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(54) **METHOD AND APPARATUS FOR PACKAGING OBJECTS OF DIFFERENT TYPES**

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(57) **ABSTRACT**

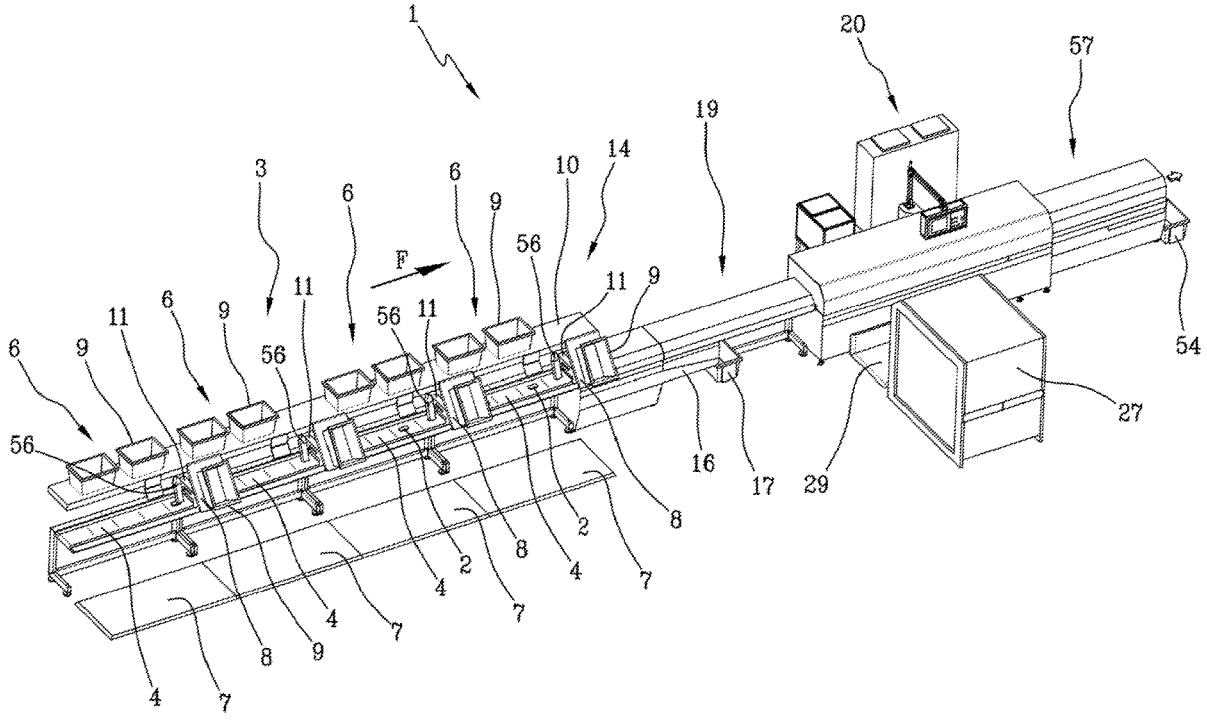
A method comprises the steps of:

positioning a plurality of objects, having different dimensions to each other, on an infeed conveyor;

delivering to an intermediate conveyor a flow of objects coming from the infeed conveyor and movable along an advancement direction;

feeding a packaging unit with the objects coming from the intermediate conveyor, the packaging unit producing a plurality of packages, starting from a web of packaging material, each package containing one object.

The method further comprises the step of checking if, in the flow of objects which advance along the intermediate conveyor, there are empty positions in which an object is missing. If an empty position is detected, there is provided filling the empty position by accelerating the objects which follow the empty position relative to the objects which precede the empty position. The intermediate conveyor comprises a plurality of conveyor belts arranged in sequence along the advancement direction. If the number of objects arriving on the intermediate conveyor in the unit of time is greater than or equal to a predetermined value, the production speed of the packaging unit is adjusted in such a way as to keep in the intermediate conveyor a predetermined average filling level.



