



IMPROVEMENTS TO MACHINES AND METHODS FOR MANUFACTURING PACKING MATERIALS BY CRUMPLING PAPER

This invention relates to machines used to manufacture a wedging/packing material
5 constituted by a stack of paper sheets folded on themselves and subjected to
folding/crumpling. The invention also relates to a new structure of this material and a new
method for manufacturing it.

Machines of this type have been known for a long time. Thus, document US-A-3
603 216, initially filed in 1968, describes a machine in which a stack of paper sheets is
10 guided into a chute, which has the shape of a truncated horizontal pyramid and narrows
towards the front so that the longitudinal edges of the stack of sheets are folded or rolled
towards the interior, then between pairs of toothed wheels superposed on and meshing with
each other, in such a manner that it is subjected to a pulling effect on the one hand, and a
crumpling effect on the other, of the corrugation and compression between each pair of
15 wheels, which assures an assembly of said stack of paper sheets folded on themselves, the
product emerging from this machine appearing in the form of a "stuffed pad" having a
permanent cohesion and being suitable for packing various articles under different
conditions.

It is possible to consider that the fundamental characteristic of this type of machine
20 lies in the fact that the same toothed wheels carry out simultaneously the pulling of the
starting material constituted by the folded sheets, the crumpling of said stack to give it
volume and the compressing of said sheets to give them this cohesion.

In practice, this plurality of functions may cause various problems, which have
induced various solutions but none of which is entirely satisfactory.

25 Thus, when the pressure exerted on the sheets is sufficient to pull them, a
consequence is that said sheets sometimes may tear. On the other hand, if the pressure is
reduced to avoid the tearing, the cohesion of the finished material will not be sufficient and
the "pad" will lose its usefulness.

A solution proposed to reconcile these two contradictory requirements is described
30 in document No. EUR-A-0 427 834, and consists of providing, on the teeth of the gears
used to pull the superposed sheets for crumpling and assembling, protrusions which
penetrate deeper into the thickness of the sheets, to enhance the cohesion of the product.
However, the regions that are "embossed" are then weakened and provide starting points
for tearing of said product, with the result that in practice, such a machine can only be used



with stacks of Kraft paper, which are proportionally more expensive.

The present invention eliminates these inconveniences by using an apparatus resulting from a fundamentally different idea and comprising a combination of means which enable a wedging/packing material of the preceding type but having a much superior cohesion to be obtained from recycled paper, which is far less costly, without creating
5 starting points for tears.

To achieve the above objective, the invention consists of allocating the functions of pulling, crumpling and assembling to produce a product of high cohesion to different and separate components, each of them adapted to perform its own function to eliminate the
10 known inconveniences.

More precisely, according to the invention, in a machine of the above mentioned type:

- the components performing the pulling function consist of a pair of superposed wheels, namely, on the one hand, an upper wheel, called pulling wheel, having the general
15 shape of a cylinder, whose median portion has a section in the form of a toric channel, and whose edge portions are crenellated but have flat parts distributed on their periphery in, such a manner that the flat areas of one of the edge portions face the areas having no flat parts of the other edge portion; and on the other hand, a lower wheel, called supporting wheel, having the general shape of a cylinder whose median portion has a section in the
20 form of a toric pad that essentially corresponds to the toric channel of the upper wheel, and the edge portions are cylinders on which the areas having no flat parts of the upper wheel move.

As will be described in detail later, the stack of sheets, pulled between the two wheels, is gripped and pulled between the cylindrical portions of the lower wheel and the
25 areas having no flat parts of the two edge portions of the upper wheel, namely, alternately to the right and to the left. These sheets are thus pulled forwards not directly along the axis, but on their left part then their right part, respectively, in relation to the axis of movement, the lateral dissymmetry resulting from the pulling being compensated at each successive flat part by the relatively flexible hollow area created in the sheets between the toric pad
30 and the toric channel. Due to this method of pulling the pressure exerted on the paper does not cause it to tear, as at this stage it does not undergo any stress apart from the axial pulling in the direction of movement.

- The components performing the function of assembling the superposed paper sheets consist of another pair of superposed wheels, namely a crenellated upper wheel and

a smooth lower cylinder on which the periphery of said teeth moves, the stack of paper sheets undergoing a certain compression from these teeth against the supporting cylinder. Again, there is no risk of tearing because the paper is not distorted between the mutually gearing wheels.

