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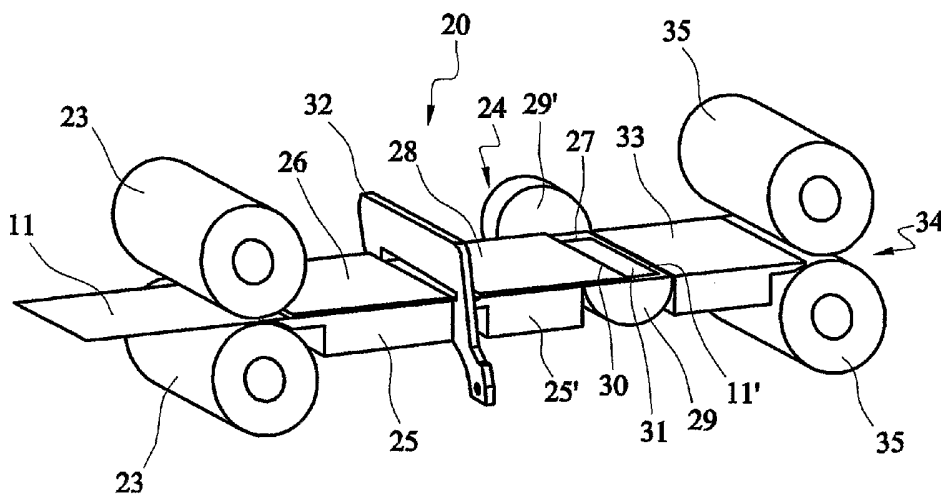
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(54) Title: APPARATUS AND METHOD FOR FOLDING A SHEET OF FOIL



(57) Abstract: An apparatus (20) for folding a sheet of foil (11) includes a feeder (23) and a folding means (24). The feeder (23) can feed a sheet of foil to the folding means (24). The folding means (24) includes a first surface (27) and a second surface (28) which can be arranged to bear against first and second opposing faces respectively of a portion (31) of the sheet of foil (11) at or near to the leading edge (11') of the sheet of foil. One or both of the first and second surfaces (27, 28) can be rotated about a foldable axis between the first and second opposing faces to create a first fold along the foldable axis.

APPARATUS AND METHOD FOR FOLDING A SHEET OF FOIL

The present invention relates to an apparatus and method for folding a sheet of foil to create individual portions of foil having one or more folds. These portions are suitable for use, though not exclusively, in the hairdressing industry when colouring or highlighting hair.

When colouring or highlighting hair, aluminium foil is used to separate strands of hair so the stylist can 'paint' on the colour to a specific section of the hair. The foil is cut into different lengths which is determined by the length of hair to be treated, this may be between 10cm and 40cm. One end of the foil is then folded over one or two times. This fold may be in the region of 1cm.

The reason for this fold is to give the colourist a guide as to where to start the application of colour and also to give a smooth edge to the foil so it does not irritate or scratch the clients head.

The colourist selects strands of hair and places them on the cut foil, with the folded side towards the head. They then use a colour brush to cover the hair with a hair lightener or colour, depending on the desired effect. The bottom of the foil is then folded up to the top to sandwich the hair. Both the sides are then folded inwards to create a little parcel, enclosing the hair and colour. The foil not only separates the hair to allow the colour to be applied accurately to a specific area, but also retains heat to aid the speed of the colouring process.

The foils are usually supplied in a number of thicknesses 14, 18 and 20 microns and a number of widths, 10cm, 12cm and 44cm. The foil can either be bought on a roll or in pre-cut lengths. The rolls are usually in lengths of 100m, 150m, 225m, 500m and 1000m or pre-cut into lengths of 10cm and 12 cm.

To cut the foil into the required lengths is a very labour intensive and laborious process, the maker having to gauge the length, obtain a straight cut, and fold over the end. This process may have to be repeated for around 80 times per client. Even if pre-cut foils are provided it is still a very time-consuming and tedious task to fold the edge of the foil.

