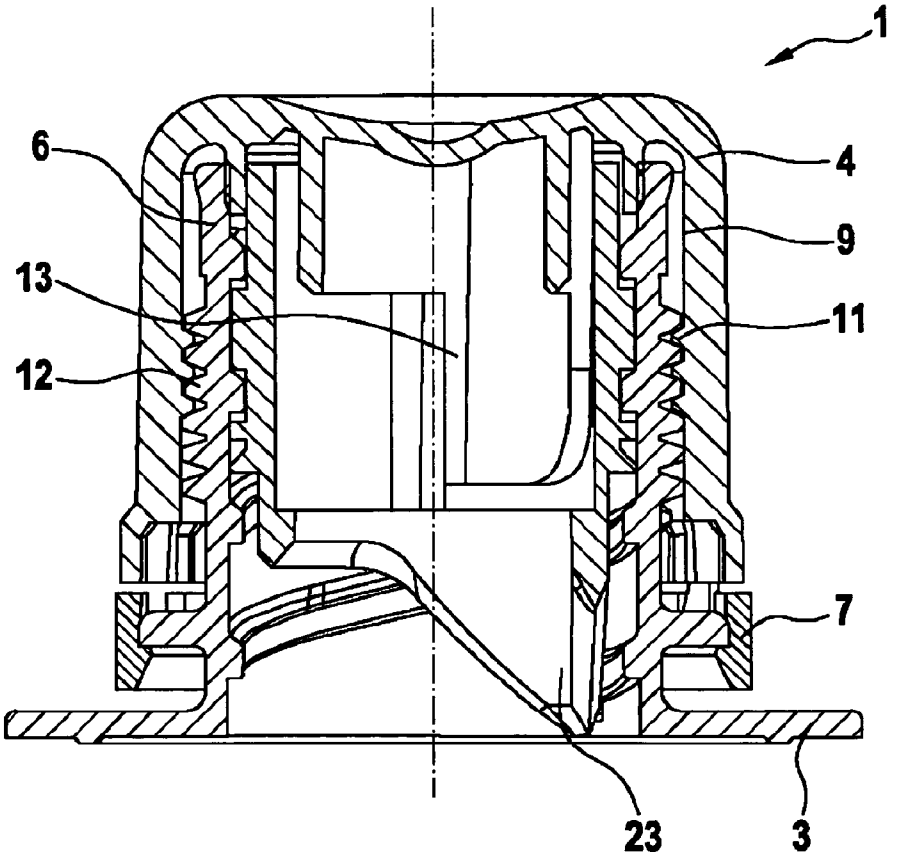


Fig. 3

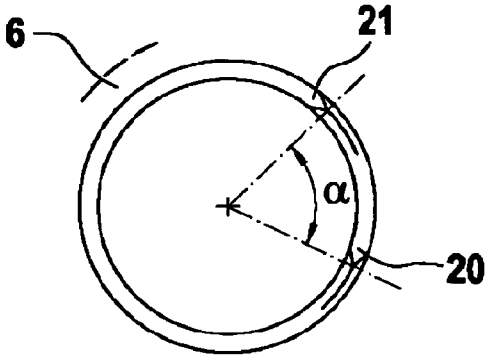


Fig. 4

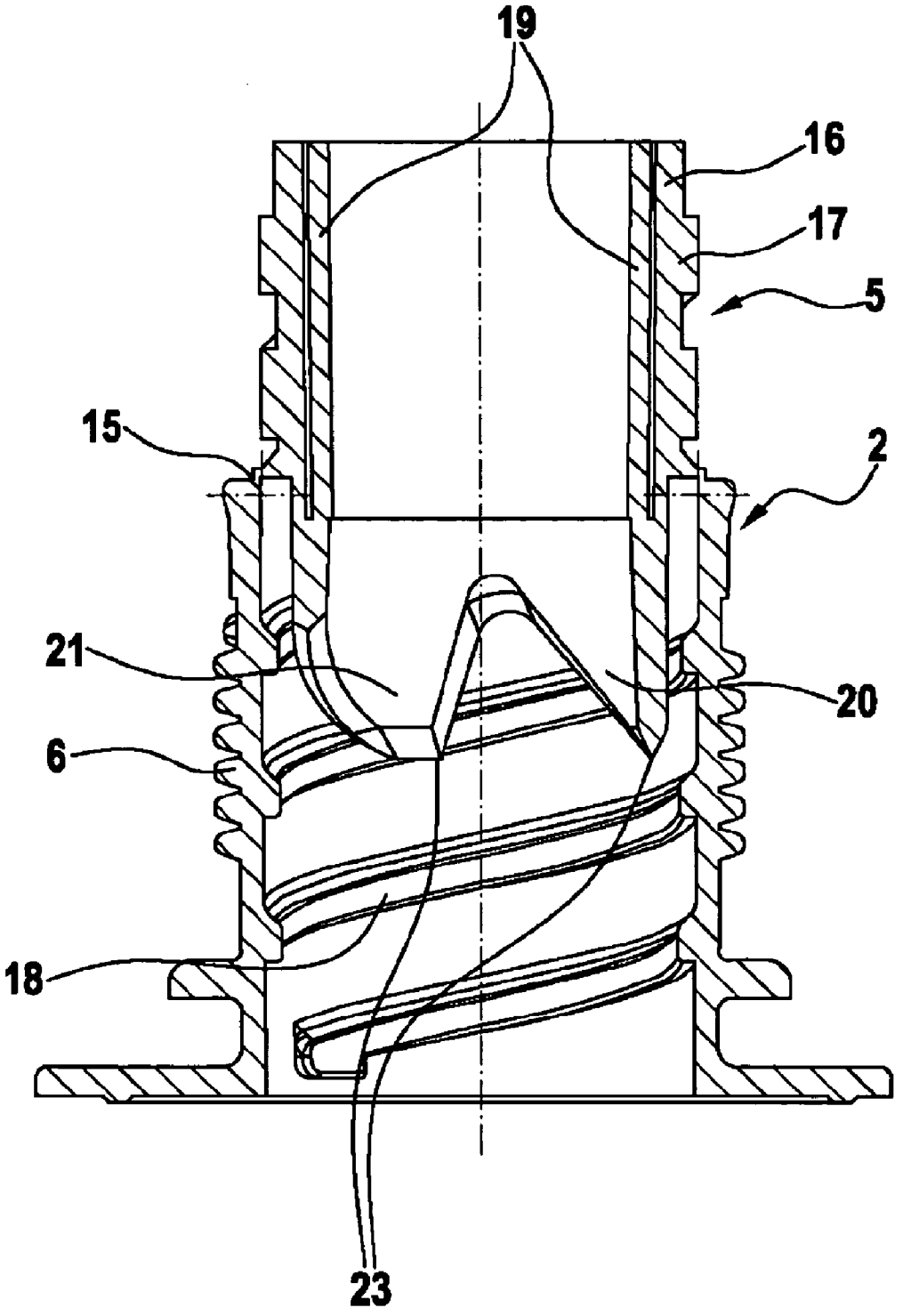