5 The components performing the crumpling function consist of a set of reducing gears linking the pulling wheels (located on the rear) and the assembling wheels (located on the front) in such a manner that the pulling wheels rotate at a speed 1.9 times higher than that of the assembling wheels. Because of this speed difference, the material is supplied to the assembling wheels faster than they rotate and is spontaneously squeezed
10 and crumpled without undergoing any constraint.

Thus there is a combination of means and actions, from the rear towards the front, between the pulling wheels, the set of reducing gears, and the assembling wheels, to achieve the result aimed at, namely, the formation of a material in the form of pads having a high cohesion without the risk of tearing.

15 This novel concept, which is completely contrasting that of conventional machines, enables paper of a lesser quality and price than that of Kraft paper, mainly low-grade recycled paper, to be used in the machine according to the present invention, which is not possible with conventional machines as described earlier.

20 The present invention relates also to various arrangements which improve, *inter alia*, the operation of the system described above.

Thus, although it is known that gear pairs are installed in previous machines to simultaneously perform two functions of pulling and assembling in flexible means which allow the mutual pressure to be adjusted, the invention brings an important modification to this type of means.

25 Indeed, since pulling is performed only by the rear wheels, while the assembling wheels do not have to exert a high pressure, arrangements are made to mount the axles of the lower wheels on a rocking compensation bar which is subjected to the action of common springs distributed in such a manner that the action of these springs is stronger at the rear (for pulling) than at the front (for assembling). In practice, the mechanical
30 assembly, which represents the main characteristic of the invention, is mounted in a cradle in which the upper axles, and the reducing set which link them, are fixed; while the lower axles are distributed in advance on a rocking compensation bar at the rear and subjected to the action of a pair of common springs which exert their pressure at a point on said bar between the rear and the front at about 1/3 from the rear edge.

Finally, the invention relates to a simplified arrangement, to be described in the following, to feed paper assuring an optimal volume of material fed into said mechanical assembly.

The invention also relates to a method for manufacturing wedging/packing materials of the general type in which a stack of superposed paper sheets, after its longitudinal borders have been folded or rolled, is subjected to a pulling action, an essentially transversal crumpling action, and a compression action at successive places to assure cohesion. The essential characteristic of this method lies in the fact that said actions are performed successively and independently from one another. In a preferred embodiment of this method the action of crumpling results from the restraint imposed on the material after the pulling action, without any means acting directly on the material.

Finally, the invention relates to a novel wedging/packing material obtained by this method and/or this machine and having a desired volume due to crumpling and a desired cohesion due to assembling by compression, but no weakened areas, which enables it to be manufactured particularly from low grade recycled paper.

The invention will be now described in further detail in reference to the accompanying drawings, in which:

- Figure 1 is a top view of the machine according to the invention, with the paper sheets in place;
- Figure 2 is a vertical sectional view cut along the longitudinal plane of symmetry of the machine(II-II in figure 1);
- Figure 3 is a cross-sectional view cut along the axle of the pulling wheels (along III-III in figure 2);
- Figure 4 is a cross-sectional view cut along the axle of the assembling wheels (along IV-IV in figure 2);
- Figure 5 is a partial perspective view of the cradle in which the mechanical assembly is mounted, seen from below, the upper wheels being removed.

In the drawings, all the usual components, carried by a frame 1 of a machine for manufacturing a wedging/packing material from a stack of paper sheets are found; namely, at least one drum of superposed paper sheets; a chute 3 in the form of a horizontal truncated pyramid oriented towards the front; the pulling, crumpling and compressing components collectively mounted in a cradle 4 and driven by a motor 5, a cutting system 6 and an extraction channel 7 at the front.

The invention is essentially that of the conception and realisation of the mechanical

assembly mounted in the cradle 4 whose various components and their arrangement are shown in Figures 3 to 5.

This assembly comprises a first pair of superposed wheels (Figure 3), namely an upper wheel or pulling wheel 8 rotating on an axle 9 mounted in the lateral flanges 10-10' of the cradle 4, and a lower supporting wheel 11 rotating on an axle 12 mounted on a compensation bar 13, which is flexibly mounted so that it can rock relative to the cradle 4 as shown in Figure 5 and described in detail later.

