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(54) Benevnelse **METHOD AND DEVICE FOR CLEANING AN EXTRUSION HEAD**

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# Method and device for cleaning an extrusion head

The present invention relates to a method and a device for cleaning off extrusion heads in the extrusion of thermoplastics which are ejected (extruded) from an annular extrusion nozzle.

Problem:
In the processing of thermoplastics such as polyolefins – predominantly in the case of medium and high molecular weight polyethylene types such as, for example, HDPE, for example by extrusion blow moulding, in particular with continuous extrusion with continuous tube discharge, but also with discontinuous tube ejection (accumulator heads), the following disadvantageous effect occurs:
When molten plastics material is ejected, it is under high pressure within the extrusion device (e.g. extrusion head). After discharge from the extrusion nozzle, the plastics material relaxes to atmospheric pressure and thereby swells. In this discharge operation, gel-like products (lubricants, additives) separate over time from the hot plastics extrudate, in particular in the case of continuous extrusion, and are deposited as troublesome material cakings in the vicinity of the nozzle mouth, mainly internally on the core but also on the external portion of the nozzle mouth. With annular ejection nozzles, there is the problem that these deposits on the internal core also cannot be seen. The deposits (separated materials) originate from low molecular weight constituents of the polymer melt (e.g. short polymer chains, additives, wax-like constituents) which, owing to the sudden pressure drop and the drop in the wall shear stresses, are deposited at the outlet edges of the nozzle channel as the melt leaves the nozzle.

The gel-like products are subject to constant high temperature effects and are transformed into resin and carbonize within a relatively short time. These constantly growing deposits become brittle and break or flake off in an uncontrolled manner. Such crumbs or fragments, which can be several centimetres long, fall into the extruded tube and lead to defective finished products (e.g. in the production of drums, leaky bottom weld seams can be obtained if such porous carbonized particles enter the weld seam region.

For example, the particles may adhere/stick only loosely to the inside wall of the blown finished product (e.g. a tight-head drum) and break off and fall when the hollow body is being filled with the actual contents, and may thus fall into the contents and contaminate them.

The deposits (gel-like products, cakings) initially have a consistency of low viscosity. However, owing to the high temperatures of the nozzle and core and under the influence of oxygen from the ambient air, the deposits oxidize over time and the viscosity increases until, ultimately, first solid regions form by carbonization.

These external deposits on the outlet nozzle grow uncontrollably. In particular in blow-moulding technology, in which a tubular parison is ejected from an annular nozzle, the inner core region of the outlet nozzle is not visible, in particular in the case of continuous melt discharge.

The deposits are from time to time, when they have grown too much and have become brittle, carried along by the inside of the passing melt tube and adhere to the inside surface of the product that is to be manufactured, for example a plastics tight-head drum. This disadvantageously leads to contamination of the contents after the drum has been filled.

When the deposits later become detached from the inside wall of a drum body, this can lead to blockages of or damage to feed pumps and can considerably impair processes of further processing of the contents. If such carbonized particles are in the region of the weld seam of a blow-moulded container, this leads to a very disadvantageous and unacceptable weakening of the container.

Furthermore, such deposits can lead to the formation of longitudinal striations and accordingly to visual and/or technical impairment of the extruded and subsequently blow-moulded product.

This phenomenon is also referred to as "die built-up", in which the deposits of thermally damaged polymers at the nozzle exit lead to undesirable surface irregularities. In the case of commercially available plastics materials, it is generally individual additives (such as stabilizers or flow aids) for influencing wall-slip effects that lead to or cause the adhering deposits.

Prior art:

This problem is also known, for example, from the field of the extrusion blow moulding of films, where deposits are stripped off by means of mechanical cleaning devices such as scrapers and transported into the waste region which is produced in film blowing at each change of the winding spindles.

However, in the case of this hitherto conventional cleaning of the extrusion tools, the extrusion process must be stopped in order that the mostly manual mechanical cleaning of the nozzle core can be carried out directly beneath the outlet edge of the melt.

Stopping the extrusion process results on the one hand in a loss of production caused by the stoppage; on the other hand, the installation must subsequently be started up again and brought into a stable operating state, generally by an experienced process engineer.

There is known from JP08332668 A an annular extrusion nozzle for discontinuous extrusion which can be adjusted very precisely in terms of the vertical position of the outer nozzle ring to the inner nozzle core. The aim here is, when the nozzle is closed at the end of each tube ejection, to position the lower ends of the nozzle and the core exactly on a common plane relative to one another so that there are in particular no protruding edges and contours directly beneath and next to the lower ring channel end on which material may be deposited during the tube ejection operation or when opening/closing the nozzle tool. This nozzle design is used in combination with a storage head for discontinuous extrusion. In such extrusion heads, the entire nozzle region can be cleaned internally and externally in a simple manner by external cleaning devices (brushes, scrapers or the like) during the filling phase when the nozzle gap is closed.

Such nozzle designs cannot be used in the case of continuous tube extrusion since the nozzle tool is never completely closed, in order to avoid a pronounced rise in the melt pressure in the region of the extruder and tube head, which can easily lead to disruptions in operation or damage in the extrusion head and plastics material lines.

JP05092467 A discloses a longitudinal slit nozzle for the production of plastics films or sheets, in which deposits are removed by means of a pair of adjustable scrapers which are guided along the nozzle tool along the linear nozzle outlet opening. The two scrapers thereby remove deposits by scraping with direct mechanical contact with the nozzle tool (metal on metal). On engagement of the scrapers, either the extrusion operation must be stopped or the production of a larger amount of rejects is accepted.