Fig. 5

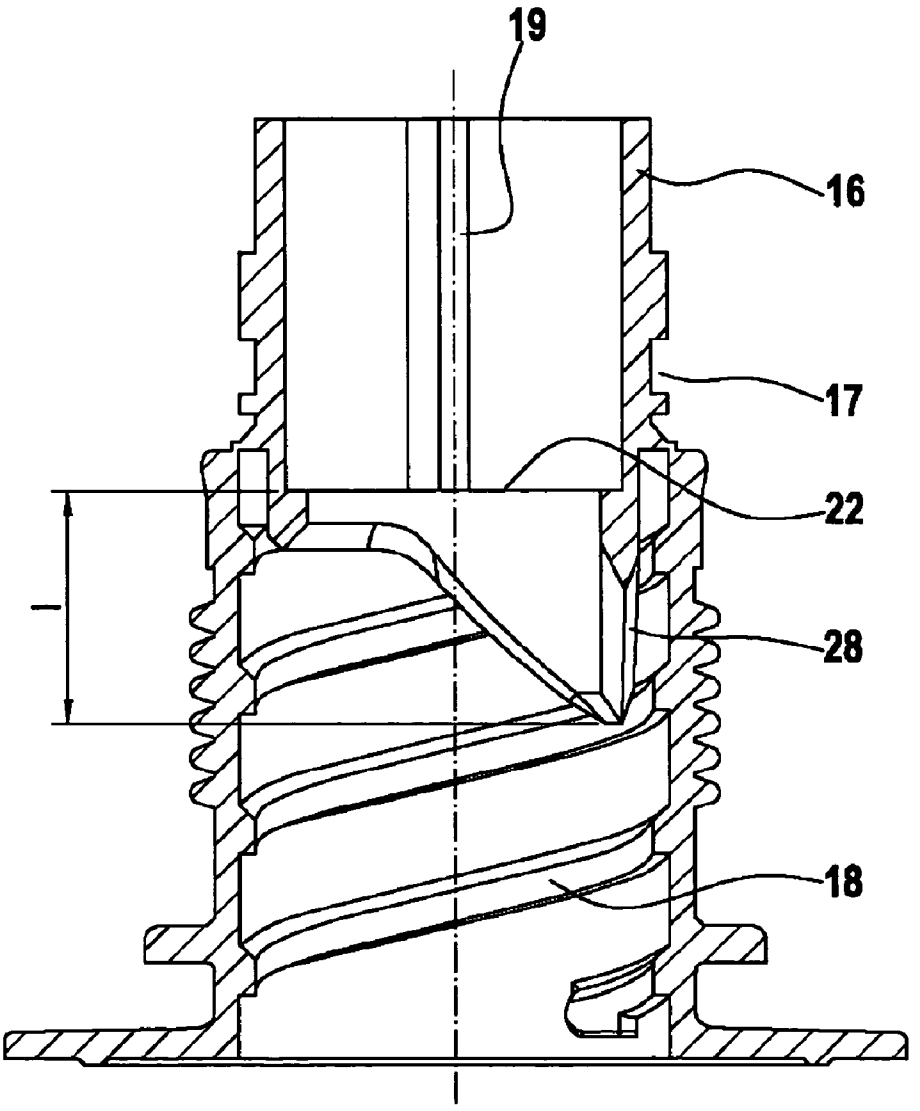


Fig. 6a

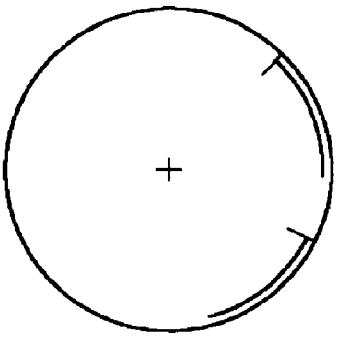


Fig. 6b

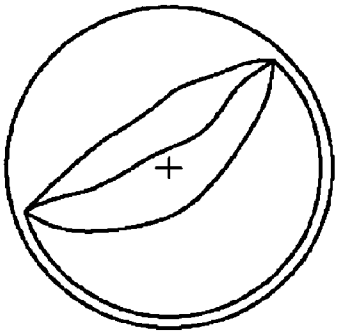