The same mechanical assembly comprises a second pair of superimposed wheels (Figure 4), namely, an upper wheel or compressing wheel 14 rotating on an axle 15 mounted in the lateral flanges 10, 10' and driven to rotate by the motor 5, and a lower supporting wheel 17 rotating on an axle 18 also mounted on the bar 13 rocking flexibly in relation to the cradle 4.

In the embodiment herein described, the two axles 9 and 15 are positively driven by the motor 5, namely the axle 15 is directly driven and the axle 9 via a set of reducing gears denoted by 16a, 16b, 16c between Figures 3 and 4.

The structure and the functions of the two sets of wheels are as follows:

As shown in Figure 3, the pulling wheel 8 is of a generally cylindrical shape, with a central portion 19 in the form of a toric channel having an essentially semicircular section, and two edge portions 20, 20' having a cylindrical periphery interrupted at regular intervals by fiat parts 21 characterised in that the fiat parts 21 of the portion 20 face the cylindrical areas 22' of the portion 20', while, conversely, the fiat parts 21' of the portion 20' face the cylindrical areas 22 of the portion 20.

Furthermore, the supporting wheel 11, with which the pulling wheel 8 interacts, has a generally cylindrical shape but it has, in its median portion, a toric pad 23 whose protruding section essentially corresponds to the hollow section of the toric channel of the wheel 8.

The material M, emerging from the chute 3 and consisting of a stack of paper sheets folded on themselves, passes between the wheels 8 and 11, and is pulled towards the front by the pulling wheel 8 in a manner characterised as follows. As shown in Figure 3, said material band M is gripped by a variable force, as explained later, on the supporting wheel 11 when the cylindrical areas 22, 22' of the portions 20, 20' pass by, but remains free when the flat parts 21, 21' pass by. Due to its movement between the flat parts of the two portions 20, 20', the band M is therefore alternatively pulled on each side of its longitudinal axis, instead of being pulled only axially by pressure which may cause tearing. This

successive movement from one side to the other leads to an excess of paper in the central part compared with its plane configuration. The excess is created by the pad 23 sinking into the channel 19, which leads to more efficient crumpling.

5 This method of pulling the material band M is original and constitutes part of the invention.

As shown in Figure 4, the compressing wheel 14 has a generally cylindrical shape and has two crenellated edge portions 24, 24' linked by a neutral median portion 25; furthermore, the supporting wheel 17 is a smooth cylinder on which the grooves 24, 24' rotate, the material band M emerging from the first pair of wheels 8-11 being gripped
10 between said teeth and this smooth surface by a variable force, as will be explained later. This compression is, however, limited, and will not damage said material since the latter is not distorted between the teeth of the meshing gears as in previous systems. The action of the grooves 24, 24' on the material is thus to assure, by this simple compression, the assembly of the sheets of said material and the cohesion of this assembly, by removing the
15 pleats of the paper.

An essential feature of the second pair of wheels is that it performs only the assembling function, but does not contribute to the movement of the product (on the contrary, it restrains the movement).

For this reason, the force with which the supporting wheels of the pairs, namely the
20 wheel 11 and the wheel 17, are subjected, according to the present invention, to the action of the springs 26, 26' which support them on the upper wheels 8 and 14 but with a different ratio of forces.¹ For this purpose, as shown in Figure 5, the compensation bar 13, 13' carrying the axles 12, 18 of the wheels 11, 17 is subjected to the action of the springs 26, 26' at a point 27, 27' along its length and situated closer to the rear, namely to the axle 12,
25 than to the front, namely to the axle 18. The force exerted by the springs 26, 26' is thus distributed in such a manner that the pressure exerted by the wheel 11 is greater than that exerted by the wheel 17. This difference of forces is justified by the fact that the wheel 11 interacts with the pulling wheel 8, and thus must grip the material M proportionally better than the wheel 17 whose only role is to support the assembling teeth 24, 24'.

30 Preferably, the force ratio can be from 1/3 to 2/3, but it is possible, if desired, to choose a different ratio by modifying the application points 27, 27'.

The axle 18 can be better guided by letting its edges cross the vertical cut-outs 34,

¹ Translator's note: The original sentence is incomplete

34' of the flanges 10, 10' of the cradle 4.