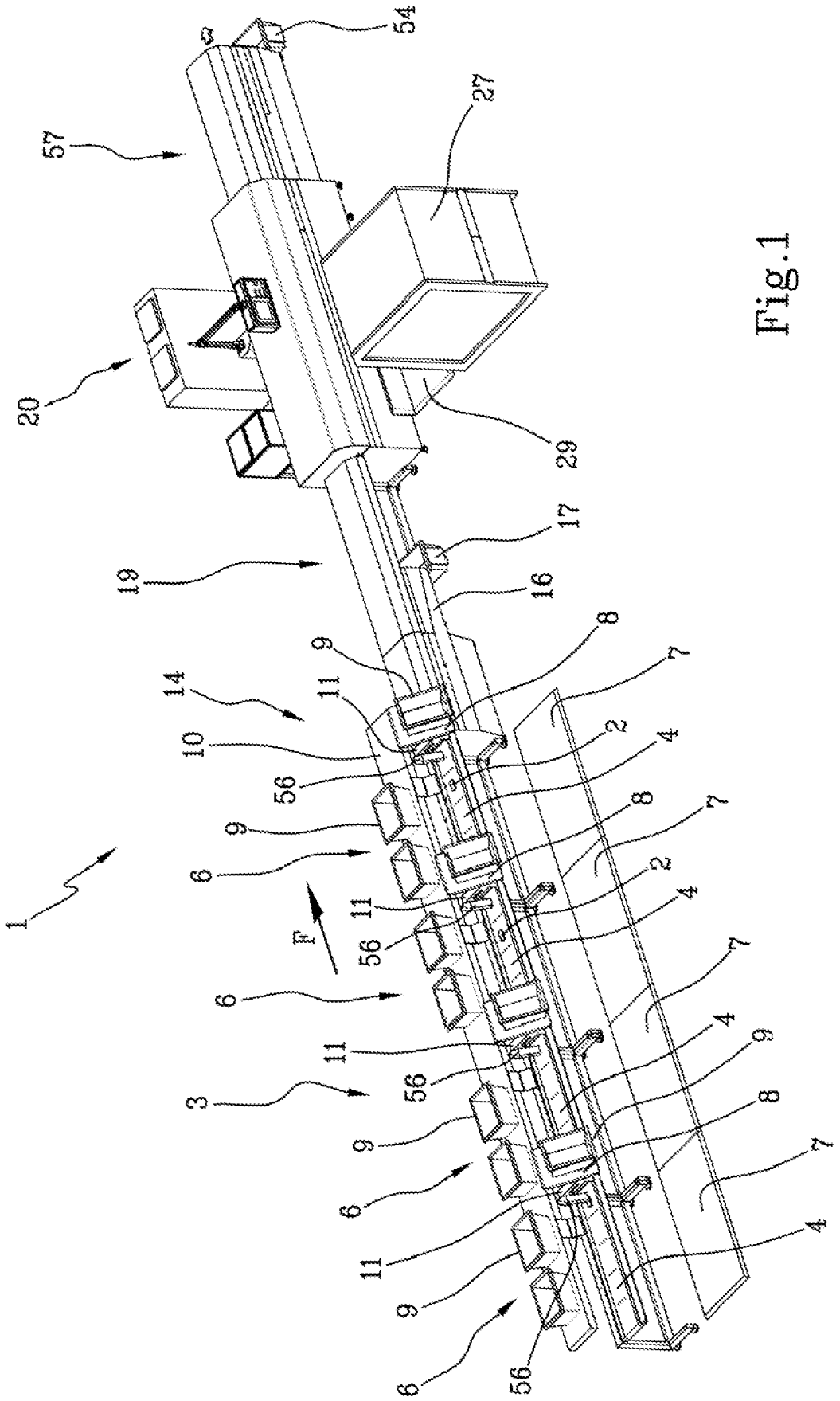

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Fig.1

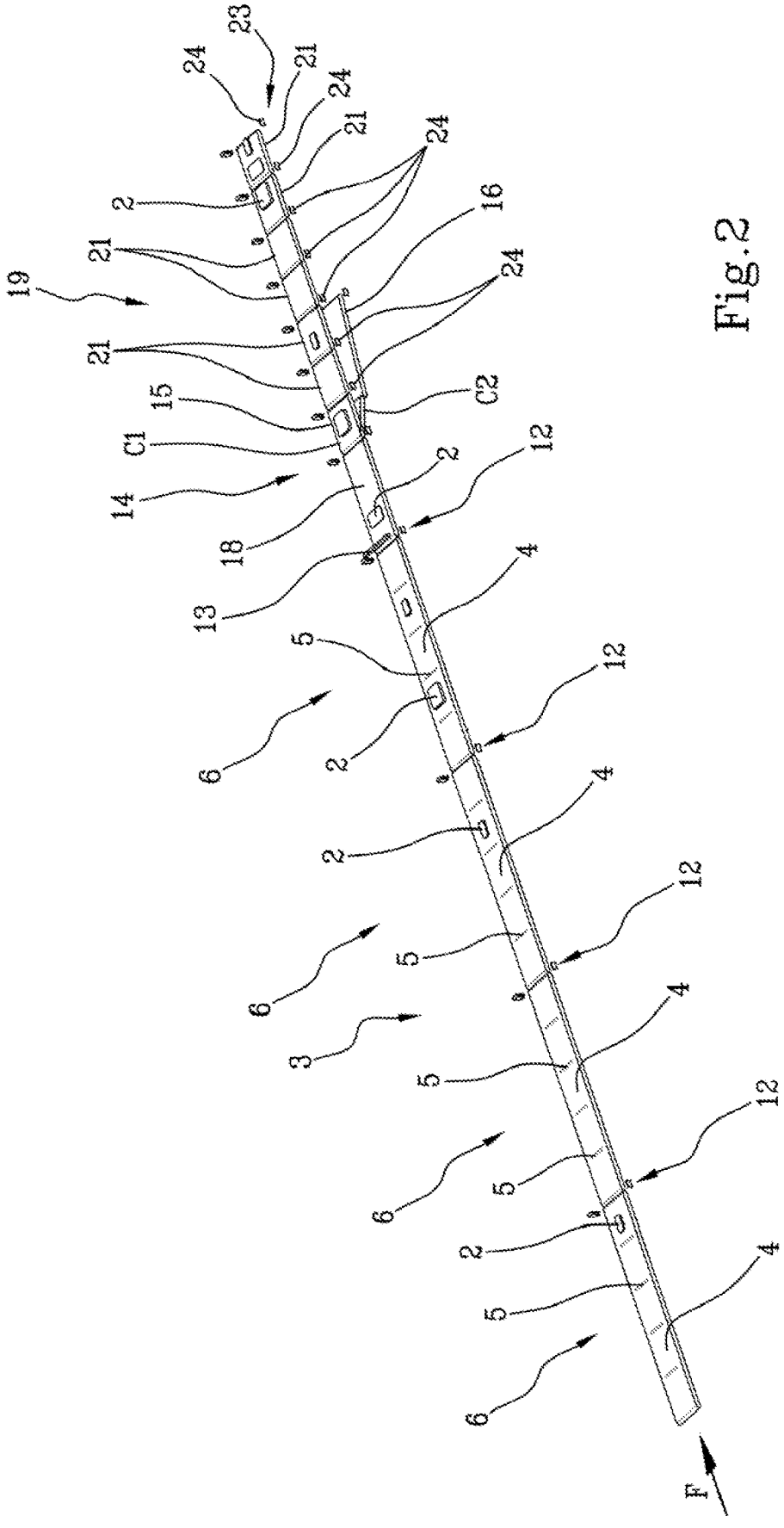
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Fig.2

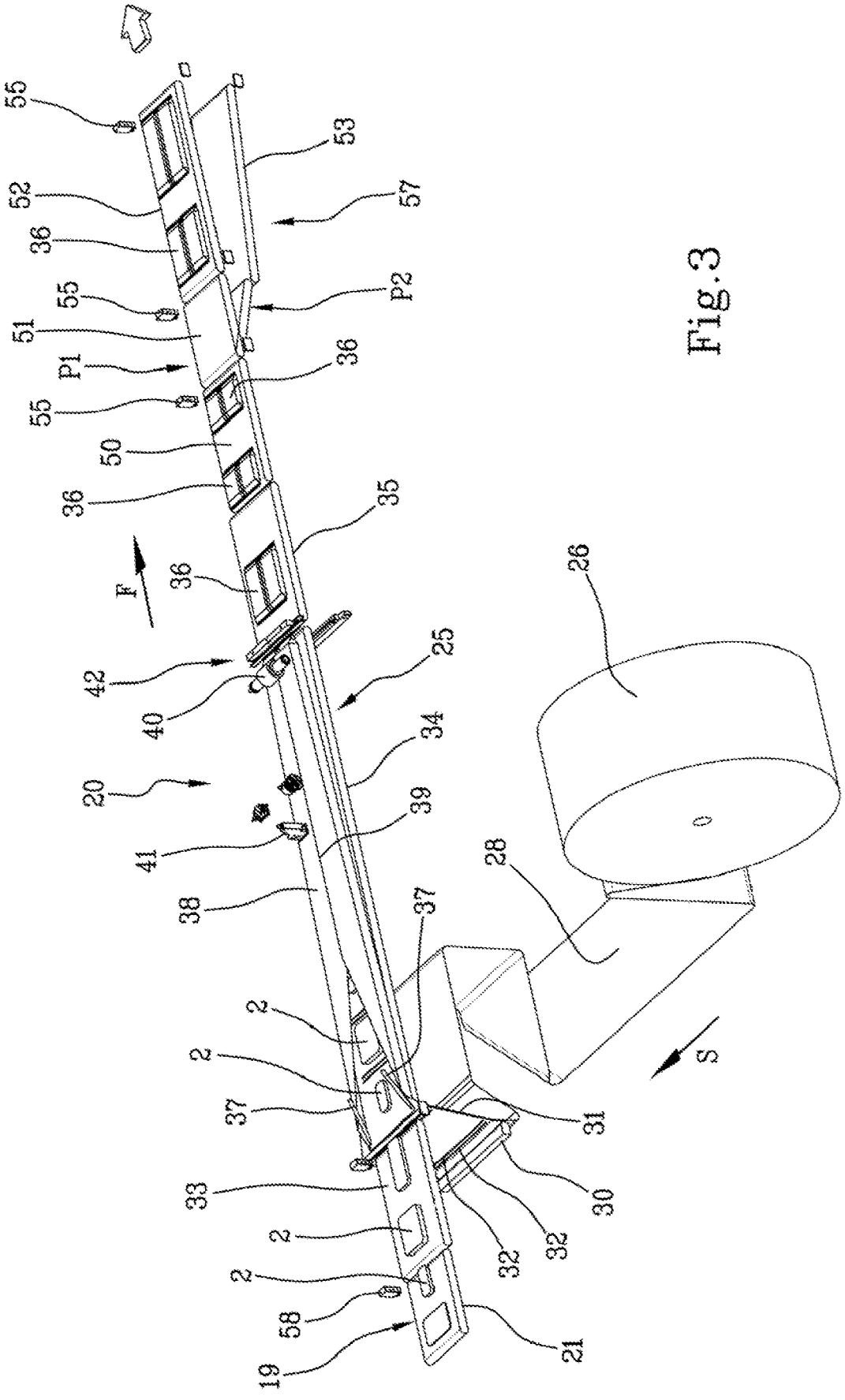
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Fig.3