Pending US patent application, published under number US2002-0003157A1, discloses an apparatus for producing folds in aluminium foil. The machine feeds aluminium foil to a knife mechanism which cuts the trailing edge of the sheet to produce cut sheets. The knife mechanism creates a folded part on the trailing edge which can interact with a knock-down roller provided with indentations. The interaction between the roller and the folded part causes the folded part to fold over on itself as the cut sheet advances. This apparatus offers little control over the creation of the fold.

According to a first aspect of the present invention there is provided an apparatus for folding a sheet of foil, the apparatus comprising:

a feeder for feeding the sheet of foil to a folding means, the folding means comprising a first surface and a second surface arranged to bear against first and second opposing faces respectively of a portion of the sheet of foil at or near to the leading edge of the sheet of foil, wherein one or both of said first and second surfaces are rotatable about a foldable axis between the first and second opposing faces to create a first fold along the foldable axis.

Arranging the first and second surfaces to bear on opposite faces of the foil and then rotating the foil between them provides a greater degree of control over where the fold is created along the length of the foil. Creating the fold towards the leading edge means that once the foil is folded it can immediately leave the folding means without coming into contact with anything which disturbs the fold.

Preferably, the first and second surfaces can be rotated to create multiple folds at or near to the leading edge of the sheet of foil.

Conveniently, the first and second surfaces can be disposed at the same point along the length of the foil, at or near to the leading edge of the foil; and

in which, in use, the first and second surfaces can be rotated, in the same sense about the foldable axis to create one or more folds in the foil.

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In preferred embodiments, the first and second surfaces, prior to the folding, can be disposed on either side of the sheet such that the surfaces are non co-planar with the plane of the sheet. This enables the first and second surfaces to approach the sheet of foil from virtually any angle.

The first and second surfaces may be rotated through substantially 180 degrees. In other embodiments, the first and second surfaces can be rotated through a further 180 degrees or more. Rotating the first and second surfaces through around 180 degrees provides a single fold in the foil. Further rotation to around 360 degrees creates a double fold in the foil.

Conveniently, the first and second surfaces are withdrawable from the sheet.

Preferably, the first and second surfaces are connected to each other in a common plane. The first and second surfaces may be connected to each other so as to form a generally u-shaped member. A u-shaped member can easily be positioned such that each of its limbs can bear opposite faces of the sheet of foil. The foil can then simply be twisted around the u-shaped member to create a suitable fold or folds. The limbs of the u-shaped member may be substantially 10 cm to 50 cm in length. Most preferably, the limbs are between substantially 10 cm and 20 cm in length. The separation between the limbs may be substantially 1 to 5 mm. Most preferably, the separation is around 2 to 3 mm.

In another embodiment, the first surface rotates, in use, about the foldable axis and the second surface is stationary in use.

Most preferably, the second surface has a first edge, the first surface being rotatable in use relative to the second surface about the axis of the foldable portion, from a first position in which the first and second surfaces are parallel and staggered relative to each other, to a second position in which the first and second surfaces capture the foldable portion to create a first fold along the foldable axis, the first surface being rotatable back to the first position.

Capturing the foil between the first and second surfaces and folding it over the first edge of the stationary second surface creates a sharp, well-defined fold in the foil.

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The apparatus, may comprise a guide member which prevents lateral movement of the foil during the folding. Preferably, the guide member is integral with the first and/or second surfaces. Use of a guide member prevents the foil from diverging from its path during the folding operation.

Conveniently, the apparatus comprises cutting means for cutting a trailing edge of the portion of foil. The cutting means may comprise a knife or guillotine. Most preferably, the portion of foil is cut after completion of the folding operation.

Preferably, the apparatus further comprises receiving means for receiving the portion of foil after the folding. The receiving means may take the form of a substantially flat surface on to which the cut portion can be advanced.