The assembling function and the method for adjusting it with respect to the pulling function are also novel and constitute part of the invention.

Finally, according to an essential feature of the present invention, the crumpling
5 function is not carried out by gear systems as in previous systems, leading to inconveniences, but by a purely mechanical phenomenon which does not affect the strength of the material.

For this purpose, as symbolically suggested by the schematic representation of pinions 16a, 16b, 16c, which form a set of reducing gears between Figures 3 and 4, the
10 motor 5, which drives the wheel 14, also drives the wheel 8 in the same direction, but at a higher speed. The result is that the material band M leaving the pair of wheels 8-11 will be recaptured at a lower speed by the pair of wheels 14-17. As a consequence, the material will be squeezed between these two pairs of wheels, creating permanently a series of transversal pleats denoted by P in Figure 2. The function of crumpling of the material M is
15 thus accomplished by this difference in rotary speeds of the two pairs of wheels, the pulling pair rotating faster than the assembling pair. Experience has shown that a speed ratio of the order of 1.9 led to better results. This ratio can be obtained by using 20-tooth pinions 16a and 16b and a 38-tooth pinion 16c, provided that the pinion 16b plays no other role but ensuring that the pinion 16c, hence the wheel 14, rotates in the same direction with
20 the pinion 16a, hence the wheel 8.

Naturally, a ratio of 1.9 is considered preferable, but it could be different depending on the circumstances, for instance, on the desired degree of crumpling. Similarly, this ratio is valid for the wheels 6 and 14 which have the same diameter, but it could be different for wheels of different diameters.

25 The main advantage of this feature is that, contrary to previous machines, the crumpling of the material can be "spontaneously" achieved without using any other component which could damage the material, for example toothed wheels, such as, for instance, those, mentioned in Document EU-A-2 427 834, which form starting points for tearing, restricting the application of such machines to highly resistant types of paper. To
30 the contrary, due to this feature, it is possible to use in the machine according to the present invention, common quality paper such as low-grade recycled paper.

Finally, as illustrated particularly in the sectional view of Figure 2, the invention provides a method to create the material M from the paper of the drum 2 with a guiding system which ensures that the longitudinal borders are folded in a simple and efficient

manner.

This system comprises, firstly, a pair of pulleys provided with flanges 30, made of, for instance, rubber, adjustably and rotatably mounted on an axle 31 rocking around two arms pivoting at 32 in the direction of the arrow F (Figure 2) to free the entrance of the chute 3, thus facilitating the process of loading of the paper from the drum 2 into the machine. In this position, the pulleys 30 are axially adjusted to form any desired gap, for instance, at 30', to meet the requirements of different types of paper, which can or must be folded according to the different radii of curvature in the chute 3.

When the paper is in the chute 4, the assembly 30-31 is raised by making it rock around 32 in the direction opposite that of the arrow F, to the vertical position (Figure 2). In this position the flanges 30 assist in lowering the lateral borders of the stack of sheets so that they (the borders) are rolled up around a plate 33 mounted inside the chute 3. At the exit of the chute 3 the stack of sheets is completely folded on itself around said plate 33, giving a material M which is then recaptured by the pulling pair 8/11 in the cradle 4.

The lower part of the chute 3 consists of two plates 40, 40', obliquely cut to guide the longitudinal borders during the folding of the sheets constituting the material M which is being pulled to the stages of crumpling and assembling.

The upper and lower plates of said chute 3 extend to 41 and 42, on each side of the pairs of wheels 8/11 and 14/17, so that the material M is securely guided to the cutting system 6.

The front of the plate 33 is terminated by a round portion 35 which is used to receive the sheet M on its upper part. The rear portion of the plate 33 comprises the triangular vertical borders 36, which give further volume to the borders of the mattress formed by the folding of the sheet M caused by the chute 3.

It should be noted that a spring 40, used to maintain and support the flanges 30 against said round portion 35 while the machine is operating, is fixed on the rear border of the upper partition of the chute 3.

This system eliminates all complicated structures that are fitted to previous machines, and in this capacity, is a part of the invention.

It should be noted that each of the stages characteristic of the method is itself original and is claimed as such, but the best results of the invention are obtained by combining two stages or all stages with one another and that the present invention thus encompasses all these combinations.