There is known from JP 2003305761 A a method according to which, by means of a complex device, rubber-like cakings or deposits which form at the outlet nozzle of an extruded plastics strand are to be detached and removed by blown compressed gas or compressed air, so that the plastics strand remains free of adhering contaminants. Apart from the particular compressed gas system construction, the constant blowing of the compressed gas constitutes a cost-intensive operation of the plastics extrusion device. However, it cannot thereby be ensured that the cakings or particulate deposits that are blown off do not nevertheless adhere to the extruded plastics strand and contaminate it. In addition, in this known extrusion method, a solid plastics strand is extruded from a circular outlet nozzle, in which cakings or deposits that form are readily visible from outside. The outlet nozzle is here freely accessible from outside and the adhering deposits are comparatively easy to remove.

Finally, US 2008/099940 A1 discloses a method and a device in which, for cleaning an extruder mouthpiece, a thin metal wire is guided transversely over the outlet surface of the mouthpiece having one or more extrusion openings, in such a manner that the wire is located sufficiently close to or directly on the surface of the outlet surface, in order to remove from the outlet surface troublesome extrudate drops adhering to the outlet surface. Different types of plastics material can be ejected in the horizontal or vertical direction in rod- or thread-like form from the one or plurality of extrusion openings, which are located directly behind an extruder, following which they are cut at least into pellets and processed further in the form of small particles. In this known cleaning method, the extrusion openings can be cleaned off by means of the thin metal wire during the operation of extruding the

plastics strands, but the extrudate drops that are cut off or scraped off cannot be caught and conveyed away in a controlled manner. Unwanted caking of the scraped-off extrudate drops on the extruded plastics material cannot be ruled out or prevented.

Object of the invention:

The object of the present invention is to overcome the disadvantages of the prior art and to provide a method and a device for cleaning the outlet region of extrusion tools – in particular of annular nozzles with a core - which operate during the ongoing operation of continuous extrusion without interrupting the production process. The material deposits are thereby purposively to be conveyed away and discharged from the production process.

This object is achieved in terms of the method with the features according to the invention of Patent Claim 1 in a characterizing manner in that the tubular parison is briefly deflected and compressed by means of at least two mechanical engagement means in the form of partially circular strip-like pressure-exerting elements, wherein the engagement means move in the radial direction close beneath the outlet nozzle without touching the outlet nozzle, or with no direct contact therewith, wherein the deposits adhering to the outside in the vicinity of the outlet gap of the annular extrusion nozzle are wiped off and transported away by the tubular parison during ongoing operation with continuous extrusion, and wherein the tubular parison itself acts as a cleaning element while it is being deflected. The key feature of the invention is that the tubular parison is itself used as a cleaning element while it is being deflected.

In this manner, which is simple *per se*, cakings which have formed in the course of the extrusion process and been deposited in the vicinity of the outlet nozzle can be detached and removed during the ongoing operation of continuous extrusion without interrupting the production process.

In an embodiment of the invention, it is provided that the deflection of the tubular parison for cleaning off the extrusion nozzle is performed at predeterminable time intervals. Advantageously, the deflection of the tubular parison for cleaning off the extrusion nozzle is performed precisely when the tubular piece is ejected from the

extrusion nozzle, which tubular piece is then detached, in the form of a waste slug piece, from the definitively blow-moulded hollow body.

In order purposively to be able to convey the material deposit away and discharge it from the production process, those tubular pieces to which the cleaned-off residues are attached are separated from the rest of the production process following deflection of the tubular parison.

In a preferred embodiment of the invention, the tubular parison is deflected by means of partially circular pressure-exerting elements which surround the parison externally, over more or less 360°, directly beneath the outlet nozzle and deflect it inwards.

In order to achieve the underlying object, the device according to the invention for cleaning off extrusion heads in the extrusion of thermoplastics which are ejected from an extrusion nozzle is distinguished in that mechanical engagement means are provided directly beneath the extrusion nozzle and are equipped with a corresponding drive such that the engagement means can be brought into operative contact with the extruded tubular parison.
The mechanical engagement means comprise at least two circle-segment elements which can be adjusted, that is to say moved, in the radial direction by actuators and then, in the moved-in position, form a for the most part closed circular ring. The actuators can be actuated in very different ways and can be provided for that purpose with a, for example, electropneumatic, electrohydraulic or electric drive.

Functioning:
The closed circle-segment elements forming a circular ring compress the emerging melt tube radially for an adjustable time. The compressed melt tube flows inwards over the edge of the core for the adjusted period of time and thus purposively carries with it the material deposited in that region. The time at which the circle segments are moved in and the holding time in the moved-in state are freely selectable and adjustable.

The cleaning times are preferably so adjusted that the annular deposits which are detached as a whole all round are located in the slug region of the container that is subsequently produced.

The emerging melt tube itself is thereby used as a cleaning medium. There is no mechanical contact between the engagement means, the actuators or the circle segments and the nozzle tool.

As a result, the internal nozzle core is cleaned gently without direct engagement of scratching, scraping or cutting mechanical aids. As a result of the particular type of nozzle cleaning, damage to the precisely manufactured flow channel geometries in the nozzle region is ruled out.

The circle-segment elements move beneath the extrusion nozzle without touching it. Advantageously, the engagement means are designed such that they can be adjusted in the height and/or depth direction (radial direction) in order to be able to be adapted to the emerging tube.