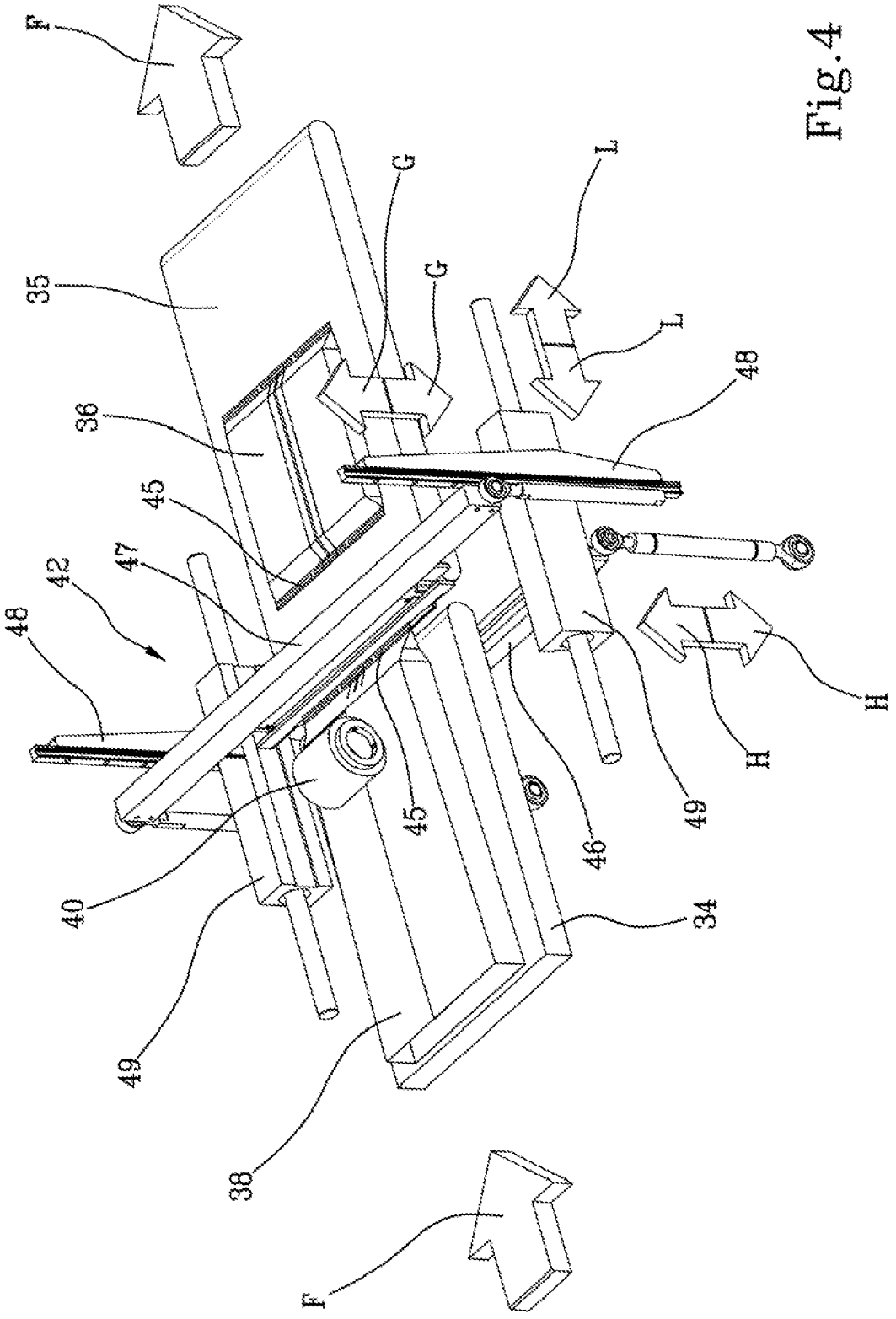

Fig.4

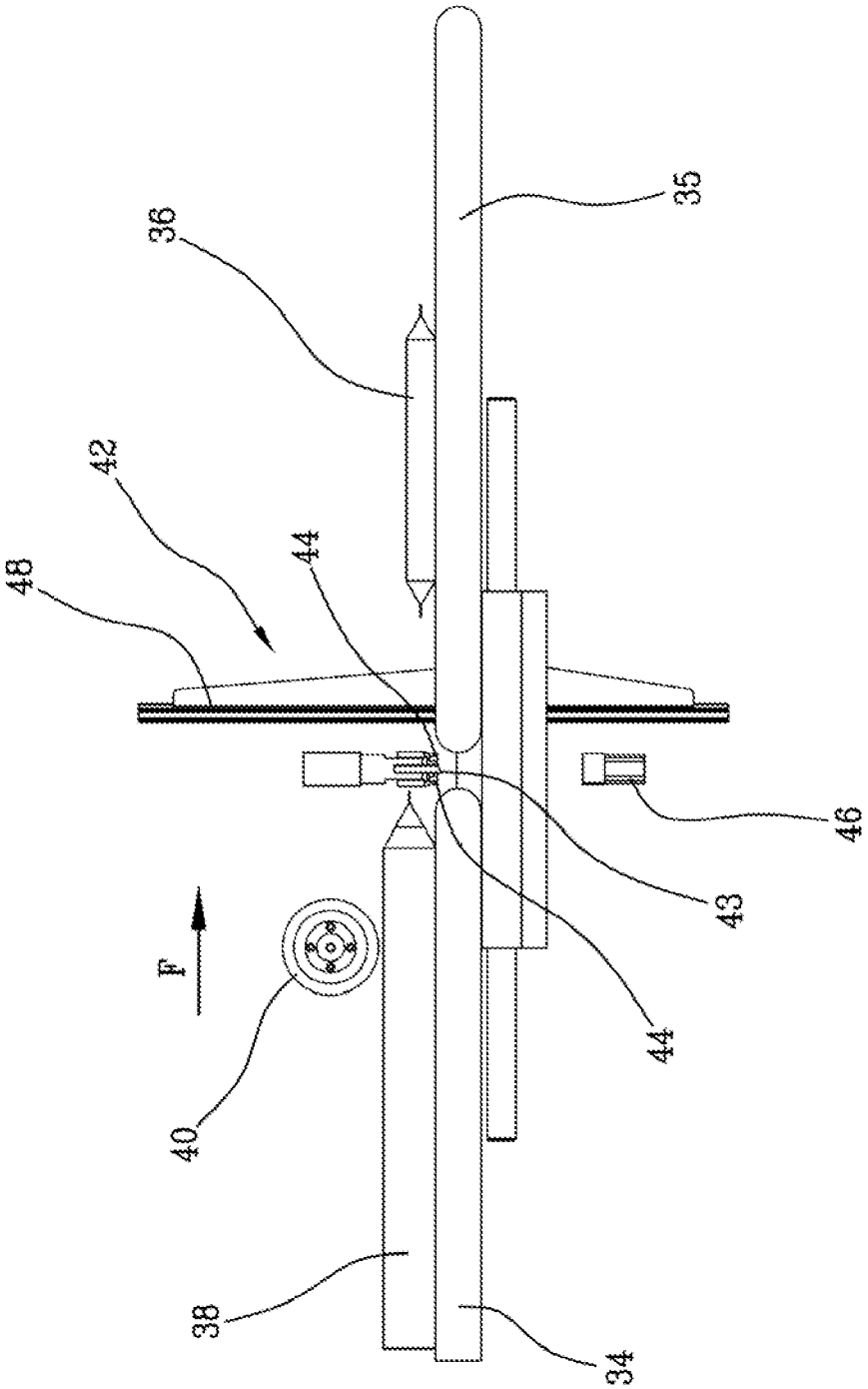

Fig.5

METHOD AND APPARATUS FOR PACKAGING OBJECTS OF DIFFERENT TYPES

[0001] This invention relates to a method and an apparatus for packaging, one after the other, objects of different types, which consequently have dimensions generally variable between one object and the next.

[0002] The method and the apparatus according to the invention are particularly suitable for being used in the e-commerce field, in order to package objects ordered using the Internet, which must be packaged before being delivered to the customers who have requested them.

[0003] In the e-commerce field, apparatuses are known for packaging objects different from each other, which have been ordered by various customers and must be dispatched.

[0004] The prior art apparatuses comprise a packaging machine for packaging each object in a flexible packaging, for example an envelope. Flexible packaging may be made using a web of paper which, after being unwound from a reel, interacts with a glue applicator which applies an adhesive substance to the paper. The paper is then folded around the object to make the package and then subjected to a cutting operation for separating a package from the next one.

[0005] Upstream of the packaging machine, there are positioned in order an infeed conveyor on which the operators manually load the objects to be packaged, a rejection station for rejecting non-conforming objects and a phasing conveyor for positioning the objects in such a way that between one object and another there is an empty space with constant dimensions.

[0006] It may happen that, in the flow of objects which enters the phasing conveyor, there are positions in which, for various reasons, an object is missing. This may be due, for example, to the fact that an object has been rejected in the rejection station, or due to the fact that an operator has not been able to fill all the positions, or due to other reasons.

[0007] When there is an empty position in the flow of objects which enters the phasing conveyor, that position is treated as corresponding to an object having the minimum length which can be processed by the machine.

[0008] Consequently, the packaging machine produces an empty package, which has to be then rejected.

[0009] This results in various drawbacks.

[0010] Firstly, rejecting the empty packages results in a waste of material, since the packaging material with which the empty packages are made must be disposed of.

[0011] Moreover, the rejected empty packages are conveyed to a temporary storage area from which they must be periodically removed, which makes it necessary to stop the apparatus, with consequent productivity drops.

[0012] Thirdly, due to the rejecting of the empty packages it may be difficult to decide with sufficient precision the hourly productivity at which the packaging process must be set, which will be used by the control unit of the apparatus to calculate the linear advancement speed of the packaging material.

