

A METHOD AND AN ARRANGEMENT FOR THE REMOVAL OF
WASTE MATERIAL IN ROTARY PUNCHING

The present invention relates to a method for the removal of waste material in punching units with co-operating rolls, one of which has a number of holes arranged to pick up the waste material punched out. The invention also relates to an arrangement for the realisation of the method.

In the punching of a repeated punching pattern on a material web in general rotary punching is applied making use of a male roll provided with projecting punches and a female roll provided with corresponding recesses. The material web may consist e.g. of a laminated packing material which, with the help of a packing machine is to be gradually converted to packing containers of the non-returnable type for juice, milk or other beverages. In cases where it is intended for the beverage to be drunk directly from the packing container with the help of a suction tube, the material web is provided with suction tube holes in a predetermined pattern corresponding to the shape of the individual packing containers which is done by advancing the material web in the nip between the punching rolls so that suction tube holes are produced according to the desired pattern. This means that the waste material is produced in the form of small punched-out discs which have to be collected so that they do not land on the ready-punched web or at some other place where they cause difficulties. Since the waste material discs are small and light it is very difficult, because of the high punching and feeding rates, to collect and remove them.

Up to now the waste material was usually removed via internal ducts in the female rolls, and, more particularly, in that the recesses or holes present in the roll surface were connected to an inner cavity in the roll, this cavity in turn being joined to a vacuum source so that the punching waste in this manner is sucked away from the punching region in the nip between the rolls. Owing to problems of seal-forming and noise the vacuum has to be kept within certain limits and the method, therefore, has a natural

limitation which makes it unsuitable for use at high punching speeds since the rotation of the female roll then causes an outwardly directed force which counteracts the vacuum and leads to the waste material sometimes sticking in the holes or even being
5 blown out of the same on the outside of the roll.

It is an object of the present invention to provide a method for overcoming the above mentioned problem, this method not being subject to the disadvantages of the earlier methods.

It is a further object of the present invention to provide
10 a reliable and simple method for the effective removal of waste material even when the rotary punching takes place at very high speeds.

These and other objects have been achieved in accordance with the invention in that a method for the removal of waste material
15 in a punching unit with co-operating rolls, one of which has a number of holes arranged to pick up the waste material punched out, has been given the characteristic that a piston located in each hole is moved during the rotation of the roll between an inner and an outer position so as to retain and to release
20 respectively the waste material punched out.

Preferred embodiments of the method in accordance with the invention have been given, moreover, the characteristics which are evident from subsidiary claims 2-8.

In accordance with the invention a strong vacuum is provided
25 during a very short period in the holes which retain the waste material punched out, whereafter they are released from the holes and sucked away. The event is synchronised with the rotation of the rolls and provides a very safe and rapid handling of the waste material.

30 It is a further object of the present invention to provide an arrangement for the realisation of the method in accordance with the invention, this arrangement being capable of operating at great speed and reliability and not being subject to the disadvantages of the earlier arrangements.

35 It is a further object of the present invention to provide an arrangement for the removal of waste material in rotary punching,

13

- 3 -

this arrangement being of a simple and reliable design and, therefore, capable of being turned out at low cost.

With the aforesaid objects in view the invention consists in a method for the removal of waste materials in punching units
5 with co-operating rolls one of which has a number of holes arranged to pick up the waste material punched out, characterised in that a piston located in each hole is moved during the rotation of the roll between an inner and an outer position so as to retain and to release respectively the waste material punched out.

10 The invention further consists in apparatus adapted to carry the aforesaid method into effect comprising a roll with holes for the picking up of punching waste characterised in that each hole comprises a piston axially movable in the hole which is in airtight contact with the wall of the hole together with manoeuvring
15 elements for the displacement of the piston between different axial positions during the rotation of the roll.