Fig. 6c

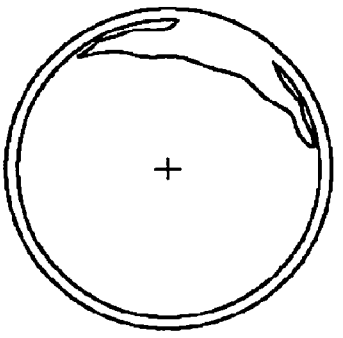


Fig. 7

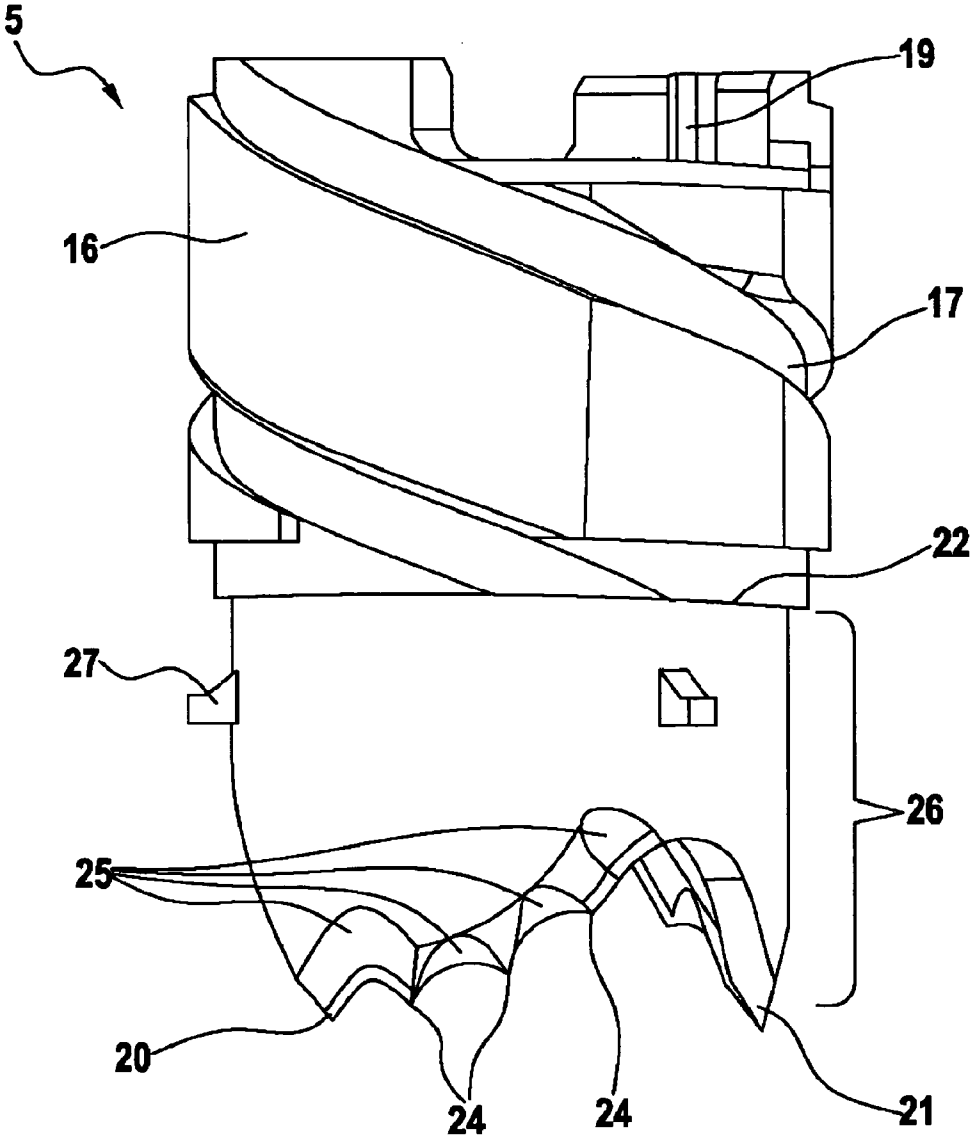
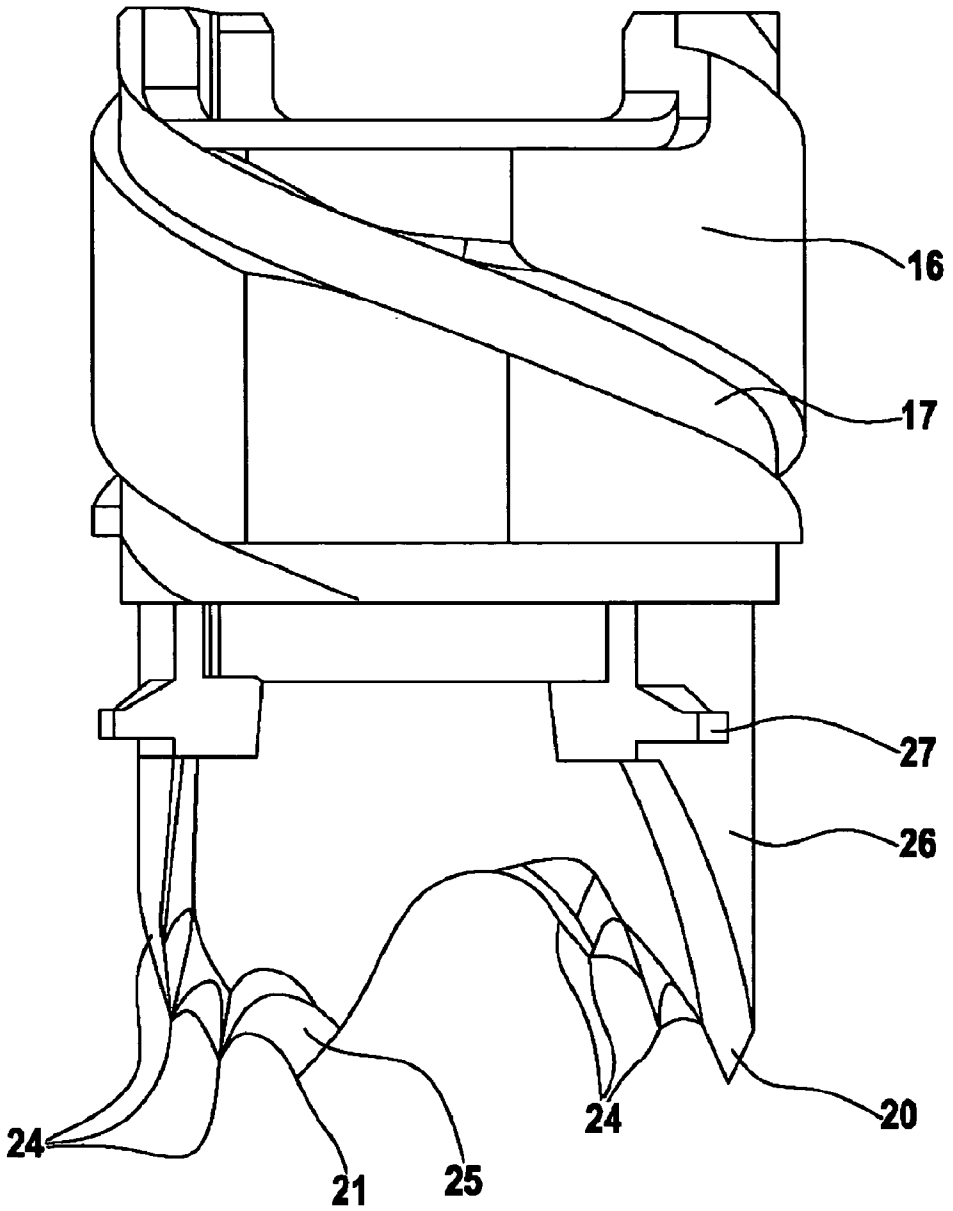