Conveniently, the apparatus further comprises flattening means which in use can be brought into engagement with the folded end of the foil to flatten the fold or folds. Preferably, the flattening means comprises a pair of rollers between which the folded portion of the foil can pass. Alternatively, the flattening means may comprise a pair of opposed surfaces which can be brought together to receive the folded portion of the foil. Use of flattening means presses or smoothes the folded portion to prevent the fold or folds from springing apart.

In preferred embodiments, the apparatus further comprises scoring means which, in use, can be used for scoring the first and/or second face of the sheet of foil between the folded portion and the trailing edge. Preferably, the score is substantially parallel to the trailing edge and / or folded portion. Providing a score on the surface of the foil sheet between the trailing edge and the folded portion provides a guide for a hairstylist when folding the foil up to create a folded package when colouring hair. Preferably, the score is substantially midway between the trailing edge and folded portion.

Preferably, the apparatus further comprises removal means for removing the portion of the foil sheet from the folding means. The removal means may comprise a pair of roller. The scoring means may form part of the flattening means, the receiving means, or the removal means.

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In certain embodiments, the apparatus comprises marking means for marking one or both of the opposing faces of the portion of foil with one or more identification marks. The identification marks may include one or more colours, preferably stripes of colours. The stripes may be between 10 mm and 50 mm in length. Identification marks can be used to identify individual sheets of foil which are to be used in a designated way. For example, if a particular colour is marked on the foil this can be used to indicate which colour(s) of dye is to be used in conjunction with that piece of foil. Alternatively, or additionally, information may be stamped or imprinted on to the surface(s) of the foil, such as the length of time which a piece of foil has to be held in contact with the hair to effectively dye the hair. The marking means may comprise an inkjet printer or a stamp. In other embodiments, the scoring means may be used to imprint identification marks on the surface(s) of the sheet of foil.

Most preferably, the first and second surfaces are rigid. Use of rigid surfaces helps to produce a sharp, well-defined, and secure fold.

In preferred embodiments, the first and second surfaces are substantially planar. Use of substantially planar surfaces creates flat folded surfaces.

The length of the individual sheets may be varied. The length of the individual sheets may be varied by varying the length of the second surface and/or by varying the distance between the first edge and the cutting means. The width of the folded portion from the leading edge in a direction towards the trailing edge may be varied by varying the separation between the first edge and the receiving means.

In other embodiments, the apparatus may be contained within a housing.

According to a further aspect of the present invention there is provided a method for folding a sheet of foil, the method comprising:
providing an apparatus as defined in any of the embodiments defined above.

Most preferably, the method comprises:
feeding the sheet of foil to the folding means;

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bearing the first and second surfaces against first and second opposing faces respectively of the portion of the sheet of foil at or near to the leading edge of the sheet of foil; and

rotating one or both of said first and second surfaces about the foldable axis between the first and second opposing faces thereby creating a first fold along the foldable axis.

Conveniently, the method comprises:

disposing the first and second surfaces at the same point along the length of the foil, at or near to the leading edge of the foil; and

rotating the first and second surfaces, in the same sense about the foldable axis thereby creating one or more folds in the foil.

Preferably, the method comprises:

rotating the first and second surfaces through substantially 180 degrees.

In preferred embodiments, the method comprises:

rotating the first and second surfaces through a further 180 degrees or more

Preferably, the method comprises:

rotating the first surface relative to the second surface about the axis of the foldable portion, from a first position in which the first and second surfaces are parallel and staggered relative to each other, to a second position;

capturing the foldable portion using the first and second surfaces in the second position thereby creating a first fold along the foldable axis; and

rotating the first surface back to the first position.

Conveniently, the method further comprises:

advancing the sheet of foil to provide a further foldable portion at or near to the leading edge;

rotating the first surface relative to the second surface about the axis of the further foldable portion, from the first position to the second position;

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capturing the foldable portion using the first and second surfaces in the second position thereby creating a second fold along the foldable axis; and rotating the first surface back to the first position.