[0013] In prior art apparatuses, another drawback is linked to the behaviour of the glue if the operation of the apparatus must be stopped for any reason. The flaps of paper to be joined by gluing must be brought into contact with each other and subjected to an adequate pressure within a predetermined maximum time—which is usually several tens of seconds—from the moment the glue has been applied. If this condition is not complied with, the glue dries and there is no certainty that the package will remain adequately closed. Consequently, if the apparatus undergoes a stoppage for longer than the period of time during which the glued joint must be closed, the packages present in the packaging machine, which have not yet been subjected to pressure in order to close the glued joint, must be rejected. This results in wastage of packaging material and loss of time, with a consequent reduction in productivity.

[0014] An object of the invention is to improve the methods and apparatuses for packaging objects, particularly objects having dimensions which are variable between one object and the next.

[0015] Another object is to reduce the waste of packaging material, particularly paper and glue.

[0016] Another object is to reduce the number of packages which must be rejected, which would allow the stoppages to be minimised for removing from the apparatus the packages to be rejected.

[0017] Yet another object is to make the hourly productivity of the apparatus more easily predictable.

[0018] A further object is to reduce the rejection of packages which have not been glued and closed in a reliable manner during the stoppages of the apparatus.

[0019] In a first aspect of the invention, there is provided a method comprising the steps of:

[0020] positioning a plurality of objects, having different dimensions to each other, on an infeed conveyor;

[0021] delivering to an intermediate conveyor a flow of objects coming from the infeed conveyor;

[0022] feeding a packaging unit with the objects coming from the intermediate conveyor, the packaging unit producing a plurality of packages, starting from a web of packaging material, each package containing one of said objects;

[0023] wherein the method further comprises the step of checking if, in the flow of objects which advance along the intermediate conveyor, there are empty positions in which an object is missing and wherein, if an empty position is detected, there is provided filling the empty position by accelerating the objects which follow the empty position relative to the objects which precede the empty position.

[0024] Owing to the first aspect of the invention, the empty positions which could be present in the flow of objects loaded on the intermediate conveyor are filled before the objects reach the packaging unit. The latter may thus be fed by a continuous flow of objects, that is to say, by a flow in which there are no objects missing, which means that all the packages produced by the packaging unit have an object inside them.

[0025] The drawback of the prior art is therefore practically eliminated, in which any empty positions in the flow of object entering the packaging unit resulted in empty packages, which had to be subsequently rejected.

[0026] In this way, it is possible to reduce the waste of packaging material and minimise, or even eliminate, stoppages of the apparatus linked to the need to remove the rejected empty packages.

[0027] Moreover, since it is no longer necessary to reject many empty packages, the number of rejected packages decreases drastically, which makes it easier to precisely decide the hourly productivity of the apparatus.

[0028] In an embodiment, the intermediate conveyor acts as a buffer in which a plurality of objects is temporarily accumulated while waiting to enter the packaging unit.

[0029] By using the intermediate conveyor as a buffer, the productivity of the packaging unit may be optimised in such a way as to be less affected by the variations which may occur in the number of objects which are loaded on the infeed conveyor to be fed on the intermediate conveyor.

[0030] In an embodiment, the intermediate conveyor comprises a plurality of conveyor belts arranged in sequence along the advancement direction.

[0031] In an embodiment, if the number of objects arriving on the intermediate conveyor in the unit of time is greater than or equal to a predetermined value, the production speed of the packaging unit is adjusted in such a way as to keep in the intermediate conveyor a predetermined average filling level.

[0032] This allows the operation of the apparatus to be better controlled.

[0033] In particular, the packaging unit may be controlled in such a way as to produce packages with an adaptive productivity, that is to say, with a productivity which adapts to the number of objects present on the intermediate conveyor, that is to say, to the filling level of the intermediate conveyor with the objects to be packaged.

[0034] In an embodiment, an applying device applies glue on the web of packaging material to generate at least one joint and to close a corresponding package. If there are no objects present on the intermediate conveyor, the web of packaging material is fed to the packaging unit at a linear speed calculated in such a way that the glue remains on the packaging material, before applying pressure to said at least one joint, for a length of time less than a working life of the glue.

[0035] This prevents the glue which has been applied on the packaging material by the applying device from drying if the infeed conveyor is not able to feed objects in a sufficiently fast manner, with a consequent need to reject the packages which have not been closed in a reliable manner.

[0036] In a second aspect of the invention, there is provided an apparatus comprising:

[0037] an infeed conveyor for receiving a plurality of objects, having different dimensions to each other;

[0038] an intermediate conveyor, arranged downstream of the infeed conveyor for receiving a flow of objects coming from the infeed conveyor in an advancement direction;

[0039] a packaging unit located downstream of the intermediate conveyor for producing a plurality of packages, each of which containing an object, starting from a web of packaging material;

[0040] wherein along the intermediate conveyor at least one sensor is arranged for controlling whether, in the flow of objects advancing along the intermediate conveyor, there are empty positions in which an object is missing and wherein the intermediate conveyor comprises a plurality of conveyor belts arrange in sequence along the advancement direction so that, if an empty position is detected, the objects which follow the empty position are accelerated to fill the empty position.

[0041] Owing to the second aspect of the invention, it is possible to obtain the advantages described above in terms of reducing the waste of packaging material and of reducing the stoppages of the apparatus.

[0042] The invention can be better understood and implemented with reference to the accompanying drawings which illustrate a non-limiting example embodiment thereof, wherein:

[0043] FIG. **1** is a schematic perspective view showing an apparatus for packaging products with variable dimensions;

[0044] FIG. **2** is an enlarged perspective view showing a first part of the apparatus of FIG. **1**, wherein some components have been removed for the sake of clarity;

[0045] FIG. **3** is an enlarged perspective view showing a second part of the apparatus of FIG. **1**, wherein some components have been removed for the sake of clarity;

[0046] FIG. **4** is an enlarged perspective view showing a cutting unit of the apparatus of FIG. **1**;

[0047] FIG. **5** is a side view of the cutting unit of FIG. **4**.

[0048] FIG. **1** shows an apparatus **1** for packaging objects **2**, which are generally of different types from each other and have dimensions which vary between one object and another. The apparatus **1** is designed to be used in the e-commerce field in order to package objects which have been ordered using the Internet before dispatching these objects to the customers who requested them. By way of a non-limiting example, the objects which the apparatus **1** allows to be packed may be books, CDs, items of clothing, items for the home or for free time, and many others.

[0049] The apparatus **1** makes it possible to produce, for each object **2**, a package which contains the object **2** and is made of a packaging material, which in the example shown is paper. However, it is also possible to use other packaging materials, such as, for example, plastic film or biofilm.

[0050] The apparatus **1** may comprise an infeed conveyor **3**, arranged for receiving the objects **2** from one or more operators who manually position the objects **2** on the infeed conveyor **3**. The latter is configured for advancing the objects **2** along an advancement direction F.

[0051] The infeed conveyor **3** may comprise a plurality of infeed belts **4**, arranged in sequence along the advancement direction F. In the example shown, four infeed belts **4** are provided, even though the number of infeed belts **4** may be different.

[0052] Each infeed belt **4** is provided with a plurality of positioning notches or marks **5**, which are more clearly visible in FIG. **2**, which can be printed on the infeed belts **4**. The positioning marks **5** are positioned at a predetermined constant distance along the advancement direction F, in such a way as to provide the operator with a visual indication of the position in which each object **2** must be positioned.

[0053] Along the infeed conveyor **3** there is a plurality of work stations **6**, in each of which an operator can work for loading successive objects **2** on the infeed belt **4** positioned in front of him/her. In the example shown, there are four work stations **6**, one for each infeed belt **4**, but this condition is not necessary. It is possible to provide a number of work stations different from four, for example equal to the number of infeed belts **4**.

[0054] Each work station **6** may comprise a platform **7** on which the corresponding operator can position him/herself to place the objects **2** on the infeed belts **4**.

[0055] Each work station **6** further comprises a supporting element **8** suitable for supporting a crate **9** containing the objects **2** to be packaged. Above the infeed conveyor **3** a resting plane **10** is provided on which a plurality of crates **9**

full of objects **2** are rested. The resting plane **10** may be defined by a motor-driven roller conveyor or by a motor-driven conveyor belt.

[0056] The operator manually picks up a crate **9** from the resting plane **10** and positions it on the supporting element **8**, at the start of his/her work shift or when he/she has emptied a previous crate **9** after positioning all the respective objects **2** on the infeed conveyor **3**.