Fig. 8



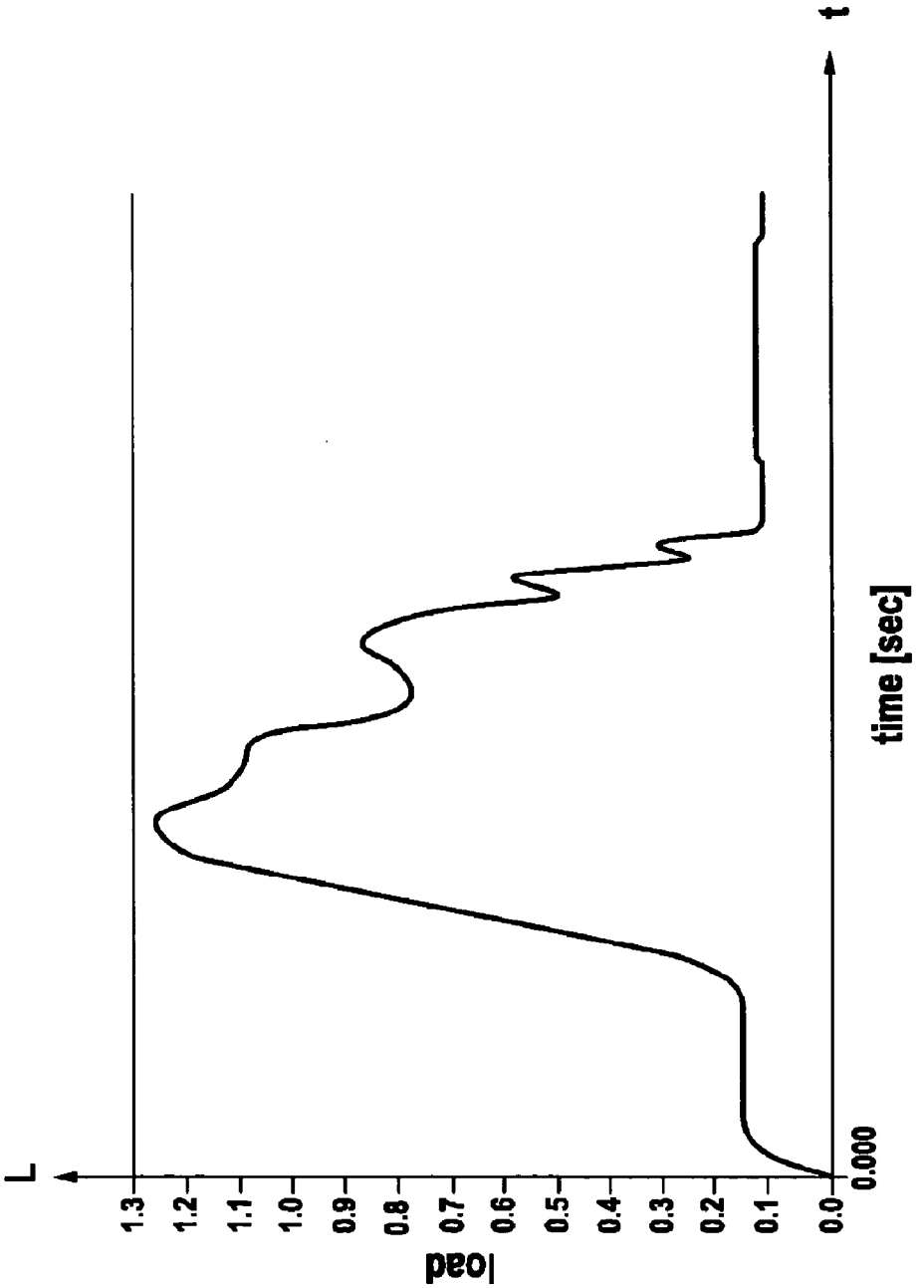


Fig. 9

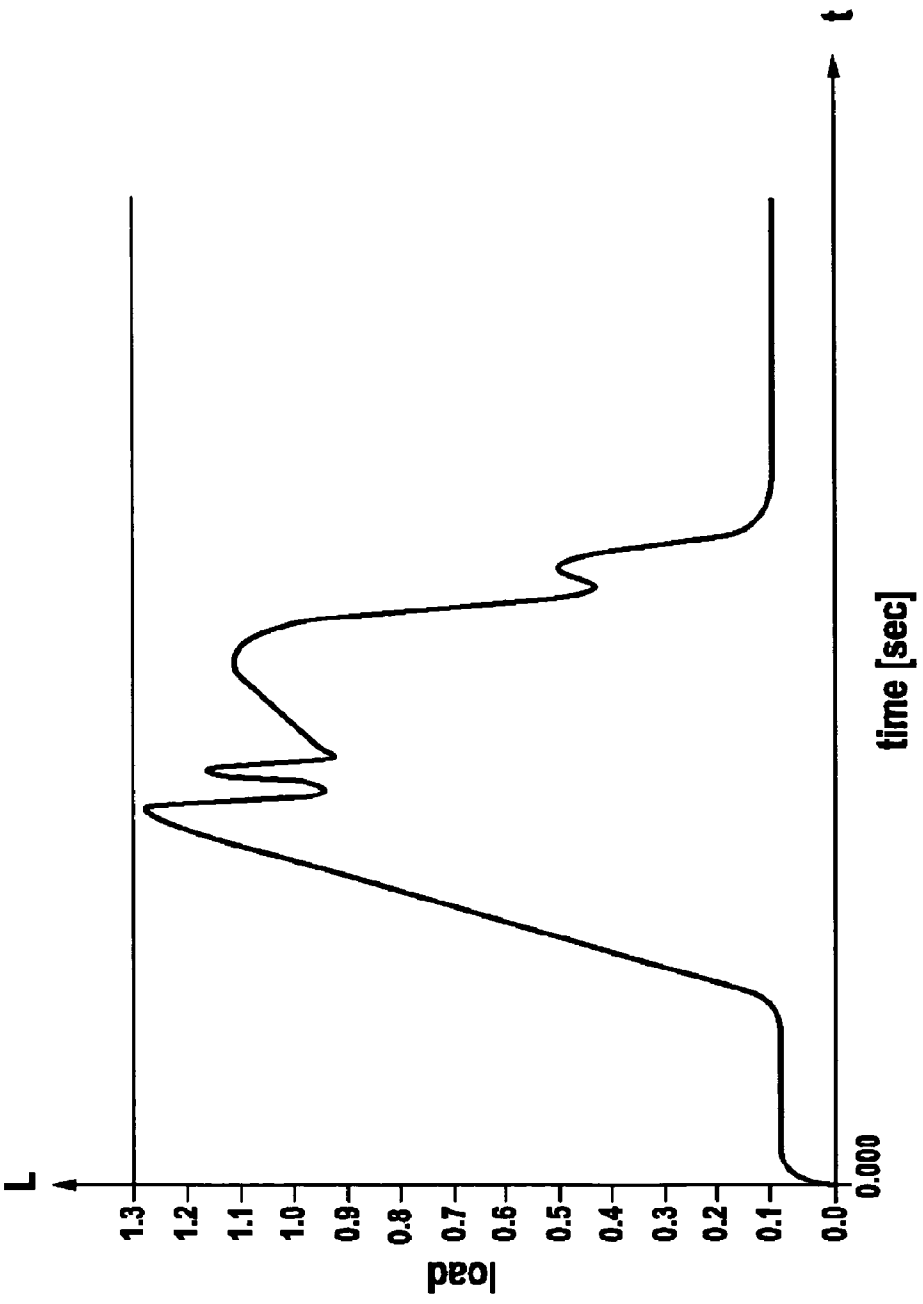


Fig. 10

PLASTIC CLOSURE COMPRISING A CUTTING AND PERFORATING DEVICE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a closing device consisting of a plastic material for applying to a closed container consisting of a plastic film material, wherein said closing device comprises a lower part with a cylindrical outlet and a flange for attaching same to the container and a screw cap which is screwably fixed to the lower part. Said closing device further comprises a cylindrical perforator having external thread, which is open to both sides in the axial direction and travels in the outlet of the lower part, in the internal thread thereof, wherein means are located in the screw cap, which move the perforator downwards in a helical manner during the initial unscrewing movement of said screw cap and wherein said cylindrical perforator has cutting teeth on the cylindrical wall thereof at the end which is directed towards the container wall.

[0002] Closing devices of the type previously mentioned have to date only been applied to containers produced from laminated film material. These laminated films comprise at least three layers of different types of material. First of all, such a film consists of a cardboard layer, which provides the container with the necessary rigidity, an aluminum layer serving as an aroma barrier and a plastic layer which ensures the required denseness. In order to separate these three layers, the corresponding perforator of the aforementioned closing device must fulfill various functions. A plurality of saw teeth are often recommended for separating the cardboard layer, wherein a raised tooth cuts through the aluminum layer with a forward cutting edge and wherein a perforating tooth breaks through the plastic layer before the aforementioned cutting edge can continue to cut the plastic film. In the case of these containers consisting of laminated film material, the separation of the cardboard material generally represents a problem. Particularly if the partial press cut, which serves as a support and at least separates the cardboard layer to some extent, does not exactly correspond to the cutting line of the perforator, the teeth are then either too weak or in the case of a considerable number of teeth, the cardboard material comes between the teeth and said teeth can thereafter hardly produce a perforating effect.