By placing the pistons directly adjoining the region where the vacuum is to operate, a maximum vacuum is achieved which safely retains the punching waste in the die hole. The simple design of the
20 unit and the direct control of the axial movement of the piston by means of a cam track guarantee also an accurate synchronisation between the movement of the piston and the rotation of the roll.

A preferred embodiment of the method as well as of the apparatus in accordance with the invention will now be described in more detail
25 with special reference to the enclosed schematic drawings which only show the parts necessary for the understanding of the invention.

Fig.1 is a side elevation of an arrangement in accordance with the invention as used in a rotary punching unit, a part of the arrangement having been removed for a clearer illustration of the
30 invention.

Fig.2 shows on a larger scale a cross-section through the material web as well as the two punching rolls, the arrangement in accordance with the invention being clearly illustrated.

Fig. 3, 4 and 5 shows on an enlarged scale a section through
35 the female roll, the stepwise operation in accordance with the method according to the invention being illustrated schematically.

The apparatus in accordance with the invention shown in figure 1 comprises a punching unit with two punching rolls namely a male roll 1 and a female roll 2, which between them process a material web 3. The directions of movement of the material web 3 as well as of the two punching rolls 1, 2 are indicated by means of arrows in figure 1. The two rolls 1, 2 are supported in a stand, not shown, and are adjustable in conventional manner in a direction towards or away from one another, so as to make possible the control of the distance between the roll surfaces in the nip where the material web 3 is to pass. The male roll 1 is substantially cylindrical and comprises in conventional manner a number of punches 4 distributed in a regular pattern over the peripheral surface. The punches 4 project somewhat outside the peripheral surface of the male roll 1 in order to make possible in co-operation with corresponding holes 5 in the female roll 2, the punching of the material web 3. The punches 4 for the rest are also conventionally designed and their shape and attachment in the male roll 1 can be varied in different ways, well known to those versed in the art, which are of no significance for the present invention and, therefore, do not have to be described in detail in this connection.

The female roll 2 placed opposite the male roll 1 and parallel with the same, as mentioned earlier, has on its peripheral surface a number of holes 5 co-operating with the punches 4 which are distributed over the peripheral surface of the female roll 2 in a pattern corresponding to the distribution of the punches 4. The holes 5 comprise in each case an outer die part 5' and an inner piston part 5". The outer die part 5' of the hole 5 has a shape which corresponds to the shape of the punches 4 and a cross-sectional area which somewhat exceeds the corresponding cross-sectional area of the punches, as a result of which the punching is made possible in conventional manner in that the punches 4 penetrate slightly into the holes 5 with simultaneous punching out of part of the material web 3 in the desired form. The punched out part or punching waste 6 will land in the die part 5' of the hole 5 where it rests against a steplike transition which exists between the different parts of the hole 5, since the die part 5' has a

larger cross-sectional area than the piston part 5". The shape of the die part 5' may be varied within wide limits depending upon the desired form of the punching whilst the piston part 5" is preferably cylindrical and has a cross-sectional area which

5 substantially corresponds to the cross-sectional area of a piston 7 which has a sliding fit in the piston part 5" of the hole 5. The piston 7 is axially movable in the hole 5 and is moved during the rotation of the roll 2 between different axial positions. The piston 7 forms an air-tight seal with the wall of the hole 5 within

10 the region of the hole which serves as a piston part 5". When the material web 3 is to be provided with holes whose size and diameter correspond to the diameter of the piston 7, the piston part 5" will on its front end also serve as a die part 5', but the punching waste 6 punched out frequently is of an irregular

15 shape and of a size greater than the piston 7 which makes necessary the provision of a die part 5' of a larger area than the piston part 5". The die part 5' with surrounding material region may also be in the form of an exchangeable die which in conventional manner is placed in a corresponding recess in the roll surface and

20 thus can be simply substituted in case of wear or alteration of the size and shape of the punched hole.