Similarly, the components characteristic of the machine are claimed independently

as well as in any combination, better results being obtained by combining all these components.

The invention also relates to all equivalent stages or all components equivalent to those that have been described only as examples.

CLAIMS

1. A method for manufacturing a wedging/packing material from a stack
5 of paper sheets by longitudinally folding these sheets on themselves, pulling the folded block, crumpling the block, and assembling the crumpled block by successive punctual compressions characterised in that the operations of folding, crumpling and assembling are performed separately at the successive stations that are independent from one another.

10 2. A method as claimed in claim 1, characterised in that the crumpling operation results spontaneously from a difference of speed between the pulling speed and the assembling speed.

3. A method as claimed in claims 1 and 2, characterised in that the pulling
15 operation is performed in two parallel areas located on both sides of the axis of the stack of sheets after folding, at successive points located alternately on one side and then on the other side, the axial area of the material remaining relatively flexible.

4. A machine for manufacturing a wedging/packing material according to
20 any of claims 1 to 3, characterised in that the means performing the folding function, the pulling function, the crumpling function and the assembling function to assure the cohesion of the material are independent components acting separately, each one being adapted to its own function in order to eliminate all risks of damaging the material or causing its tearing.

5. A machine as claimed in claim 4 characterised in that the components
25 performing the pulling function consist of a pair of superposed wheels, namely, on the one hand, an upper wheel, called pulling wheel, having the general shape of a cylinder, whose median portion has a section in the form of a toric channel, and whose edge portions are crenellated but have flat parts distributed on their periphery in such a manner that the flat areas of one of the edge portions face the areas having no flat parts of the other edge portion; and on the other hand, a lower wheel, called supporting wheel, having the general
30 shape of a cylinder whose median portion has a section in the form of a toric pad that essentially corresponds to the toric channel of the upper wheel, and the edge portions are cylinders on which the areas without flat parts of the upper wheel move.

6. A machine as claimed in claim 4 or 5 characterised in that the components performing the function of assembling the superposed folded paper sheets consist of a pair

of superposed wheels, namely a crenellated upper wheel and a smooth lower cylinder on which the periphery of said teeth moves, the stack of paper sheets undergoing a certain compression from these teeth against the supporting cylinder.

7. A machine as claimed in any of claims 4 to 6 characterised in that the
5 means performing the crumpling function consist of a set of reducing gears connecting the pulling wheels (located on the rear) and the assembling wheels (located on the front) in such a manner that the pulling wheels rotate faster than the assembling wheels so that, due to this speed difference, the material is supplied to the assembling wheels faster than they rotate and is spontaneously squeezed and crumpled without constraint.

10 8. A machine as claimed in claim 7 characterised in that the pulling wheel and the assembling wheel have essentially the same diameter, the pulling wheel rotating approximately 1.9 times faster than the assembling wheel.

9. A machine as claimed in claim 8 characterised in that the axles of the
15 lower wheels are rotatably mounted on a rocking compensation bar subjected to the action of the common springs, distributed in such a manner that the action of these springs is stronger on the rear, namely on the pulling wheels, than on the front, namely on the assembling wheels.

10. A machine as claimed in claim 9 characterised in that the springs acting on
20 the compensation bar are placed along the length of the compensation bar at about the first 1/3 from the rear.

11. A machine as claimed in any of claims 4 to 10 characterised in that the
system for guiding paper from the drum comprises, firstly, a pair of flanged pulleys adjustably and rotatably mounted on an axle supported by arms rocking between a rear position, freeing the entrance of a chute to allow the initial loading, and a second raised
25 position at which said flanged pulleys fold down the borders of the paper in order to guide it into the chute; and secondly, an essentially horizontal plate placed in this chute and passing it at the front and at the rear, and around which the paper is rolled as it proceeds towards the exit of the chute.

12. A wedging/packing material manufactured from a stack of paper sheets by
30 folding, crumpling and assembling by compression points characterised in that it is obtained by using the method according to claims 1 to 3 and/or the machine according to claims 4 to 11.

13. A wedging/packing material as claimed in claim 12, characterised in that the paper used is recycled paper.

14. A material as claimed in any of claims 11 to 13 characterised in that it does not contain any perforation or starting point for tearing.