SUMMARY OF THE INVENTION

[0003] The present invention relates, however, to a closing device, which is applied to a pure plastic film material. Such tubular receptacles, mostly referred to as pouches in the technical language, have not been opened to date by means of the aforementioned closing devices. On the contrary, an opening was already punched out and a closure including the outlet thereof was welded on the pouches so as to be correctly positioned or was shrink-wrapped between two film layers. Because the shelf-life of the filled food material or beverage is thereby solely dependent upon the impermeability of the closure, such closures were virtually used only in unproblematic areas, particularly in the area of cosmetics.

[0004] When using a closing device of the kind mentioned at the beginning of the application, the container pouch remains completely closed until the point of first being opened. An increased shelf-life is thereby provided. In addition, the plastic film in such applications according to the invention is substantially more robust and is designed having a greater wall thickness than the very thin plastic film layer in the case of a laminated film. This in turn gives rise to other demands being placed on the closing device. Initial trials with closing devices from prior art did not produce any reliable results.

[0005] Perforators as, for example, from the American patent publications U.S. Pat. No. 5,020,690 or U.S. Pat. No. 5,141,133 comprise a plurality of teeth. These teeth abutting one another basically form the shape of an annular saw blade. Such solutions have either led to a rondelle being completely cut out of the plastic film and falling into the container or as a result of the toughness of the film to individual teeth being broken off and falling into the container. Because the containers involved here typically relate to containers for beverages, this is totally unacceptable.