During nozzle cleaning, the brief compression of the tube against the nozzle core due to the continuous melt discharge at the same time results in swelling of the tube in the circumferential direction (outwards) between the nozzle outlet edge and the moved-in circle segments. The melt tube which also swells outwards thereby also carries with it the annular deposits adhering to the external nozzle outlet edge.

In terms of the process, the cleaning cycle (e.g. every 2 hours, every x cycles) with cleaning repeats (1x or multiple times in succession) is freely adjustable, depending on the tendency of the raw material to be processed to form deposits and the growth of the cakings. Contaminated tube portions or contaminated slug waste are very purposively separated and discharged. Contamination of the raw material circuit (regranulate) with material containing carbonization deposits is thereby prevented. If slug regions are too short for complete cleaning off (e.g. if the tube outlet speed is too high), it is possible, for example, for the following article also to be discharged and disposed of (only one reject).

The method according to the invention and the device designed therefor can advantageously in principle be retrofitted to all extrusion blow moulding machines

with continuous melt discharge. In principle, the method and the corresponding device can naturally also be retrofitted to accumulator head machines with discontinuous melt discharge.

The method and the particular device are versatile in use and can be combined with a wide variety of extrusion head designs, for example with a fixed nozzle/core design (without axial wall thickness adjustment), with a conventional nozzle/core design (only axial wall thickness control) or with fully adjustable wall thicknesses of the extruded tubular parison with a nozzle and/or core with statically and/or dynamically flexibly adjustable diameter geometries (axial and radial wall thickness adjustment = PWDS).

The invention will be explained and described in greater detail hereinbelow with reference to exemplary embodiments shown schematically in the drawings, in which:

Figure 1 is a cross-sectional view of an extrusion head according to the invention with a detail drawing in the operative position "open",

Figure 2 is a cross-sectional view of an extrusion head according to the invention with a detail drawing in the operative position "closed",

Figure 3 is a plan view from beneath of an extrusion head according to the invention with two circle-segment engagement means in the operative position "open",

Figure 4 is a plan view from beneath of an extrusion head according to the invention with two circle-segment engagement means in the operative position "closed",

Figure 5 is a plan view from beneath of an extrusion head according to the invention with four circle-segment engagement means in the operative position "open",

Figure 6 is a plan view from beneath of an extrusion head according to the invention with four circle-segment engagement means in the operative position "closed",

Figure 7 is a side view of a blow-moulded tight-head drum with two slug pieces.

In Figure 1, an extrusion head according to the invention is designated with the reference numeral 10, in which extrusion head a tubular parison 12 of heated thermoplastic is ejected from an outlet nozzle 14. The outlet nozzle 14 is defined externally by a housing ring 16 and internally by a core 18. The core 18 is designed such that it can be axially adjusted in order to be able to change or adjust the wall thickness of the ejected parison 12 of molten plastics material (e.g. HD-PE) during the extrusion operation, as required by the hollow body to be blown.

In the vicinity of the outlet nozzle 14, annular cakings 20 form in the course of the extrusion process on the outer edge of the internal core 18 and also on the inner edge of the external outer ring 16 on the housing side, which cakings – when they have become too large – from time to time fall off in an uncontrolled manner and then disadvantageously render the particular finished product unusable.

In order to gain control of this disadvantageous effect and allow the operation of removing the cakings 20 to take place in a controlled manner, the extrusion head 10 according to the invention is provided with two or more engagement means 22 which are each actuatable by an actuator 24.

The engagement means are configured as a tong-like, strip-shaped pressure-exerting tool which is arranged directly beneath the outlet nozzle of an extrusion head and equipped with a displacement drive, such that it can be pivoted in during the normal run of the ejected plastics tube. The pressure-exerting tool for an annular extrusion nozzle consists of at least two or more tong-like, partially circular pressure-exerting elements which surround the ejected plastics tube externally and are able to move substantially transversely to the ejection direction of the plastics tube. The pressure-exerting elements or engagement means 22 are fastened with actuator 24 close beneath the outlet nozzle 14 to the outer ring 16 of the outlet nozzle on the housing side or directly to the housing of the extrusion head 10.

In the enlarged encircled detail, the annular cakings 20 adhering to the outer edge of the internal core 18 is clearly visible. The engagement means 22 are here in the "open" position and the tubular parison 12 flows closely past the annular cakings 20.

By comparison, in Figure 2 the engagement means 22 have each been moved *via* their actuator 24 into the "closed" position and brought into operative engagement

with the ejected tubular parison 12. It will thereby be seen that the tubular parison 12 is briefly deflected inwards and wipes off the annular caking 20 adhering to the outer edge of the internal core 18, so that the caking then adheres (sticks) to the tubular parison 12 internally and is transported away. At the same time, however, the tubular parison 12 is briefly compressed and pushed outwards above the engagement means 22, so that annular cakings adhering there – on the inner edge of the external outer ring 16 on the housing side – are likewise pushed off, wiped off and stuck to the outside of the tubular parison 12 and are transported away. The tubular parison 12 itself is thus used as a cleaning element while it is being deflected.

In Figure 3, the extrusion head 10 according to the invention is shown in a plan view from beneath, wherein the two engagement means 22 with their respective actuator 24 are visible in the "open" position. In this embodiment variant, the two engagement means 22 consist of two movably suspended 90° circle-segment elements 26, which are still significantly spaced apart from the tubular parison 12. In contrast, in Figure 4, the engagement means 22 have again each been moved by means of actuator 24 into the "closed" position and the four circle-segment elements 26 have been brought into operative engagement with the ejected tubular parison 12. The tubular parison 12 is thereby deflected inwards and pressed onto the annular caking 20, so that the annular cakings then adhere or are stuck to the tubular parison 12 internally and are subsequently transported away in a controlled manner.