[0057] Each work station **6** further comprises a portal **11** which, as shown in more detail in FIG. **2**, includes a detector **12**, for example a photocell, arranged for generating a signal when a front edge of an object **2** passes in front of the detector **12**. The latter is further configured to generate a further signal when a rear edge of the object **2** just detected passes in front of the detector **12**. On the basis of the time between the two signals generated by the detector **12** for the same object **2** and of the linear speed of the infeed conveyor **3**, it is possible to measure the length of each object **2** in the advancement direction F.

[0058] The length of each object **2** is a parameter which will be subsequently used to determine the length of the paper with which each object **2** must be wrapped. The length of the paper is equal to the length of the corresponding object **2** measured by the detector **12**, to which an additional value must be added, which ensures that each package can be closed, at the same time minimising the consumption of packaging material, that is to say, paper.

[0059] Each work station **6** may further be provided with a data entry device for allowing the corresponding operator to identify him/herself at the start of his/her shift.

[0060] Moreover, each work station **6** may comprise a code reader **56**, for reading an identification code present on each product **2** which is positioned on the infeed conveyor **3**. The identification code may be, for example, a one-dimensional bar code or a two-dimensional code, such as a QR code, or other code.

[0061] In the work station **6** located in a more advanced position along the advancement direction F, there is provided a further detector **13** for measuring the width of each object **2**, that is to say, its horizontal dimension perpendicular to the advancement direction F, and the height of each object **2**.

[0062] The width and height of each object **2** are used mainly to check that the dimensions of the object **2** fall within a dimensional range which can be processed by the devices of the apparatus **1** located downstream of the infeed conveyor **3**.

[0063] The apparatus **1** further comprises an object rejecting device **14** located downstream of the infeed conveyor **3** for rejecting any non-conforming objects **2**. The object rejecting device **14** is intended in particular for rejecting the objects **2** which, after the measurements performed by the detectors **12** and by the further detector **13**, are found to have dimensions outside the dimensional range which can be processed by the apparatus **1**. The object rejecting device **14** is further intended to reject objects **2** which, on the basis of the reading of the identification code of each object by the code reader **56**, are found to have been incorrectly loaded on the apparatus **1** and are intended to be processed in other places.

[0064] As shown in FIG. **2**, the object rejecting device **14** comprises a tiltable conveyor **15**, for example of the belt type, which may be positioned in a conveying configuration C**1** or alternatively in a rejecting configuration C**2**. In the conveying configuration C**1** the tiltable conveyor **15** is substantially horizontal and allows the objects **2** to be conveyed along the advancement direction F. In the rejection configuration C**2** the tiltable conveyor **15** is, on the other hand, tilted downwards, in such a way that an object **2** to be rejected, coming from the infeed conveyor **3**, is diverted onto an underlying removal conveyor **16**, arranged for moving the rejected object away from the apparatus **1**. At the outfeed from the removal conveyor **16** a container **17**, shown in FIG. **1**, may be positioned for collecting the rejected objects **2**. An operator will remove the container **17** when the latter is full of rejected objects, replacing it with an empty container or repositioning it at the outfeed of the removal conveyor **16** after the container **17** has been emptied. This operation does not require the apparatus **1** to be stopped and consequently does not result in loss of productivity.

[0065] The object rejecting device **14** may further comprise a passage conveyor **18**, of the belt type, interposed between the infeed conveyor **3** and the tiltable conveyor **15**, for conveying the objects **1** coming from the infeed conveyor **3** on the tiltable conveyor **15**.

[0066] The apparatus **1** further comprises an intermediate conveyor **19**, located downstream of the infeed conveyor **3** along the advancement direction F. More precisely, the intermediate conveyor **19** is located downstream of the object rejecting device **14**.

[0067] Downstream of the intermediate conveyor **19** a packaging unit **20** is provided for producing packages made of packaging material, particularly paper, each of which encloses an object **2**.

[0068] The intermediate conveyor **19** is intended for transporting the objects **2** coming from the infeed conveyor **3** towards the packaging unit **20** along the advancement direction F.

[0069] The intermediate conveyor **19** comprises a plurality of conveyor belts **21** arranged in sequence along the advancement direction F. In the example shown, six conveyor belts **21** are provided, but the number of conveyor belts **21** included in the intermediate conveyor **19** may be different from six. The conveyor belts **21** can be driven at linear speeds (that is to say, respective movement speeds at which the objects **2** are moved in the advancement direction F) which may vary over time and which can vary between one conveyor belt **21** and the other, so as to accelerate or slow down the objects **2** which the conveyor belts **21** advance, for the reasons described in more detail below.

[0070] The intermediate conveyor **19** further comprises a sensor arrangement **23** for detecting the presence of an object **2** on each of the conveyor belts **21**. The sensor arrangement **23** may comprise a plurality of sensors **24**, for example photocells, each of which is suitable for detecting passage of an object **2** close to the sensor **24** considered. The sensors **24** may be positioned in the transit zones between two consecutive conveyor belts **21**. A sensor **24** may further be located downstream of the conveyor belt **21** in the most advanced position along the advancement direction F. Moreover, a sensor **24** may be positioned upstream of the first conveyor belt **21**, that is to say, upstream of the conveyor belt **21** located at the most rearward position along the advancement direction F.

[0071] The intermediate conveyor **19** receives a flow of objects **2** coming from the infeed conveyor **3**, after these objects have passed through the object rejecting device **14**. In the flow of objects **2** which arrive on the intermediate

conveyor **19**, there may be empty positions, that is to say, positions in which, contrary to what is expected, an object **2** is missing.

[0072] The empty positions in the flow of objects **2** which arrives on the intermediate conveyor **19** may be due to the fact that, for various reasons, the operators have been unable to load an object **2** in the position considered, or they may be due to the fact that a non-conforming object **2** has been rejected in the object rejecting device **14**, leaving the corresponding position empty.

[0073] The sensors **24**, which detect the presence of the objects **2** on the intermediate conveyor **19**, detect when there is an empty position in the flow of objects **2** which arrive on the intermediate conveyor **19**. In this case, a control unit of the apparatus **1** accelerates one or more of the conveyor belts **21**, arranged downstream of the empty position relative to the advancement direction F, so as to reduce the distance between the object **2** which precedes the empty position and the object **2** which follows the empty position relative to the advancement direction F. The objects **2** are thus compacted along the intermediate conveyor **19** and the empty position is filled by the subsequent objects **2**. In this way, the flow of objects **2** which leaves the intermediate conveyor **19** to enter the packaging unit **20** is a continuous flow, that is to say, a flow which does not have empty positions in which an object **2** is missing.

[0074] The control unit can adjust the speed of the conveyor belts **21** in such a way that the distance (also known as "gap") between two consecutive objects **2** is controlled, as set by the control unit. Generally speaking, the distance between two consecutive objects **2** is not necessarily constant. The distance between two consecutive objects **2** may be selected as a function of an optimisation logic of the packaging process and may vary between a minimum value and a maximum value. More in detail, the distance between two consecutive objects **2** may be selected as a function of numerous parameters, such as: height of the object **2**, length of the object **2**, linear speed of the packaging unit **20**, number of conveyor belts **21** of the intermediate conveyor **19** on which there are objects **2**, basic weight of the paper used at that moment in the packaging unit **20**, properties of the glue used at that moment in the packaging unit **20**, status of certain digital signals present in the work stations **6**, status of certain digital signals received from a line supervision unit or "controller", and other parameters.

[0075] As described in more detail below after having described the packaging unit **20**, the intermediate conveyor **19** acts as a buffer, that is to say, as a temporary storage system in which one or more objects **2** are temporarily stored before transferring them to the packaging unit **20**.

[0076] As shown in FIG. **3**, the packaging unit **20** comprises a packaging conveyor **25** for transporting along the advancement direction F the objects **2**, wrapped in the packaging material, which in the example shown is paper, while a package is formed around each object **2**. The packaging conveyor **25** may comprise a plurality of conveyor belts, arranged in sequence along the advancement direction F. In particular, the packaging conveyor **25** may comprise a first conveyor belt **33**, located immediately downstream of the intermediate conveyor **19**, a second conveyor belt **34** for supporting the objects **2** during the packaging process, and a third conveyor belt **35** owing to which a plurality of packages **36** containing respective products can come out from the packaging unit **20**. The second conveyor belt **34** is interposed between the first conveyor belt **33** and the third conveyor belt **35**.