[0006] It has been assumed up until now that a plurality of teeth is advantageous because a plurality of perforations thereby arise. It has, however, actually been determined that a plurality of perforations do not provide an advantage per se. It has in fact been shown, that a plurality of teeth automatically leads to these teeth having to be relatively weak. This leads to the disadvantage previously mentioned above.

[0007] Based on this realization, further developments have accordingly been put into place, in which on the one hand the number of teeth was reduced and on the other hand the shape of the teeth was variably configured. A solution is therefore known, for example, from the European patent publication EP-A-1415926 having equally high teeth, which, however, are distributed over the periphery in a non-uniform manner. In addition, a closing device of the type mentioned at the beginning of the application is known from the American patent publication U.S. Pat. No. 6,279,779 having a perforator which comprises only a single tooth. This tooth is designed in a suitably strong manner and has different surfaces with a different effect. The one-tooth version has definitely not proven its worth. The procedures for severing the film as well as the perforation thereof, the subsequent cutting of the complete material and finally the folding away of the cut-out part have not been able to be optimized in a single element. The applicant therefore conducted trials with a perforator according to the WIPO patent publication WO2007/030965, wherein three teeth are present, which are distributed over the periphery and are minimally offset from a uniform distribution. Even though perforators of this type have proven their worth in many instances, cases frequently occur in which either the film is completely cut out and the corresponding rondelle fell into the receptacle or in other cases the films were cut only at three locations to an approximately equal width and the film remained hanging in an occluding manner over the opening. Based on these realizations, the applicant undertook elaborate trials to find an optimal solution, which reliably implements an opening incision in such a way that a flap-like rondelle, which stays in contact with the receptacle, remains hanging, said rondelle also being pushed out of the open area of the perforator by the teeth.

[0008] A closing device of the kind mentioned at the beginning of the application meets this aim, wherein said device is characterized by having exactly two equally high teeth which are arranged in an angular region of between 70° and 120° of the circumference. This has the effect that the plastic film to be cut open is pre-tightened by the two teeth and that said teeth subsequently begin to perforate and cut the film. After a short distance, the subsequent tooth then extends into the cutting area of the previous tooth and is thereby rendered

inoperative. If the perforation of the film occurs virtually immediately upon first contact, the film still cannot completely be annularly cut out and consequently a plastic film rondelle does not fall into the container. If the perforation and the following incision occur relatively late, a sufficiently long incision is still produced, which ensures that the section of the subsequent tooth runs into the area of the section of the previous tooth and as a result a section is still achieved, which extends more than 180°; thus enabling the film to be cut open sufficiently wide to achieve a sufficient flow rate.

[0009] As previously mentioned, the closing device according to the invention is applied to a container consisting of a pure plastic film material. This one or multiple layer plastic film is substantially thicker than the plastic film which is used as an impermeability layer in the composite film consisting of diverse materials.

[0010] Whereas in the case of the thin film, wherein the perforation must foremost be done to ensure a reliable opening on account of the high elasticity of said film, this appears to no longer play a central role in the case of the film now being used. Experiments observed at a strong magnification have shown that apparently the film is slit open while forming swarf.

[0011] In light of this evidence, it is therefore an additional aim of the present invention to equip the teeth with swarf control means as in the case of a steel processing cutting plate. In solutions from prior art, this swarf has actually accumulated on the tooth tip and the torque output applied by means of said prior art was thus substantially higher than is the case with the now present solution.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A preferred exemplary embodiment of the subject matter of the invention is depicted in the drawings and subsequently described. In the drawings:

[0013] FIG. **1** shows the closed plastic closure prior to initial use in a side view and

[0014] FIG. **2** shows the same in a diametral vertical section

[0015] FIG. **3** shows in a simplified depiction the perforator from below with a view of the edge having the two cutting teeth

[0016] FIG. **4** shows the perforator and the lower part with a flange as a one-piece subassembly prior to assembly, again in a diametral vertical section and

[0017] FIG. **5** the same view rotated 180°.

[0018] FIG. **6***a*-**6***c* show various sectional views.

[0019] FIG. **7** shows a perforator suitable for harder plastic films comprising two teeth which are offset at an angle and have different cutting characteristics and

[0020] FIG. **8** shows the same perforator rotated 120°.

[0021] FIG. **9** shows a load-time diagram for the perforator according to the FIGS. **7** and **8**, whereas

[0022] FIG. **10** shows such a load-time diagram for the perforator having the tooth configuration according to the FIGS. **4** and **5**.

DETAILED DESCRIPTION

[0023] The plastic closing device is denoted in its entirety with the numeral **1**. Said device comprises three components, of which two can be produced as one piece resulting from the manufacturing processes thereof, as is subsequently described in FIGS. **4** and **5**. Said plastic closing device **1** comprises a screw cap **4**, on the lower edge of which a tamper evidence band **7** is molded via predetermined breaking point bridges so as to align with the jacket wall of the screw cap. In the side view according to FIG. **1**, only a flange **3**, which is a part of the lower part **2**, of the closing device **1** can be seen.

[0024] In the cross-sectional view according to FIG. **2**, it can be seen that the screw cap **4** has a jacket wall **9** as well as a top surface **10**. Said screw cap **4** has internal screw thread **11** which is designed as fine-pitch-pitch thread. The lower part **2** including the flange **3** thereof, which serves as a welded or glued connection to the container, comprises a cylindrical outlet **6**, which is tubular and open to both sides. This outlet **6** has external thread **12** which is also designed as fine-pitch thread and meshes with the internal thread **11** of said screw cap **4** when said screw cap **4** is screwed on and off. The fine-pitch thread **11**, **12** is preferably designed as a double-start thread. The fine-pitch thread has the advantage of easy assembly due to the internal thread of the said screw cap being able to be pushed over the external thread **12** of the outlet **6** in a ratchet-like manner. This allows for assembly without a relative rotation of the parts with respect to one another. Two driving elements **13** diametrically opposed to one another are located in said screw cap **4**, wherein said driving elements are integrally formed with the bottom side of the top surface **10** of said screw cap **4**. Said driving elements **13** act together with the driving element **14** in the perforator **5**. Said perforator **5** is subsequently described in detail with the aid of FIGS. **4** and **5**.