At the back of the piston 7 there is a piston rod 8 which extends radially through the female roll so as to run on its inner end facing towards the centre axis of the roll 2 via a roller 9

25 on a stationary cam track 10. Between the piston 7 and the roller 9 the piston rod 8 is provided with a flange 11 against which a helical spring 12 rests with one of its ends. The spring 12 is enclosed in a spring chamber 13 in the female roll 2 and rests with its other end against one of the short sides of the spring

30 chamber 13. The spring 12 is a compression spring and will act owing to its placing between the flange 11 and the end wall of the spring chamber 13 upon the piston rod 8, and consequently the piston 7, in a direction axially inwards against the centre axis of the female roll 2, so that the roller 9 will be constantly

35 pressed against the cam track 10.

Figure 1 also shows how the lower part of the female roll 2

is surrounded by a suction casing 14 which via a connecting duct 15 is connected to a vacuum source, not shown, and a collecting chamber for punching waste. In the suction casing 14 are present, moreover, one or more blow nozzles 16 which are directed substantially tangentially to the peripheral surface of the female roll 2 seen in the direction of movement of the roll. During operation of the apparatus in accordance with the invention the two rolls 1, 2 are rotated in opposite directions with the help of drive units, not shown, the material web 3 being fed between the rolls with simultaneous punching out of selected parts. The material web 3 may be a web of laminated material which is intended to be used for the manufacture of non-returnable packages. The finished packing containers are to be provided with emptying openings or holes for suction pipes which with the help of the apparatus in accordance with the invention are punched according to a predetermined pattern which corresponds to the pattern of the packing container blanks on the material web. During the punching out, punching waste 6 is produced in the form of small, in particular circular or oval, bits of material web which owing to their smallness and lightness tend to whirl about and make working difficult.

When punching a hole into the material web 3 a projecting punch 4 on the male roll 1 is co-operating in conventional manner with corresponding holes 5 in the female roll 2, the punching waste 6 punched out being pushed down by the punch 4 into the outer end of the hole 5 which in accordance with the invention may be designed as a die part 5'. The die part 5', as mentioned earlier, has a contour and shape which correspond to the desired shape of the hole which is to be punched into the material web 3 and the punching waste 6 will with its peripheral edge, therefore be substantially in contact with the limiting wall of the die part 5'. The underside of the punching waste 6 is pushed until it rests against the steplike transition between the die part 5' of the hole 5 and the piston part 5" of the hole which has a smaller area than the die part 5' (figure 3). The piston 7 which is axially movable in the hole 5 is moved periodically to and fro

during the rotation of the female roll 2 between substantially three axial positions, namely an inner position (figure 3), an outer position (figure 4) and an intermediate position (figure 5). This movement takes place against the effect of the spring 12 which presses the roller 9 against the cam track 10 so that during the rotation of the female roll 2 the said cam track 10 periodically moves the piston 7 between the different axial positions. The cam track 10 is designed so that the piston 7 which at a given instant is closest to the material web 3 is displaced axially inwards from the intermediate position to the inner position at the same time as occurs the punching out of the punching waste 6 in the form of a material disc. On punching, as mentioned earlier, the punching waste 6 is pushed down into the die part 5' of the hole 5 where it forms a seal against the step-like shoulder between the die part 5 and the piston part 5". The simultaneous movement downwards of the piston 7, owing to the piston forming an air-tight seal against the wall of the hole 5', causes a partial vacuum in the space above the piston 7, that is to say the space in the hole 5 which is situated between the top of the piston 7 and the punching waste 6. The said vacuum is maintained and is successively increased owing to the cam surface of the cam track 11 during approx. 1/4 turn approaching the centre axis of the female roll 2. The piston is thus moved successively closer to its inner position at the same time as it is moved by the female roll 2 from a position vertically upwards to a position straight to the right in figure 1. During this quarter of the rotation of the female roll the punching waste 6, owing to the increasing vacuum in the hole 5, will thus be retained by the surrounding air pressure in the die part 5' of the hole 5. By the placing of the piston 7 directly below the punching waste 6 a direct and strong vacuum is provided which, moreover, successively increases so as to ensure retention even if there is a certain amount of leakage between the punching waste 6 and the hole 5.