[0077] The packaging unit **20** further comprises a supporting core (not illustrated) for supporting a reel **26** of packaging material, more specifically paper. The reel **26** is housed in a cabinet **27**, shown in FIG. **1**, located on one side of the packaging conveyor **25** and spaced from the latter.

[0078] An unwinding device, not illustrated, is arranged for unwinding from the reel **26** a continuous web **28** of paper, which initially advances in an unwinding direction S which is transversal, more particularly perpendicular, to the advancement direction F, passing below a platform **29** interposed between the cabinet **27** and the packaging conveyor **25**.

[0079] Along the path from the reel **26** to the packaging conveyor **25**, the continuous web **28** of paper interacts with a plurality of diverting rollers, having the purpose of modifying a direction of movement of the continuous web **28** of paper, which initially coincided with the unwinding direction S perpendicular to the advancement direction F. After interacting with the diverting rollers, the continuous web **28** of paper is arranged parallel to the advancement direction F, immediately above the packaging conveyor **25** (more specifically, above the second conveyor belt **34**), in such a way that the objects **2** coming from the intermediate conveyor **19** and now moved by the first conveyor belt **33** are positioned above the continuous web **28** of paper.

[0080] The packaging unit **20** comprises an applying device **30** for applying on the continuous web **28** of paper an adhesive substance, particularly pressure sensitive glue, suitable for keeping closed the packages which will be formed with the continuous web **28** of paper. The applying device **30** may comprise one or more nozzles or spreading elements. The applying device **30** is configured to apply, on the continuous web **28** of paper, a longitudinal strip **31** of glue, which extends, for example continuously, along a longitudinal edge of the continuous web **28** of paper. When the continuous web **28** of paper is positioned on the packaging conveyor **25**, the longitudinal strip **31** of glue is parallel to the advancement direction F. The applying device **30** is further configured to apply, on the continuous web **28** of paper, two transversal strips **32** of glue, positioned transversally, in particular perpendicularly, to the advancement direction F. The transversal strips **32** may extend continuously from a longitudinal edge of the continuous web **28** of paper to the opposite longitudinal edge.

[0081] The applying device **30** may be configured to apply on the packaging material a single type of glue, or two types of glue different to each other. If the applying device **30** applies on the packaging material two different types of glue, the latter may be applied at different positions on the packaging material and may have properties and working life (or setting times or open times) which are different to each other.

[0082] Along the packaging conveyor **25**, in particular along the second conveyor belt **34**, two deflector elements **37** are provided having the function of folding two opposite longitudinal flaps of the continuous web **28** of paper around the objects **2**, in such a way that the continuous web **28** of paper forms a tubular enclosure **38** around the objects **2**. The longitudinal edge of the continuous web **28** of paper having the longitudinal strip **31** of glue is thus brought above a further longitudinal edge of the continuous web **28** of paper, in order to form a longitudinal joint **39**, which extends

continuously parallel to the advancement direction F. Along the longitudinal joint **39**, the longitudinal edges of the continuous web **28** of paper overlap one another.

[0083] A presser roller **40** is positioned along the packaging conveyor **25**, in particular above the second conveyor belt **34**, for applying pressure at the longitudinal joint **39**, in such a way that the glue stably glues the two overlapping longitudinal edges of the continuous web **28** of paper.

[0084] The packaging unit **20** may further comprise a printing device **41** for printing, on a portion of the continuous web **28** of paper intended to remain visible, an identification code to which information is associated relating to the specific object **2** which that portion of paper is intended to wrap. The identification code printed by the printing device **41** may be a bar code. In the example shown, the printing device **41** is positioned upstream of the presser roller **40**.

[0085] The printing device **41** may be used to personalise each package **36**, that is to say, to print on each package **36** information specific of that package **36**, different from the information printed on the other packages **36**. For example, the printing device **41** may be configured to print on each package **36** an identification code, such as a bar code, which uniquely identifies each package **36** produced (that is to say, each order made by a consumer, if the device **1** is used in the e-commerce field). It is further possible to use the printing device **41** to print on the packaging material the name of the recipient to whom the corresponding package **36** must be sent, and/or its delivery address, and/or any other information useful for tracking the package **36** or for dispatching it.

[0086] The packaging unit **20** further comprises a cutting and closing device **42** for separating consecutive packages **36** from each other and for closing the packages **36** transversally to the advancement direction F.

[0087] As shown in FIG. **5**, the cutting and closing device **42** may comprise a cutting blade **43**, which extends transversely, in particular perpendicularly, to the advancement direction F to cut the continuous web **28** of paper, which has been folded to form the tubular enclosure **38**, so as to separate two adjacent packages **36**.

[0088] The cutting blade **43** is interposed between two presser elements **44**, which in the example illustrated have a linear geometry and extend transversely, in particular perpendicularly, to the advancement direction F. The presser elements **44** are arranged for applying pressure to two portions of the tubular enclosure **38** arranged, respectively, upstream and downstream of the cutting blade **43**, on which the transversal strips **32** of the glue have been previously applied.

[0089] In this way, two transversal joints **45** are obtained for closing, respectively, a rear end of one package **36** and a front end of the next package **36**.

[0090] The cutting blade **43** is positioned above the packaging conveyor **25**. Beneath the packaging conveyor **25** an abutment element **46** is arranged, against which the cutting blade **43** abuts for cutting the tubular enclosure **38**, and against which the presser elements **44** abut for applying pressure to the portions of paper intended to be joined by the glue.

[0091] The cutting blade **43** and the presser elements **44** are supported by a transversal bar **47** which extends perpendicularly to the advancement direction F above the packaging conveyor **25**.

[0092] The transversal bar **47** is movable in a vertical direction, as indicated by the arrows G, along a pair of guides **48** located at the sides of the packaging conveyor **25**. Also the abutment element **46** is movable vertically, as indicated by the arrows H.

[0093] In this way, the transversal bar **47** and the abutment element **46** can move towards each other, in order to separate two adjacent packages **36** and close them near the cut, or to move away from each other for disengaging from the paper.

[0094] The guides **48** are movable forwards and backwards parallel to the advancement direction F, as shown by the arrows L, owing to a pair of carriages **49**. In this way, the cutting blade **43** and especially the presser elements **44** can remain engaged with the tubular enclosure **38** of paper for a stretch of the path of the tubular enclosure **38** along the advancement direction F, so that the presser elements **44** apply pressure to the glue for a sufficient period of time.

[0095] After the cutting and closing device **42** has interacted with the tubular enclosure **38**, individual packages **36** are separated from the tubular enclosure **38**, the individual packages **36** containing respective products. The third conveyor belt **35** removes the individual packages **36** from the packaging unit **20**. As shown in FIG. **3**, the dimensions of the packages **36**, in particular a length measured parallel to the advancement direction F, are variable between one package **36** and the next one, depending on the dimensions of the object **2** to be packaged.

[0096] Downstream of the packaging unit **20** a packages rejecting device **57** is arranged, suitable for allowing non-compliant packages **36** to be removed from the apparatus **1**.

[0097] The packages rejecting device **57** may comprise an initial conveyor **50**, a tiltable conveyor **51** and a final conveyor **52**, arranged in sequence along the advancement direction F. The initial conveyor **50** is located downstream of the packaging unit **20** for receiving packages **36** from the packaging belt **25**.

[0098] The tiltable conveyor **51** is intended to receive the packages **36** from the initial conveyor **50** and, as shown in FIG. **3**, may be arranged in a first position P**1** or alternatively in a second position P**2**. In the first position P**1**, the tiltable conveyor **51** is arranged substantially horizontally for conveying the packages **36** coming from the initial conveyor **50** towards the final conveyor **52**. In the second position P**2**, the tiltable conveyor **51** is, on the other hand, tilted downwards, so as to divert the packages **36** downwards, thereby directing them to a removal conveyor **53** located under the final conveyor **52**. The packages **36** to be rejected fall from the removal conveyor **53** on an underlying box **54**, shown in FIG. **1**, in which they accumulate. The box **54** shall have to be emptied by an operator when it is full of packages **36** to be rejected. The box **54** may be emptied without having to stop the apparatus **1**, so as not to have loss of productivity.

[0099] Along the packages rejecting device **57**, a plurality of photocells **55** may be provided.

[0100] During operation, the apparatus **1** starts to operate in an empty configuration, in which no object **2** has yet been loaded on the infeed conveyor **3**.