[0025] As previously described, the perforator **5** and the lower part **2** are manufactured as one piece, just as is depicted in FIG. **4**. In this case, said lower part **2** and said perforator **5** together form a subassembly, which can be manufactured using a single injection mold. During assembly, said lower part **2** and said perforator **5** can simply be pushed together. In so doing, said perforator **5** comes to rest completely within the cylindrical outlet **6**. In this position, said perforator **5** is integrally formed as a subassembly on the upper edge of the outlet **6** via predetermined breaking points. Said perforator **5** consists of a cylindrical pipe section **16**, which has course thread **17** on the outside. Said course thread **17** having a large pitch meshes with a correspondingly adapted trapezoidal thread **18** on the inside of the outlet **6**. Said perforator **5** additionally comprises two entraining ribs **19** which are diametrically opposed to one another and on which the aforementioned driving elements **13** of the screw cap **4** make contact during the respective screwing movement. Two cutting teeth are integrally formed on the lower edge of said perforator **5**. Both of said teeth can be seen in FIG. **2**, whereas in FIG. **5** only the subsequent tooth can be seen while the leading tooth has been cut away. Said leading tooth is denoted with the reference numeral **20** and said subsequent tooth with the reference numeral **21**. Both teeth **20**, **21** have the same length l. This length designates the vertical distance from the lower edge **22** of the cylindrical pipe section **16** to the tip of the corresponding cutting tooth.

[0026] In the assembled state as is shown in FIG. **2**, the perforator **5** completely lies within the cylindrical outlet **6**. The tip or rather the two tips of the cutting teeth **20**, **21** lies at the height of the lower edge of the flange **3** of the lower part **2**. When the screw cap **4** is unscrewed, said perforator **5** moves axially in the opposite direction, wherein said perforator carries out a substantially larger translational vertical travel per rotation than said screw cap **4** in the opposite direction. Said perforator **5** actually carries out maximally a

rotary motion of around approximately 330°, whereas said screw cap goes through one or several turns until being completely unscrewed.

[0027] Depending upon strength, elasticity and other factors, in particular with regard to the pre-tightening force on the plastic film of the pouch receptacle, the plastic film is sooner or later perforated. Said film is practically always perforated simultaneously by the cutting teeth **20**, **21**. The sectional views as depicted in FIGS. **6***a* to *c* thus arise. In FIG. **6***a*, the partial sections of the subsequent tooth have not yet advanced into the section of the leading (previous) tooth. On the other hand in FIG. **6**B, this has already happened. This figure shows the cutting line obtained in the worst case, which lies in the magnitude of 200 to 240°. Were this the end position, the leading (previous) tooth would basically push the flap-like part L downwards so that also in this case, the passage is open more than 50%. The cutting line normally extends about a partial circle of around 330°. This situation is depicted in FIG. **6***c*.

[0028] In FIG. **3**, the perforator **5** is depicted in a simplified form with a view of the teeth in the direction of the rotational axis of the cylindrical pipe section **16**. If radii are drawn from tooth tips to the center of the longitudinal axis, an angle α is then formed between them. Said angle α must be within an angular range between 70° and 120°. In addition, it is advantageous if the steepness of the external thread of the perforator **5** and the internal thread **18** of the outlet **6** are selected in such a way that during the unscrewing movement of the screw cap **4**, the cutting teeth **20**, **21** travel through a maximum cutting distance of 210° in the cutting direction from the point of contact on the plastic film of the container to be severed up until said unscrewing movement of said screw cap **4** has completely ended. If the maximum angle, which the leading tooth **20** and the subsequent cutting tooth **21** enclose together, namely an angle of 120°, is now added to the 210°, this then results in a maximum cutting line which extends over 330°. A sufficient connection between the plastic film of the container and the aforementioned flap L thereby remains. If the worst case is assumed, that the perforation of the film first occurs after a quarter turn, i.e. after 90°, and the angle between the two cutting teeth amounts to only 70°, said leading tooth still implements a minimum cutting line of 120° while said subsequent tooth **21** travels through the additional 70°; thus enabling a cutting line of over 180° also to be formed in the worst case.

[0029] Because the resulting forces on the cutting teeth are substantially greater in this version than in the case of a plurality of small teeth, it is advantageous for the wall thickness of the cutting teeth **20**, **21** to be selected to be larger than the wall thickness of the cylindrical pipe section **16** of the perforator. This can be seen most clearly in FIG. **5**. This does not appear to be the case in FIG. **4**; however, this is merely due to the fact that the cutting line travels in this instance through the entraining ribs **19**.

[0030] It is known that plastic films can be obtained in many different qualities. Said films differ not only in the selection of the plastic materials used but also in thickness, stiffness, hardness, etc. With regard to the production of pouch receptacles, which are to have a comparable strength to those consisting of multilayered laminates comprising cardboard, such plastic films cannot be reliably opened with the plastic closing devices known to date. The stronger the film being used was, the greater the thickness of the teeth had to be, and in doing so the films could hardly be opened without too high of a torque being required for the operation, which then users could not be expected to produce. The pouch receptacles were in fact entirely manufactured from this relatively thick and hard material, wherein, however, an opening was press cut and sealed with a film section, which was substantially softer and could be cut with the usual plastic closing devices known until that time. The plastic closing device was in turn welded to the film section.

[0031] The trend is to move away from this technology and it has been shown that this is possible if the leading as well as the subsequent tooth is designed in the manner depicted in FIGS. **7** and **8**. Whereas emphasis was especially placed on a perforation of the film when using the teeth from prior art, weight is now placed on the cutting of the film. In the case of the softer plastic films, a much stronger stretching occurs and accordingly it was essential for the two teeth to make contact at approximately the same time and thereby to tighten the film so that a perforation takes place. After that, the film itself could subsequently be cut practically without resistance along the cutting edge of the corresponding teeth. This process is, for example, depicted in the time-load diagram according to FIG. **10**. FIG. **9**, on the other hand, shows the load-time diagram of the perforator according to FIGS. **7** and **8** comprising the new tooth configuration. Both curves cannot be directly compared when considering the fact that a thin, substantially more elastic film is cut in the case depicted in FIG. **10** whereas a thicker film, which is substantially harder but less elastic, has been cut in the diagram according to FIG. **9**.