Another embodiment of an extrusion head 10 according to the invention is shown – likewise in a plan view from beneath – in Figure 5, wherein the two engagement means 22 with their respective actuators 24 have been placed out of operation in the "open" position. Each of the four 90° circle-segment elements 26 is here equipped with its own actuator 24. In Figure 6, the engagement means 22 have been moved into the "closed" position again and the four circle-segment elements 26 are in operative engagement with the parison 12. The tubular parison is thereby completely surrounded externally, wherein the four 90° circle-segment elements 26 in the moved-in position form a for the most part closed circular ring. According

to the invention, the ejected plastics tube is thereby used as a "cleaning means". During the ejection process, the tube is briefly pushed and displaced to the side by means of corresponding engagement means, or engagement device, so that the cakings are "wiped off" and "stick" to the plastics tube. The actuators 24 can be provided with an electropneumatic, electrohydraulic or electric drive.

The engagement means are advantageously designed such that they can be adjusted in the height or/and depth direction (= radial direction), in order to be able to be adapted to the particular circumstances of the emerging tube and the intended deflection with corresponding compression.

Figure 7 shows as an example of a blow-moulded product a plastics tight-head drum 28 which has just been removed from the blow mould, wherein the squeezed-off waste pieces, the so-called slug pieces 30, are still hanging from the upper and lower drum edge.
According to the procedure according to the invention, the cakings 20 have been moved from the outlet nozzle precisely into those regions of the waste pieces, so that there is generally no reject due to these incorporated carbonization residues.

This invention imparts the technical teaching of how the outlet region of extrusion tools can automatically be cleaned comparatively simply and cost-effectively in terms of the method and device during the ongoing operation of continuous extrusion, without interrupting the production process. The material deposits that contaminate the product are thereby purposively conveyed away and discharged from the production process.

**List of reference numerals**

| | |
|---|---|
| 10 | extrusion head |
| 12 | tubular parison |
| 14 | outlet nozzle |
| 16 | housing ring 16 |
| 18 | core |
| 20 | cakings |
| 22 | engagement means |
| 24 | actuator |
| 26 | circle-segment elements |
| 28 | plastics tight-head drum |
| 30 | slug pieces |

**Patentkrav**

1. Fremgangsmåte for rengjøring av ekstruderingshoder (10) ved ekstrudering av termoplastiske kunststoffer som blir kastet ut eller ekstrudert fra en utløpsdyse (14), som en rørformet formet del (12),
karakterisert ved at
den rørformete formete delen (12) blir kortvarig avbøyet og komprimert ved hjelp av i det minste to mekaniske inngrepsmidler (22) i form av delvis sirkelformete stripeformete trykkelementer, hvor inngrepsmidlene (22) beveger seg i radiell retning tett under utløpsdysen (14), uten å berøre utløpsdysen (14) og uten å direkte kontakte utløpsdysen (14), hvor avsetningene som er festet på utsiden i nærheten av utløpsspalten av den ringformede utløpsdysen (14) blir visket av og transportert borte ved hjelp av den rørformete formete delen (12) i kontinuerlig drift under kontinuerlig smelteutløp, og hvor den rørformete formete delen (12) i seg selv fungerer som et rengjøringselement mens den blir avbøyet.

2. Fremgangsmåte ifølge krav 1, karakterisert ved at
avbøyingen av den rørformete formete delen (12) for rengjøring av utløpsdysen (14) utføres i forutbestemte tidsintervaller.

3. Fremgangsmåte ifølge krav 1 eller 2, karakterisert ved at
avbøyingen av den rørformete formete delen (12) for rengjøring av utløpsdysen (14) utføres nøyaktig når det rørformede stykket blir kastet ut fra utløpsdysen (14), idet det rørformede stykket deretter blir løsnet som et stykke med en liten luftboble, fra det ferdig blåste hullegemet, som et avfallstykke.

4. Fremgangsmåte ifølge krav 1, 2 eller 3, karakterisert ved at,
etter avbøyningen av den rørformete formete delen (12), det rørformede stykke på hvilket de rengjorte avsetningene er festet, sorteres ut fra resten av produksjonsprosessen.

5. Fremgangsmåte ifølge krav 1, 2, 3 eller 4, karakterisert ved at
avbøyningen av den rørformete formete delen (12) utføres ved hjelp av delvis sirkelformete trykkelementer som omgir den formete delen (12) direkte under utløpsdysen (14), fra utover, over mer eller mindre 360°, og avbøyer den innover.

6. Ekstruderingshode (10) for ekstrudering av termoplastiske kunststoffer fra et utløpsdyse (14), som har en innretning for å rengjøre ekstruderingshodet (10), karakterisert ved at
rett under utløpsdysen (14) i det minste to mekaniske inngrepsmidler (22) i form av delvis sirkelformete stripeformete trykkelementer er anordnet, som er utstyrt med en aktuator (24), som drives av et forskyvningsdrev, slik at inngrepsmidlene (22) kan beveges under utløpsdysen (14) uten å berøre utløpsdysen (14) og uten å direkte kontakte utløpsdysen (14), og kan bringes i operativ kontakt med den ekstruderte rørformete formete delen (12), hvor sistnevnte kortvarig avbøyes og komprimeres og derfor også brukes til å rengjøre utløpsdysen (14) i kontinuerlig drift under kontinuerlig smelteutløp.