The method may comprise:

cutting a trailing edge of the portion of foil after completion of the folding.

Preferably, the method further comprises scoring the foil sheet between the folded portion and the trailing edge.

In certain embodiments, the method further comprises marking one or both of the opposing faces of the portion of foil with one or more identification marks. Preferably, the marking takes place after the folding operation. Most preferably, the sheet of foil is marked after the cutting operation.

The apparatus would be conveniently located in the hair salon and would consist of a means of holding the roll of foil allowing it to rotate as required.

According to a yet further aspect of the invention there is provide a method of preparing aluminium foil at preferably a hair salon by a semi automatic apparatus, operated by a member of staff.

Conveniently, the aluminium foil is cut into predetermined lengths and one end folded over according to requirements .The aluminium foil may be in different widths and thickness. In alternative embodiments, the aluminium foil is cut into predetermined lengths and one end folded over according to requirements in a fully automatic mode.

Conveniently, the aluminium foil is cut into predetermined lengths and one end folded over according to requirements by mechanical means. In other embodiments, the aluminium foil is cut into predetermined lengths and one end folded over according to requirements by mechanical means electronically driven. Preferably, the aluminium foil is cut into

predetermined lengths and one end folded over according to requirements to a predetermined number.

To operate the apparatus, the foil would be placed onto a rotating spindle and the loose end threaded between a pair of rollers. A length of foil extends beyond the rollers and is gripped by a folding device. This may be tapered with the narrowest part at the end farthest from the mounting. This would be capable of rotating. Having been rotated one or more times it is drawn away from the first set of rollers to the preset position at which the flattening device is located. It then moves horizontally away, leaving the foil in an open folded configuration. This is flattened with the flattening positioned above the preset position. The section members then return starting position close to the rollers. The foil is then parted by a scissor or other cutting means. The process is then repeated.

Embodiments of the present invention will now be described, by way of example only, with reference to the following figures in which:

Figure 1 shows a first embodiment of the present invention before the start of a folding operation;

Figure 2 shows the apparatus of Figure 1 in which planar surfaces are interacting with a leading edge of the foil;

Figure 3 shows the apparatus of Figure 2 after the rotation of the planar surfaces;

Figure 4 shows the apparatus as in Figure 3 with the foil in an advanced position;

Figure 5 shows the apparatus of Figure 4 with the planar surfaces withdrawn and the foil in a folded configuration;

Figure 6 shows the apparatus of Figure 5 prior to a cutting operation to create an individual foil sheet and the folded leading edge about to enter a flattening means;

Figure 7 shows the apparatus of Figure 6 with a cutting means in contact with the sheet of foil;

Figure 8 shows the planar surfaces about to receive a further leading edge of the foil prior to the start of a further folding operation;

Figure 9 shows a side view of an apparatus according to the present invention with the planar surfaces in a neutral position;

Figure 10 shows the apparatus of Figure 9 in greater detail;

Figures 11a) to 11e) show the schematic operation of the apparatus according to the first embodiment of the present invention;

Figures 12a, b, and c show respectively an asymmetric view, a plan view and a side view of an individual foil sheet prepared by the apparatus according to the first embodiment of the present invention;

Figure 13 shows an asymmetric view of a second embodiment of an apparatus according to the present invention prior to the start of a folding procedure;

Figure 14 shows the apparatus of Figure 13 in which the folding procedure has begun;

Figure 15 shows the apparatus of Figures 13 and 14 in which the folding procedure has been completed;

Figure 16 shows the apparatus of Figures 13 to 15 with a cutting means in operation;

Figures 17a) to 16f) show schematically the operation of the second embodiment of the present invention.

An apparatus (10) according to a first embodiment of the present invention is shown in Figures 1 to 11. Aluminium foil (11) which is rolled up into a roll located on a rotating spindle (12) is fed to a feeding means (13). The leading edge (11') of the foil is fed through the feeding means which in the embodiment shown takes the form of a pair of rollers (13) which feed the edge (11') of the foil towards a folding means (14).