[0101] Initially, the infeed conveyor **3** and the conveyors of the object rejecting device **14** are moved with a linear advancement speed, in the advancement direction F, which corresponds to the maximum hourly productivity Pmax of the apparatus **1**. The parts of the apparatus **1** located downstream of the object rejecting device **14**, relative to the advancement direction F, are still stationary.

[0102] One or more operators, positioned in the respective work stations **6**, after being identified by the data input device present in each work station **6**, pick up successive objects **2** from the respective crate **9** positioned on the supporting element **8** and place them manually on the infeed belt **4** located in front of them. Each operator can position each object **2** in a free position, of his/her choice, on the infeed belt **4** assigned to him/her. The infeed belt **4** carries the objects **2**, in succession, to the portal **11** associated with that infeed belt **4**. In the portal **11**, the detector **12** measures the length of each object **2**, which has been loaded on the corresponding infeed belt **4**, in the advancement direction F. Moreover, in each work station **6**, the code reader **56** reads the identification code present on each object **2**. This allows a control unit of the apparatus **1** to track the object **2**, that is to say, know the position of the object **2** on the infeed conveyor **3** (and therefore in the apparatus **1**), as well as the data of the object coded in the respective identification code.

[0103] In the portal **11** of the work station **6** arranged further downstream than the other work stations **6**, that is to say, immediately upstream of the object rejecting device **14**, the further detector **13** further allows measurement of the height of the objects **2** which pass at the portal **11** and their width perpendicularly to the advancement direction F.

[0104] At this point, the control unit compares the dimensions of each object **2** with the limit dimensions which the apparatus **1** allows to be processed. The data of the object **2** which have been acquired by the code reader **56** are also analysed. If the control unit determines that the dimensions of the object **2** are within a range which can be processed by the apparatus **1** and that the data of the object **2** acquired by the code reader **56** conform to what is expected, the object **2** passes through the object rejecting device **14** and enters the intermediate conveyor **19**. If, on the other hand, the dimensions of the object **2** do not fall within the range which can be processed by the apparatus **1** and/or the data of the object **2** acquired by the code reader **56** do not conform to what is expected, the control unit decides to reject the object **2**. The tiltable conveyor **15** is thus moved to the second configuration C**2** to carry the object **2** on the removal conveyor **16**.

[0105] When the first object **2**, which has been found to be processable by the apparatus **1** and in accordance with what is expected, enters the object rejecting device **14**, the conveyor belts **21** included in the intermediate conveyor **19** are moved. The first object **2** which arrives on the intermediate conveyor **19** is transported quickly in the advancement direction F towards the packaging unit **20**, which is at this point put into motion.

[0106] The apparatus **1** may now start to package the objects **2** for producing the packages **36**.

[0107] During operation, the sensors **24** positioned along the intermediate conveyor **19** control the position of the objects **2** which move in the advancement direction F to determine whether empty positions are present in the flow of objects **2** coming from the object rejecting device **14**. If this occurs, the conveyor belts **21** accelerate the objects **2** which follow the empty position, in such a way that the latter is filled, that is to say, in such a way as to generate a flow of objects **2**, entering the packaging unit **20**, in which there are no empty positions. This ensures that, in the packaging unit **20**, empty packages are not produced due to the presence of empty positions in the flow of objects **2** coming from the infeed conveyor **3**.

[0108] By acting on the linear speed of each conveyor belt **21**, which may be chosen independently of the linear speed of the other conveyor belts **21**, it is ensured that the distance between two consecutive objects **2** entering the packaging unit **20** is controlled, on the basis of the parameters listed previously.

[0109] The conveyor **19** acts as a phasing and distance controlling conveyor, since it positions the objects **2** one after the other in the advancement direction F, in such a way that there are no empty positions in the flow of objects **2** which enter the packaging unit **20** and in such a way that consecutive objects **2** which enter the packaging unit **20** are at controlled distances.

[0110] Each object **2** which enters the packaging unit **20** is detected by an infeed detector **58**, shown in FIG. **3**, which activates the applying device **30** so that the latter applies the glue on the continuous web **28** of paper, in zones of the paper intended to form the package **36** which will wrap the object **2** at issue.

[0111] Since a continuous flow (that is to say, without empty positions) of objects **2** enters in the packaging unit **20**, a continuous queue of objects **2** is generated in the packaging unit **20**, the objects **2** of the queue waiting to be packaged and positioned upstream of the cutting and closing device **42**. This continuous queue corresponds to a strip of paper, unwound from the reel **26**, to which the glue has already been applied in the appropriate positions for closing the packages **36** in which the objects **2** will be enclosed.

[0112] The glue has a working life or setting time or open time, that is to say, a time during which the portions of paper to be joined must be superposed and pressed against each other, so that the glue can set and form a sealed joint.

[0113] The open time depends on the type of glue used and is usually several tens of seconds. In order to have reasonable certainty that the packages **36** remain closed, the interval of time between the moment the glue is applied to the continuous web **28** of paper by the applying device **30** and the moment in which pressure is applied to superposed portions of paper to be glued, by the presser roller **40** and to the presser elements **44**, has to be less than the open time of the glue.

[0114] The speed of the packaging unit **20** is linked to the speed of the intermediate conveyor **19**. More specifically, the speed of the packaging unit **20** adapts, that is to say, it decreases or increases automatically, according to a logic which will be explained below.

[0115] As mentioned above, the intermediate conveyor **19** acts as a buffer, that is to say, as a temporary storage zone in which a controlled number of objects **2** are temporarily stored, waiting to enter the packaging unit **20**.

[0116] If a flow of objects **2** arrives on the intermediate conveyor **19** with a speed, intended as number of objects **2** per hour, which is equal to the maximum hourly productivity Pmax of the apparatus **1**, a predetermined filling level is maintained on the intermediate conveyor **19**.

[0117] "Predetermined filling level" means a predetermined value of the ratio between the space on the intermediate conveyor **19**, measured along the advancement direction F, occupied by objects **2** positioned at controlled respective mutual distances, and the total space available for the objects **2** on the intermediate conveyor **19**, in the advancement direction F.

[0118] In other words, the filling level is the ratio between the longitudinal dimension of the intermediate conveyor **19**

on which, at the considered moment, objects **2** are present which are placed at controlled respective mutual distances, and the total longitudinal dimension of the intermediate conveyor **19**.

[0119] In the illustrated embodiment, the predetermined filling level which is maintained on the intermediate conveyor **19** may be an average filling level, for example equal to approximately three conveyor belts **21** of six. This means that a predetermined number of conveyor belts **21** adjacent to the packaging unit **20** is kept occupied by objects **2**, while the remaining conveyor belts **21** closest to the object rejecting device **14** are empty.

[0120] The packaging unit **20**, which is consequently fed with a number of objects per hour which is a substantially constant (and equal to the maximum hourly productivity Pmax of the apparatus **1**) in the interval of time considered, adapts its linear speed, that is to say, the linear speed of the first conveyor belt **33**, of the second conveyor belt **34** and of the third conveyor belt **35**, taking into account only the different length of consecutive objects **2** in the advancement direction F. In other words, the linear speed of the packaging unit **20** is adjusted instant by instant, taking into account the length of the objects **2** to be packaged, to ensure that the set hourly productivity is complied with, which in the case considered is equal to the maximum hourly productivity Pmax. The linear speed of the packaging unit **20** is adjusted in such a way that the number of packages **36** coming out from the packaging unit **20** corresponds to the maximum hourly productivity Pmax.

[0121] If, as realistically occurs, the flow of objects **2** which enter the intermediate conveyor **19** varies continuously, for example because there are empty positions in this flow, the linear speed of the conveyor belts **21** is adjusted in such a way that the empty positions are filled, by accelerating the objects **2** which follow the empty positions relative to those preceding them. By modifying the linear speed of the conveyor belts **21**, it is possible to keep under control, equal to desired values, the distance between consecutive objects **2** which enter the packaging unit **20**. The latter will work with a variable speed, meaning both linear speed and hourly productivity, depending on the number and dimensions of the objects **2** which the packaging unit **20** receives from the intermediate conveyor **19** in the unit of time.

[0122] The speed of the packaging unit **20** is in this case selected to keep in the intermediate conveyor **19** a predetermined filling level, that is to say, a predetermined value of the ratio between the longitudinal dimension of the intermediate conveyor **19**, measured in the advancement direction F, occupied by objects **2** that are positioned on the intermediate conveyor **19** at a controlled mutual distance, and the total longitudinal dimension of the intermediate conveyor **19**, measured along the advancement direction F and available to receive the objects **2**.