When the piston 7, because of the rotation of the female roll 2 reaches a position horizontally to the right in figure 1, the periphery of the female roll is surrounded by a suction casing 14

18

and the punching waste 6 is released from the hole 5 to be sucked away via the suction casing 14 and the connecting duct 15. In order to ensure the removal of the punching waste 6 the piston is now moved successively to its outer position in that the
5 cam surface of the cam track 10 withdraws successively from the centre axis of the female roll 2. This produces in the first place a reduction of the vacuum in the hole 5, whereupon the top of the piston 7 comes to rest against the underside of the punching waste and mechanically pushes the punching waste 6
10 out of the hole, since the top of the piston 7 in the outer position of the piston will be substantially level with, or slightly outside, the peripheral surface of the roll 2. To ensure that the punching waste 6 really leaves the hole 5, even if, for example, the punching waste has a sticky or pasty surface, the suction
15 casing 14 is provided with a blow nozzle 16 which by means of an orifice directed tangentially to the peripheral surface of the roll ensures that an air jet flowing against the direction of rotation of the roll reliably removes the punching waste 6 and blows it in the direction towards the connecting duct 15 of the
20 suction casing 14.

After the punching waste 6 has been removed from the hole 5, the piston, during continued rotation of the roll from a position substantially horizontally (to the left in figure 1) to a vertical position closest to the material web 3, is displaced from its
25 outer position to an intermediate position. As in the case of the earlier axial position movements, the piston displacement takes place with the help of the cam track 10, whose cam surface during a quarter turn once more approaches the centre axis of the female roll 2, so that the piston rod 8 is moved by the spring 12 in the
30 direction towards the centre axis and conveys the piston 7 to the intermediate position. In the said intermediate position the top of the piston 7 is substantially level with, or slightly below, the steplike transition between the die part 5' and the piston part 5", whilst during the subsequent punching operation the
35 punching waste 6 can be pressed again into the hole 5 whereupon the described cycle is repeated again.

As mentioned earlier, the hole 5 comprises two parts separated by means of a steplike shoulder, namely the outer die part 5', whose cross-sectional area substantially corresponds to the cross-sectional area of the punch 4, and the inner piston part 5" which is cylindrical and whose diameter substantially corresponds to the diameter of the piston 7. It is implied, of course, that the different hole parts 5' and 5" may be varied independently of each other in respect of shape as well as of size. If circular holes are to be punched in the material web 3 it is also possible to give the die part 5' and the piston part 5" the same shape and size, in which case the steplike shoulder can be eliminated or can be replaced by a flange arranged at an appropriate level in the hole 5. To ensure further the formation of a tight seal between the punching waste 6 and the walls of the hole 5, the die part 5' can be provided on its inner end part facing towards the steplike shoulder with a conical portion 17 whose inner end has a diameter which is slightly less than the diameter of the punching waste 6. Such a design is shown in figure 5 and is particularly suitable for the punching of fibrous material, since the edges of the punching waste often obtain a somewhat irregular and elastic contour. The conical portion 17 here further enhances the sealing effect, but it has been found in practice that in the punching of mostly laminated plastic-coated material a fully satisfactory seal is obtained between the steplike shoulder and the underside of the punching waste 6. In many cases it has even been found in practice that on punching of cylindrical punching waste an adequate seal is obtained simply through contact between the peripheral edge of the punching waste and the cylindrical surface of the hole 5, which means that the steplike shoulder too can be dispensed with, thus making the manufacture of the female roll considerably cheaper. Obviously the detailed design of the hole 5, and especially that of its front end serving as a die part may vary within wide limits and be adapted to the different types of punches and material tubes which are to be processed. The adapting may be facilitated further by designing the punch dies as exchangeable wearing parts in the peripheral

surface of the roll which makes it possible to use the same roll for a number of different ranges of application.