In the embodiment shown, the folding means (14) takes the form of a generally u-shaped member having a pair of limbs (15) connected at a first end and separated over a part of their length by a gap (16). The folding means (14) can be introduced to a portion of the foil at or near to the leading edge (11') such that edges (15') of the limbs (15) are positioned above and below the sheet of foil (11), as shown in Figures 1 and 2.

The folding means (14) can then be rotated by around 180° to produce a first fold at or near to the leading edge (11') of the foil. Rotation of the folding means (14) by a further 180° creates a second fold at or near to the leading edge (11') of the foil. Effectively the leading edge (11') is folded back to create a double fold. After this double folding procedure has been completed, the foil can be advanced as shown in Figure 4. The folding means (14)

can then be withdrawn from the folded end (17) of the foil. This is illustrated in Figure 5.

The folded end (17) can be fed into a flattening means (18) and a cutting means (19) introduced to the sheet of foil. The cutting means (19) can impinge upon the sheet to cut the sheet and create an individual sheet having a trailing edge (20). The folded end (17) of the sheet can be received by the flattening means (18) which smooths or flattens the folded edge (17). In the embodiment shown, the flattening means (18) takes the form of two opposing surfaces which can be brought into engagement with the folded end (17). In other embodiments (not shown) the flattening means may comprise a pair of rollers through which the individual sheet can pass.

Figure 11a) shows the folding means limbs (15) of the folding means (14) engaging the leading edge (11') of the sheet (11) at a relatively acute angle. As the folding means (14) is rotated, a portion of the foil at or near to the leading edge (11') is captured and folded back towards the upper surface of the sheet (11). Figure 11c) shows the leading edge (11') having been folded through approximately 180° to produce a single fold. The leading edge (11') of the sheet may be folded through approximately a further 180° to create a second fold at or near to the leading edge (11') as shown in Figure 11c). After this double folding procedure has been completed, the folding means (14) can be withdrawn and the sheet cut as described above.

An apparatus (20) of a second embodiment of the present invention is shown in Figures 13 to 16. The apparatus (20) of the second embodiment includes a feeding means (23) which can feed a sheet of foil (11) towards a folding means (24). As the leading edge (11') of the sheet leaves the folding means (23) it passes over a pair of lower support surfaces (25, 25') and under an upper guide surface (26). The folding means (24) consists of first and second surfaces (27, 28) between which foil can be captured to create a fold. In the embodiment shown, the first surface (27) forms part of a semi-cylindrical body (29). The second surface (28) has a first edge (30) around which the foil is folded to create one or more folds in the foil. The semi-cylindrical body (29) is connected to a generally cylindrical body which has a flat surface (29') which acts as a guide member to prevent lateral movement of the foil during the folding operation. In other embodiments (not shown), the guide member may take the form of side

walls located at one or both sides of the upper guide surface (26) or the second surface (28).

Prior to a folding procedure, a portion (31) of the sheet of foil at or near to the leading edge (11') of the sheet of foil (11) projects beyond the first edge (30) of the second surface (28) in to a folding region or area. This is best illustrated in Figure 13. In this non-folding position, the portion (30) of the foil is located between the first and second surfaces (27, 28) which are parallel to each other and in a staggered configuration.

In operation, the first surface (27) is rotated relative to the second surface (28) about an axis of the foldable portion (31) from a first position in which the first and second surfaces (27, 28) are parallel and staggered relative to each other (as shown in Figure 13) to a second position in which the first and second surfaces (27,28) capture the foldable portion (31) to create a first fold along the foldable axis (as shown in Figure 14).

After a fold has been created, the first surface (27) is rotated back to the first position. The leading edge (11') of the sheet of foil is then advanced to provide a further foldable portion at or near to the leading edge. In a repeat process, the first surface (27) is rotated again relative to the second surface (28) about an axis of the further foldable portion from the first position to the second position. The first and second surfaces (27,28) capture the foldable portion in the second position and create a second fold along the foldable axis. After the second folding operation the first surface (27) is returned back to the first position.