7. Ekstruderingshode ifølge krav 6, karakterisert ved at
de mekaniske inngrepsmidlene (22) omfatter to eller flere sirkelsegment-elementer (26), som er utformet slik at de kan beveges i radiell retning ved hjelp av aktuatorer (24).

8. Ekstruderingshode ifølge krav 6 eller 7, karakterisert ved at
sirkelsegment-elementene (26) omgir den ekstruderte formete delen (12) fra utover, over mer eller mindre 360°, og danner i den tilbaketrukne posisjonen en for det meste lukket sirkulær ring.

9. Ekstruderingshode ifølge et hvilket som helst av de foregående kravene 6 til 8, karakterisert ved at
aktuatorene (24) er utstyrt med en elektro-pneumatisk, elektro-hydraulisk eller elektrisk drift.

10. Ekstruderingshode (10) ifølge et hvilket som helst av de foregående krav 6 til 9, karakterisert ved at
inngrepsmidlene (22) er utformet slik at de kan justeres i høyderetning og/eller dybderetning (radiell retning).

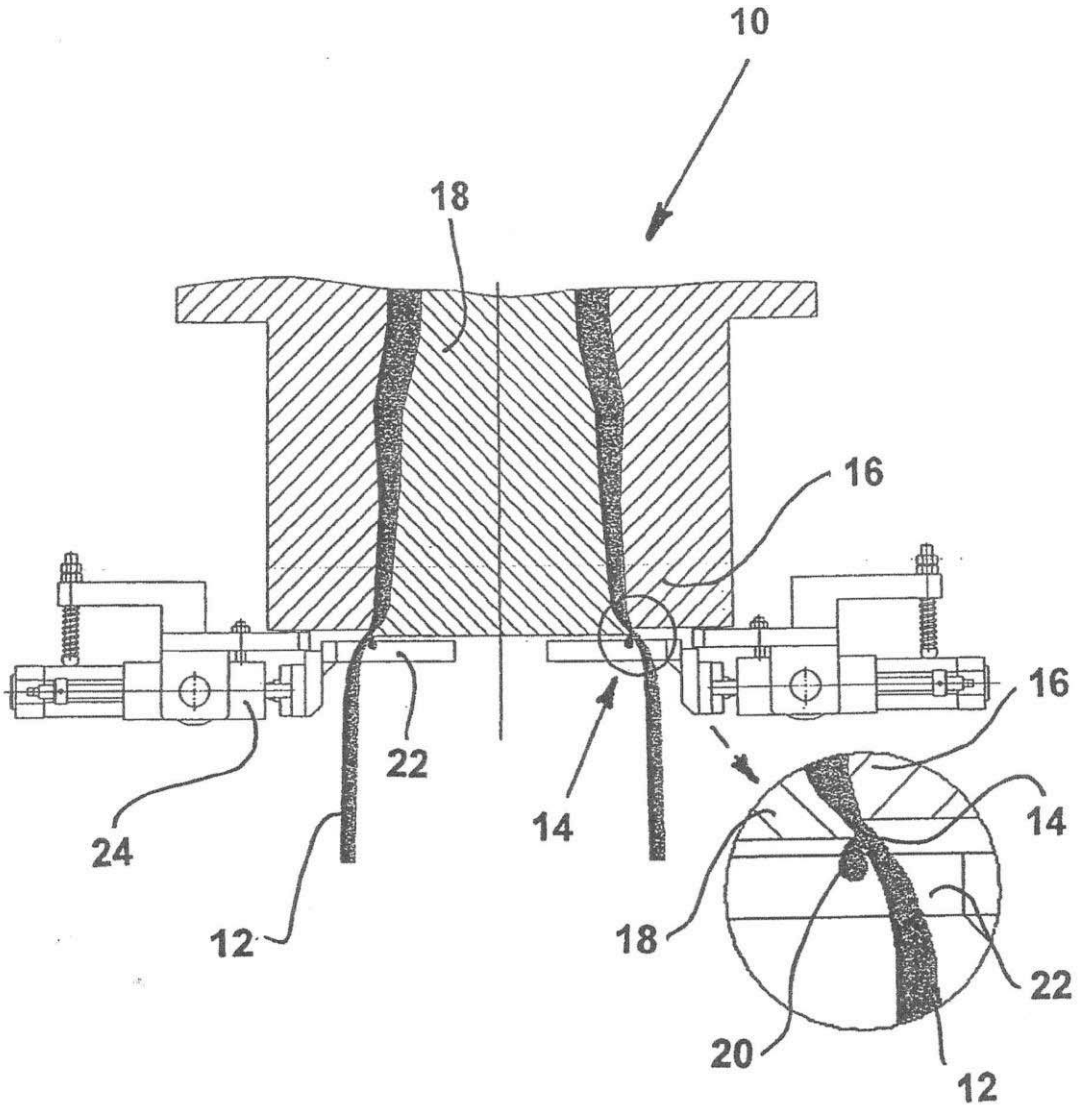


Figure 1