[0123] In the illustrated example, the predetermined filling level corresponds to a predetermined number of conveyor belts **21** occupied by the objects **2**. This filling level may be, for example, 50%, that is to say, corresponding to three conveyor belts **21** out of six which are occupied by objects **2**.

[0124] If the number of objects **2** which are received from the intermediate conveyor **19** in the unit of time decreases in a very marked manner and falls below a predetermined value, for example because the number of operators present in the work stations **6** has reduced, the control unit is configured to ensure that the number of conveyor belts **21** on which objects **2** are present is minimal. For example, it is possible to ensure that the objects **2** accumulate only on a conveyor belt **21** immediately upstream of the packaging unit **20**, or that they are even transferred immediately to the packaging unit **20** without accumulating objects **2** on the conveyor belts **21**. This result is obtained by adapting the speed of the packaging unit **20**.

[0125] More specifically, the packaging unit **20** slows down its speed, meaning in this case the productivity, that is to say, the number of packages formed per unit of time. In particular, the productivity of the packaging unit **20** is in this case determined on the basis of the working life or open time of the glue applied by the applying device **30**. In other words, under conditions of low flow of objects **2** entering the intermediate conveyor **19**, the parameter which determines the speed of the packaging unit **20** is no longer the filling level of the intermediate conveyor **19**, but becomes the working life or open time of the glue. That is to say, in these conditions, the packaging unit **20** works at the lowest production speed compatible with the open time of the glue. In other words, the speed of the packaging unit **20** is adjusted in such a way that the time the glue remains on the paper, before the respective joints are closed, is less than the open time of the glue.

[0126] If no other objects arrive on the intermediate conveyor **19**, the packaging unit **20**, proceeding at a low speed as described above, compatibly with the open time of the glue, packages all the objects **2** present in the packaging unit **20** upstream of the cutting and closing device **42**. The packaging unit **20** is thus progressively emptied.

[0127] When objects **2** to be packaged are no longer present in the packaging unit **20**, the packaging unit **20** stops while waiting to receive new objects **2** from the intermediate conveyor **19**.

[0128] When the flow of objects **2** on the intermediate conveyor **19** is re-activated, the packaging unit **20** returns to operation, guaranteeing however that the paper present in the packaging unit **20**, which has already been unwound from the reel **26** and corresponds to empty positions, in which no objects **2** were present, is rejected at the outfeed of the packaging unit **20**, as if it were an empty package, using the packages rejecting device **57**.

[0129] The start of the packaging unit, from an empty configuration of the apparatus **1**, can further be controlled by adopting other types of logic which are more sophisticated than the one described above. For example, the packaging unit **20** may be controlled in such a way as to restart only when a predetermined number of objects **2** has accumulated on the intermediate conveyor **19**. This predetermined minimum number of objects **2** may in turn be defined on the basis of a criterion or an algorithm which takes into account various parameters, such as number of operators present in the work stations **6**, number of objects **2** which are entering the infeed conveyor **3**, sum in millimetres of the lengths of all the objects present in a predetermined initial portion of the apparatus **1**, and others. The aim is to restart the packaging unit **20** only when there is reasonable certainty that there is a significant number of objects **2** at the infeed, so as to prevent the packaging unit **20** from stopping again, within a short space of time, which would result in unnecessary waste of paper.

[0130] In the embodiment of the apparatus **1** which has been described above, reference has always been made to an

intermediate conveyor **19** comprising a plurality of conveyor belts **21** arranged in sequence along the advancement direction F, wherein any empty position along the intermediate conveyor **19** is filled by increasing the speed of at least one conveyor belt **21** which conveys the objects **2** following the empty position, relative to the speed of at least one further belt conveyor **21** which conveys the objects **2** preceding the empty position.

[0131] However, it is possible to fill any empty position along the intermediate conveyor **19** and/or position the objects **2** at controlled mutual distances along the intermediate conveyor **19**, also by adopting procedures different from the increase in the speed of a subsequent conveyor belt **21** relative to a preceding conveyor belt **19**.

1. A method comprising the steps of:

positioning a plurality of objects, having different dimensions to each other, on an infeed conveyor;

delivering to an intermediate conveyor a flow of objects coming from the infeed conveyor and movable along an advancement direction;

feeding a packaging unit with the objects coming from the intermediate conveyor, the packaging unit producing a plurality of packages, starting from a web of packaging material, each package containing one of said objects;

the method further comprising the step of checking if, in the flow of objects which advance along the intermediate conveyor, there are empty positions in which an object is missing and wherein, if an empty position is detected, there is provided filling the empty position by accelerating the objects which follow the empty position relative to the objects which precede the empty position, wherein the intermediate conveyor comprises a plurality of conveyor belts arranged in sequence along the advancement direction and wherein, if the number of objects arriving on the intermediate conveyor in the unit of time is greater than or equal to a predetermined value, the production speed of the packaging unit is adjusted in such a way as to keep in the intermediate conveyor a predetermined average filling level.

2. The method according to claim **1**, and further comprising the step of controlling the speed of the conveyor belts in such a way as to arrange the objects at a controlled distance from each other at the infeed of the packaging unit.

3. The method according to claim **1**, wherein the objects which follow the empty position are accelerated by increasing the speed of at least one conveyor belt which transports the objects which follow the empty position relative to the speed of at least one further conveyor belt which transports the objects which precede the empty position.

4. The method according to claim **1**, wherein the intermediate conveyor acts as a buffer in which a plurality of objects is temporarily accumulated while waiting to enter the packaging unit.

5. The method according to claim **1**, wherein the predetermined average filling level corresponds to a predetermined value of the ratio between a longitudinal dimension of the intermediate conveyor, measured in the advancement direction, occupied by objects which are positioned on the intermediate conveyor at a controlled mutual distance, and a total longitudinal dimension of the intermediate conveyor along the advancement direction available for receiving the objects.

6. The method according to claim **1**, wherein the predetermined average filling level corresponds to a predetermined average number of conveyor belts filled with the objects.

7. The method according to claim **6**, wherein the average filling level corresponds to half of the conveyor belts filled with the objects.

8. The method according to claim **1**, wherein the web of packaging material is fed to the packaging unit with a variable linear speed which is determined on the basis of the number of objects which the packaging unit receives from the intermediate conveyor and on the basis of the length of each object in the advancement direction.

9. The method according to claim **1**, wherein an applying device applies glue on the web of packaging material to generate at least one joint and to close a corresponding package and wherein, if the number of objects arriving on the intermediate conveyor in the unit of time is less than or equal to a predetermined value, the web of packaging material is fed to the packaging unit with a linear speed calculated in such a way that the glue remains on the packaging material, before applying pressure to said at least one joint, for a length of time less than an open time of the glue.

10. The method according to claim **1**, wherein the objects have been purchased through the Internet and are packaged in the packaging unit before being dispatched to the people who ordered them.

11. The method according to claim **1**, wherein the packaging material is paper.

12. An apparatus comprising:

an infeed conveyor for receiving a plurality of objects, having different dimensions to each other;

an intermediate conveyor, located downstream of the infeed conveyor for receiving a flow of objects from the infeed conveyor in an advancement direction;

a packaging unit located downstream of the intermediate conveyor for producing a plurality of packages starting from a web of packaging material, each package containing one object;

wherein along the intermediate conveyor at least one sensor is arranged for controlling whether, in the flow of objects advancing along the intermediate conveyor, there are empty positions in which an object is missing and in that the intermediate conveyor comprises a plurality of conveyor belts arranged in sequence along the advancement direction so that, if an empty position is detected, the objects which follow the empty position are accelerated to fill the empty position, the production speed of the packaging unit being adjustable in such a way as to keep in the intermediate conveyor a predetermined average filling level.

13. The apparatus according to claim **12**, and further comprising an object rejecting device interposed between the infeed conveyor and the intermediate conveyor, the object rejecting device comprising a tiltable conveyor which can be positioned in a first configuration, in which the tiltable conveyor is arranged horizontally for conveying the objects from the infeed conveyor to the intermediate conveyor, the tiltable conveyor being further positionable in a second configuration in which the tiltable conveyor is tilted downwards to divert the objects on a removal conveyor.

14. The apparatus according to claim **12**, wherein the packaging unit comprises an applying device for applying glue on the web of packaging material, a plurality of

deflector elements for folding the web of packaging material and forming a tubular enclosure around the objects, at least one presser for applying pressure to overlying portions of the web of packaging material on which the glue is present, a cutting blade for separating successive packages from the web of packaging material.

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