Figure 15 shows the situation where the leading edge of the foil has been folded twice to create a folded edge (17). A cutting means (32) can then be brought into engagement with the sheet of foil to create a trailing edge (as described above) and an individual portion or cut section of sheet having the folded edge (17).

After the sheet has been cut the individual sheets may be received by a receiving means (33). In the embodiment shown, the receiving means takes the form of a substantially flat surface. The portion may then be fed into a flattening means (34) which smooths and flattens the folded edge (17). In the embodiment shown, the flattening means (34) comprises a pair of rollers (35).

After the individual sheets leave the flattening means (34), or before they enter it, a scoring means (not shown) can be used to score the upper surface of the individual sheets. The scoring means may include a blade element similar to the cutting means which is arranged to impinge upon the surface of the foil sheet, but not to cut through the sheet. In alternative embodiments, the scoring means may comprise a blade or other sharp element which is drawn across the foil sheet in a direction perpendicular to the direction of travel of the foil sheet. In practice, the score is parallel to the trailing edge and folded portion, and is arranged midway between these two points. Providing a score on the surface of the foil sheet acts as a guide for the colourist when folding the individual foil sheets into folded packages when colouring hair.

Figures 17 a) to f) show the various steps involved in the folding procedure used by the second embodiment of the present invention. Figure 17a) shows the first and second surfaces (27, 28) prior to a folding procedure. A foldable portion (31) of foil at or near to the leading edge of the foil extends beyond the first edge (30) of the second surface (28). The first surface (27) is then rotated relative to the second surface (28) to create a first fold and is then rotated back to its original position (Figures 17b) and c)). The procedure is then repeated (Figures 17d) to f) to produce a double fold.

In other embodiments (not shown) a marking means may be used to place identification marks on to one or both of the surfaces of the sheet of foil. The marking means can be a printer, for example an inkjet printer, which can be used to place identification marks on the surface(s) of the foil. Alternatively, the marks may simply be imprinted on to the surfaces of the foil by means of a stamp or press. The marking means can form part of one or more of the flattening means (34), the receiving means (33), or the removal means. Referring to Figures 13 to 16, the marking means may be located above flat plate of the receiving means (33). Alternatively, the marking means may be integral with the receiving means (33). The marking means can be used to mark the underside of the individual sheets of foil (11) as they pass from the folding area after the cutting procedure. The marking can take place before, during or after, the flattening procedure.

Claims:

1. An apparatus for folding a sheet of foil, the apparatus comprising:
a feeder for feeding the sheet of foil to a folding means, the folding means comprising
a first surface and a second surface arranged to bear against first and second opposing
faces respectively of a portion of the sheet of foil at or near to the leading edge of the sheet of
foil, wherein one or both of said first and second surfaces are rotatable about a foldable axis
between the first and second opposing faces to create a first fold along the foldable axis.
2. An apparatus as claimed in claim 1 wherein the first and second surfaces can be
rotated to create multiple folds at or near to the leading edge of the sheet of foil.
3. An apparatus as claimed in claim 1 or 2 wherein the first and second surfaces can
be disposed at the same point along the length of the foil, at or near to the leading edge of the
foil; and
in which, in use, the first and second surfaces can be rotated, in the same sense about
the foldable axis to create one or more folds in the foil.
4. An apparatus as claimed in claim 3 wherein the first and second surfaces, prior to
the folding, can be disposed on either side of the sheet such that the first and second surfaces
are non co-planar with the plane of the sheet.
5. An apparatus as claimed in claims 3 or 4 wherein the first and second surfaces are
rotated through substantially 180 degrees.
6. An apparatus as claimed in 5 wherein the first and second surfaces can be rotated
through a further 180 degrees or more.
7. An apparatus as claimed in any of preceding claim wherein the first and second
surfaces are withdrawable from the sheet.
8. An apparatus as claimed in any of claims 3 to 7 wherein the first and second

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surfaces are connected to each other in a common plane.