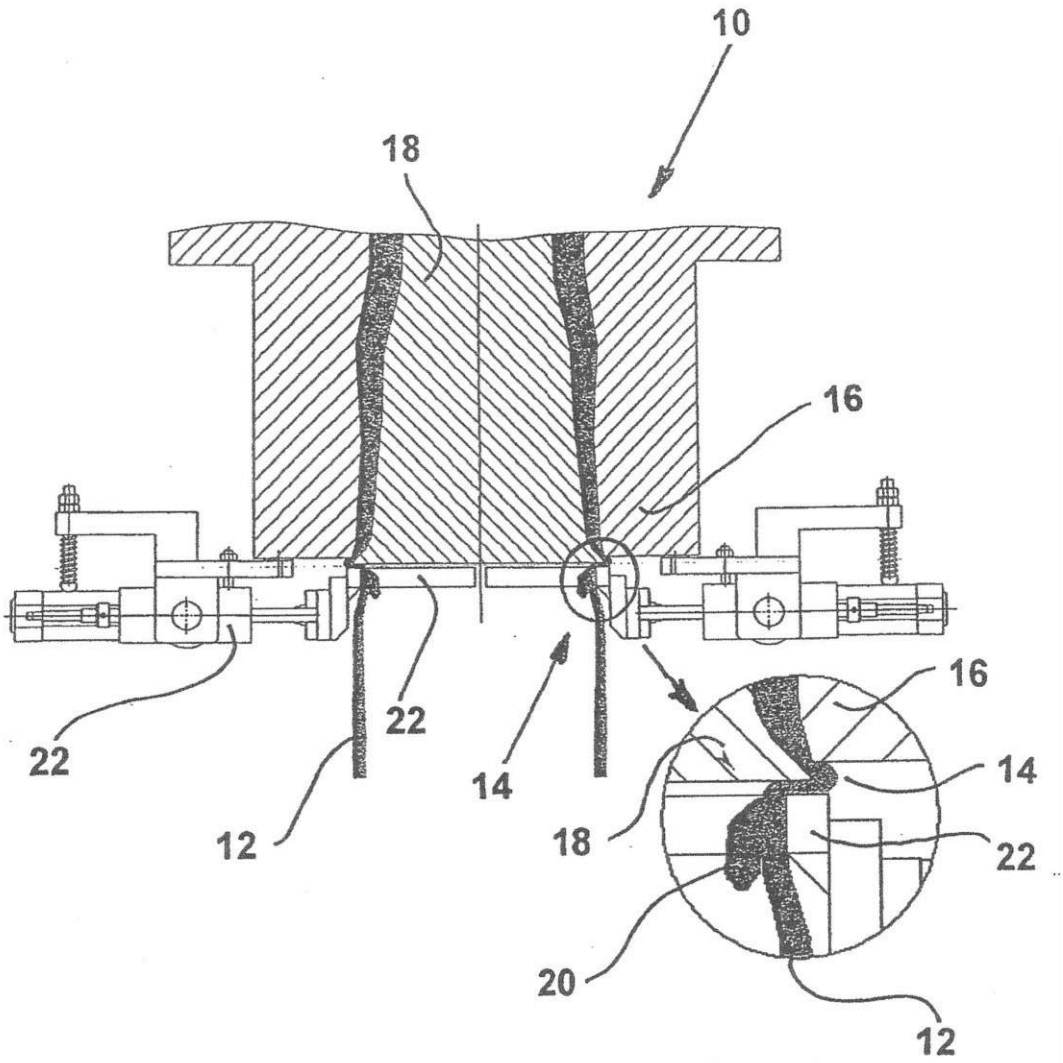


Figure 2

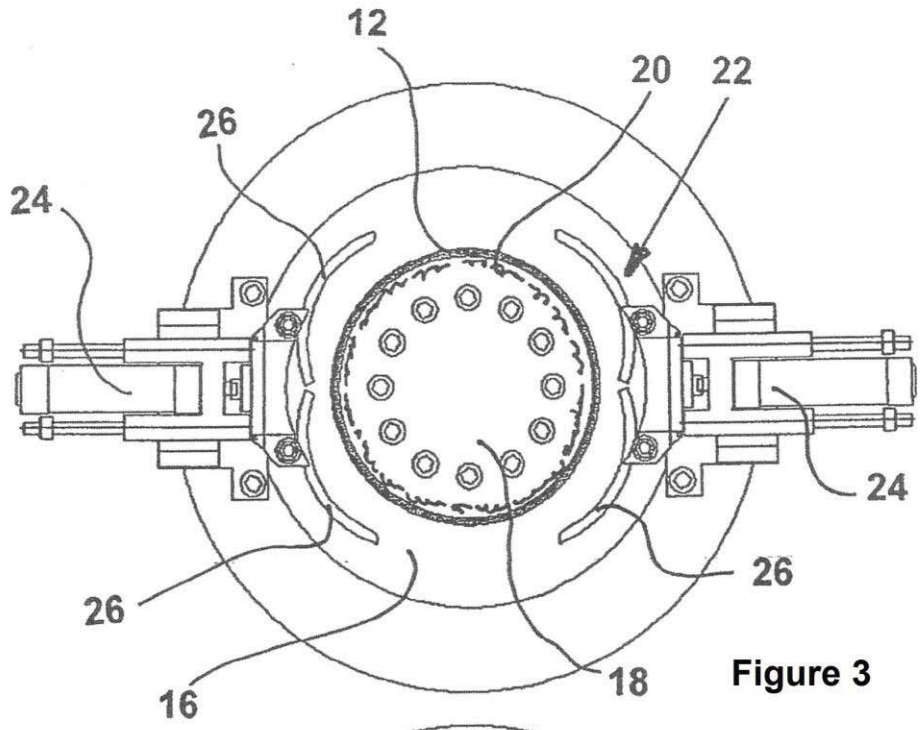


Figure 3

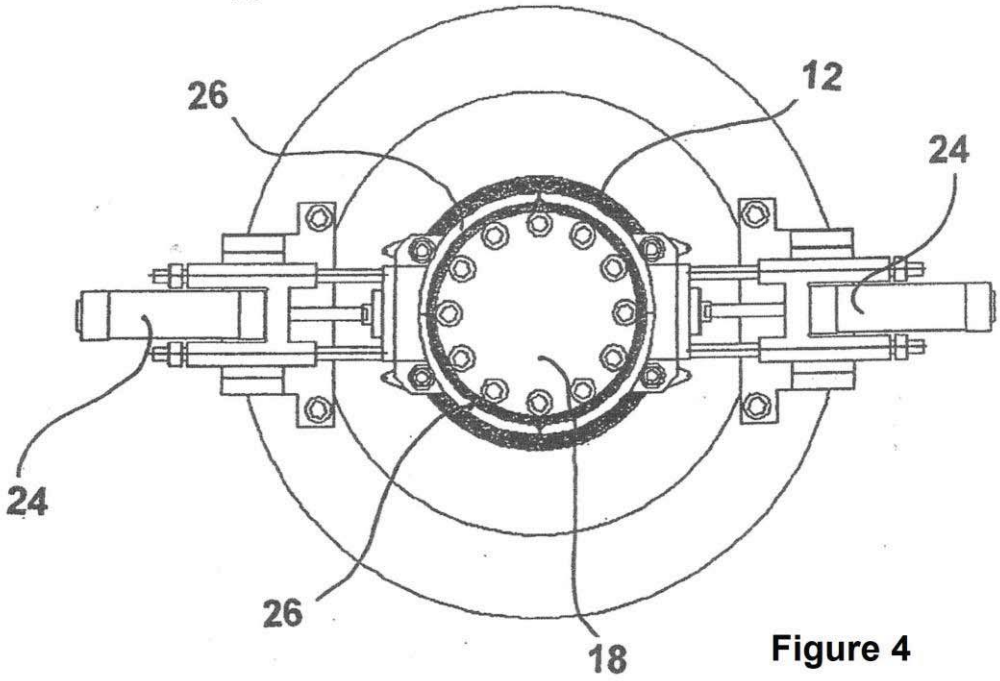


Figure 4

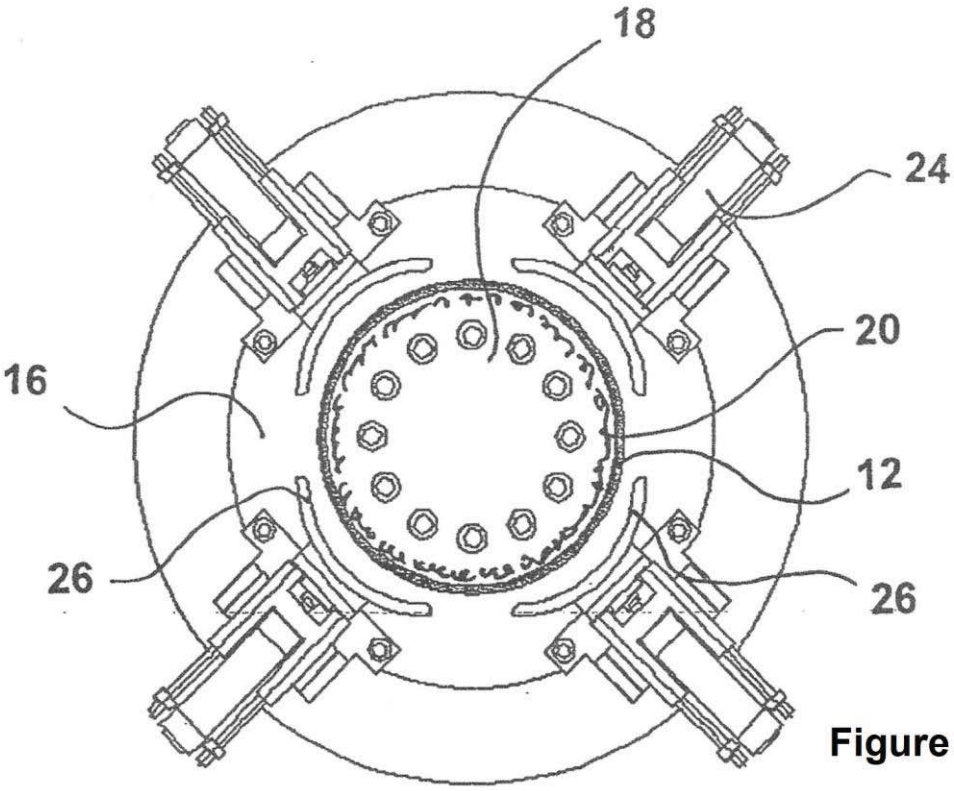


Figure 5

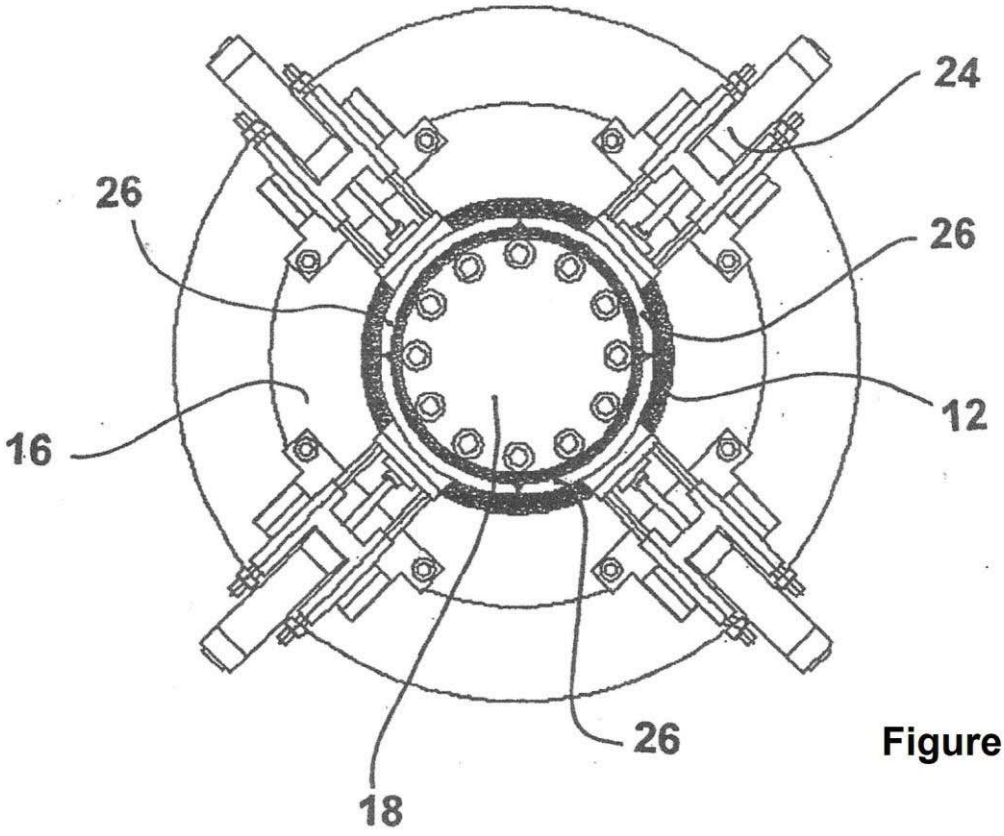


Figure 6

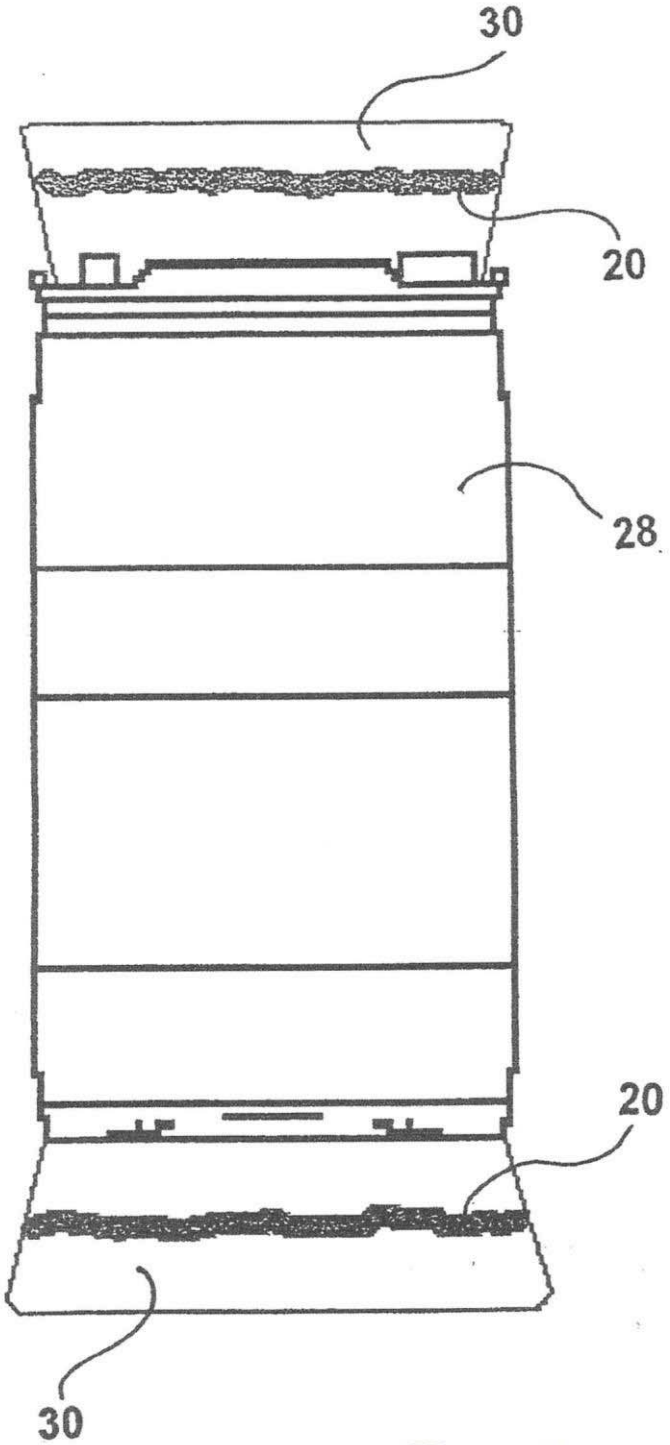


Figure 7