5 The shape of the piston 7 too can be modified in different ways and it is also possible to provide the piston with appropriate sealing elements e.g. rubber gaskets or rubber sleeves. The sealing element may also be wholly or partly in the form of a membrane enclosing the piston or the piston rod which on its outer rim forms a seal with the hole wall. The term "piston" thus should be regarded as covering different types of membranes or
10 other designs functioning in corresponding manner. However, such modification will be obvious to those versed in the art and need not, therefore, be described here in any detail.

The apparatus in accordance with the invention has proved in practical trials to work well and considerable safety in the
15 handling of punching waste has been achieved, so that this handling no longer constitutes the speed-limiting factor which previously created an upper limit to possible punching speeds.

(2A)



CLAIMS

1. A method for the removal of waste materials in punching units with co-operating rolls one of which has a number of holes arranged to pick up the waste material punched out, characterised in that a piston located in each hole is moved during the rotation of the roll between an inner and an outer position so as to retain and to release respectively the waste material punched out.
2. A method in accordance with claim 1, characterised in that the piston during its displacement to the inner position creates a vacuum which retains the waste material in the hole.
3. A method in accordance with claim 1 or 2, characterised in that the top of the piston in the outer position is situated substantially level with the surface area of the roll.
4. A method in accordance with one or more of the preceding claims, characterised in that the piston in the inner position is at such a distance from the peripheral surface of the roll that the waste material punched out can be pushed by the punch down into the hole.
5. A method in accordance with one or more of the preceding claims, characterised in that the piston on rotation of the roll after release of the waste material is moved first from the outer position to an intermediate position, and is moved to the inner position at the same time as the punching is taking place.
6. A method in accordance with claim 5, characterised in that the top in the intermediate position of the piston is level with the transition between the die part of the hole and the piston part.
7. A method in accordance with one or more of the preceding claims, characterised in that the piston during its displacement to the outer position mechanically releases the waste material from the hole.
8. A method in accordance with one or more of the preceding claims, characterised in that the waste material is pushed by the punching tool down into the hole to rest against a steplike transition between the die part and the piston part of the hole.
9. An apparatus adapted to carry into effect the method in accordance with one or more of the preceding claims, comprising a roll with holes for the picking up of punching waste characterised in that each hole comprises a piston axially movable in the hole which is in airtight contact with the wall of the hole together with manoeuvring



(22)

elements for the displacement of the piston between different axial positions during the rotation of the roll.

10. An apparatus in accordance with claim 9, characterised in that the piston is manoeuvrable by means of a cam arrangement
5 which is situated in a hollow space in the interior of the roll and comprises a stationary cam track, which via intermediate elements acts upon the piston in axial direction.
 11. An apparatus in accordance with claim 9 or 10, characterised in that the piston is acted upon by means of a spring device in
10 the direction towards the centre axis of the roll.
 12. An apparatus in accordance with one or more of claims 9 - 11, characterised in that the cross-sectional areas of the hole and of the piston are substantially of equal size, the piston having a sliding fit in the hole.
 - 15 13. An apparatus in accordance with one or more of claims 9 - 12, characterised in that the die part of the hole situated closest to the roll surface has a greater cross-sectional area than the piston part of the hole, the said greater cross-sectional area corresponding substantially to the cross-sectional area of the co-operating punch.
 - 20 14. An apparatus in accordance with claim 13, characterised in that the transition between the different cross-sectional areas in the hole occurs steplike.
 15. An apparatus in accordance with one or more of claims 9 - 14, characterised in that suction devices are arranged along a part of
25 the periphery of the female roll.
 16. A method as claimed in claim 1 and substantially as hereinbefore described.
 17. An apparatus as claimed in claim 9 and substantially as hereinbefore described.
-