[0032] It can be seen in FIG. **10** that the torque increases more slowly up until the point in time of the perforation by a first of the two teeth, whereupon the torque immediately drops until the second tooth begins to have an effect and then subsequently falls very sharply.

[0033] In contrast thereto, when severing the thicker film using the perforator comprising the newly designed teeth shapes, the load which has to be applied increases faster until the maximum pressure occurs on the film and the cutting action begins. The load now continuously decreases until the first succeeding tooth begins to have an effect and the additional effect of the further succeeding teeth can then additionally be seen in the region where the drop in load occurs. Despite the substantially harder film, the required force output remains practically the same. This astonishing result is due to the fact that the thicker film hardly ever tears but has accordingly to be cut much more, wherein the cutting characteristics resemble a cutting plate of a lathe tool. It can be microscopically determined that swarf forms at the same time the plastic is cut, and this swarf must be able to be routed into an area away from the teeth in order to prevent said swarf from moving in front of the actual cutting point of the teeth and thereby substantially increasing the torque.

[0034] A preferred exemplary embodiment of these newly configured teeth of a perforator is explained below with the aid of FIGS. **7** and **8**. The perforator in its entirety is denoted with the reference numeral **5**. This too comprises a cylindrical pipe section **16**, on the outside of which a coarse thread **17** is molded. The trapezoidal thread **18** then engages in said coarse thread **17** in the cylindrical outlet **6**. The cylindrical section **16** is equipped on the inside with entraining ribs **19**. In this option, the cylindrical section **16** is reduced in diameter in the lower cutting region **26** by approximately the depth of said coarse thread **17**. Provision is made in turn at the lower edge of this tapered cutting region **26** for a leading cutting tooth **20**

and a subsequent cutting tooth **21**. Whereas in the previously described option of this cutting tooth, a straight, relatively steep cutting surface is present in the leading position in the cutting direction, this leading cutting edge is in this case tiered; and there is a plurality of succeeding teeth **24**, which are tiered at different heights, arranged in a staggered manner. Depending upon the penetration depth, said succeeding teeth **24** are employed one after the other A swarf receiving space **25**, which runs approximately arcuately, is situated between in each case the foremost leading and subsequent cutting tooth **20**, **21** and the cutting tooth **24** disposed in the leading position in the cutting direction. Such a swarf receiving space **25** is also in each case situated between two succeeding teeth **24** arranged adjacently in each case. This can be seen most clearly in FIG. **7**.

[0035] In contrast to the solution first shown, wherein the teeth perform practically only a perforating action by means of a perforating tip **23** and thereafter the leading cutting edge **28** comes into operation, the two main teeth, namely the leading cutting tooth **20** and the subsequent cutting tooth **21**, as well as the staggered succeeding teeth **24** all work in this case the same and have altogether a swarf-removing cutting effect. After the leading tooth and the subsequent tooth **20**, **21** have come through the film, a succeeding tooth **24** must therefore take on their function. Said succeeding teeth are therefore disposed according to height in a descending step-like succession on account of the perforator **5** penetrating ever deeper into the container to be cut open during the screwing action. Said succeeding teeth also operate in a swarf-removing manner and thus said succeeding teeth are also equipped in each case with a respective swarf receiving space **25**. It is appropriate for the swarf receiving spaces **25** which operate first to be larger that the swarf receiving spaces that subsequently become operative.

1. A closing device (**1**) made of a plastic material for applying to a closed container made of a plastic film material, wherein said closing device comprises a lower part (**2**) having a cylindrical outlet (**6**) and a flange (**3**) for attaching to the container and a screw cap (**4**) which is screwably fixed to the lower part (**2**) as well as a cylindrical perforator (**5**) having an external thread, which is open on both sides in an axial direction and travels in an internal thread in the outlet (**6**) of said lower part (**2**), wherein means (**44**) are located in the screw cap (**4**) which during initial unscrewing movement of said screw cap (**4**) move the perforator (**5**) downwards in a helical manner and wherein said cylindrical perforator (**5**) has cutting teeth on a cylindrical wall thereof at the end which when mounted is directed towards the container wall, characterized in that said perforator has exactly two cutting teeth of the same height, both of which are arranged in an angular region of between 70° and 120° of a circumference.

2. The closing device according to claim **1**, characterized in that a wall thickness of the two cutting teeth is thicker than a wall thickness of a cylindrical jacket wall of the perforator.

3. The closing device according to claim **1**, characterized in that a steepness of the external thread (**12**) of the perforator (**5**) and the internal thread (**18**) of the outlet (**6**) is selected in such a way that during the unscrewing movement of the screw cap (**4**), a tooth moving in a cutting direction travels through a maximum cutting distance of 210° from a point of contact on the plastic film of the container up to a point where the unscrewing movement of said screw cap has completely ended.

4. The closing device according to claim **1**, characterized in that the external thread of the outlet is a double-start fine-pitch thread.

5. The closing device according to claim **1**, characterized in that the external thread of the perforator and the internal thread of the outlet have a trapezoidal thread profile.

6. The closing device according to claim **1**, characterized in that at least one of the two cutting teeth (**20**, **21**) has a number of staggered succeeding teeth (**24**), which are arranged at different heights in a descending step-like succession, so that depending upon a penetration depth of the perforator into the film to be cut, one succeeding tooth after the other is operative and wherein a swarf receiving space (**25**) is located in each case between the respective foremost cutting tooth (**20**, **21**) and the next operative succeeding tooth as well as between two adjacent succeeding teeth.

7. The closing device according to claim **6**, characterized in that the swarf receiving spaces (**25**), which are operative at first, are larger than the swarf receiving spaces which are subsequently operative.

* * * * *