9. An apparatus as claimed in claim 1 wherein the first surface rotates, in use, about the foldable axis and the second surface is stationary in use.

10. An apparatus as claimed in claim 9 wherein the second surface has a first edge, the first surface being rotatable in use relative to the second surface about the foldable axis of a foldable portion, from a first position in which the first and second surfaces are parallel and staggered relative to each other, to a second position in which the first and second surfaces capture the foldable portion to create a first fold along the foldable axis, the first surface being rotatable back to the first position.

11. An apparatus as claimed in any preceding claim further comprising a guide member which prevents lateral movement of the foil during the folding.

12. An apparatus as claimed in any preceding claim further comprising cutting means to cut a trailing edge of the portion of foil.

13. An apparatus as claimed in any preceding claim further comprising receiving means for receiving the portion of foil after the folding.

14. An apparatus as claimed in any preceding claim further comprising removal means for removing the portion of the foil sheet from the folding means.

15. An apparatus as claimed in any preceding claim further comprising flattening means which in use can be brought into engagement with the folded end of the foil to flatten the fold or folds.

16. An apparatus as claimed in any preceding claim further comprising scoring means which, in use, can be used to score the first and/or second face of the foil sheet between the folded end and the trailing edge.

17. An apparatus as claimed in any preceding claim further comprising marking means for marking one or both of the opposing faces of the portion of foil with one or more identification marks.

18. An apparatus as claimed in any preceding claim wherein the first and second surfaces are rigid.

19. An apparatus as claimed in any preceding claim wherein the first and second surfaces are substantially planar.

20. A method for folding a sheet of foil, the method comprising:
providing an apparatus as defined in any preceding claim.

21. A method as claimed in claim 20 comprising:
feeding the sheet of foil to the folding means;
bearing the first and second surfaces against first and second opposing faces respectively of the portion of the sheet of foil at or near to the leading edge of the sheet of foil;
and

rotating one or both of said first and second surfaces about the foldable axis between the first and second opposing faces thereby creating a first fold along the foldable axis.

22. A method as claimed in claim 21 comprising:
disposing the first and second surfaces at the same point along the length of the foil, at or near to the leading edge of the foil; and
rotating the first and second surfaces, in the same sense about the foldable axis thereby creating one or more folds in the foil.

23. A method as claimed in claims 21 or 22 comprising:
rotating the first and second surfaces through substantially 180 degrees.

24. A method as claimed in any of claims 21 to 23 comprising:
rotating the first and second surfaces through a further 180 degrees or more.

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25. A method as claimed in claim 21 comprising:

rotating the first surface relative to the second surface about the foldable axis of the foldable portion, from a first position in which the first and second surfaces are parallel and staggered relative to each other, to a second position;

capturing the foldable portion using the first and second surfaces in the second position thereby creating a first fold along the foldable axis; and

rotating the first surface back to the first position.

26. A method as claimed in claim 25 further comprising:

advancing the sheet of foil to provide a further foldable portion at or near to the leading edge;

rotating the first surface relative to the second surface about the axis of the further foldable portion, from the first position to the second position;

capturing the further foldable portion using the first and second surfaces in the second position thereby creating a second fold along the foldable axis; and

rotating the first surface back to the first position.

27. A method as claimed in any of claims 20 to 26 further comprising:

cutting a trailing edge of the portion of foil after completion of the folding.

28. A method as claimed in any of claims 20 to 27 further comprising:

scoring the first and/or second face of the portion of foil between the folded end and the trailing edge.

29. A method as claimed in any of claims 20 to 28 further comprising:

marking one or both of the opposing faces of the portion of foil with one or more identification marks.

30. An apparatus substantially as described hereinbefore with reference to the accompanying drawings.

31. A method substantially as described hereinbefore with reference to the

accompanying drawings.

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FIG. 1

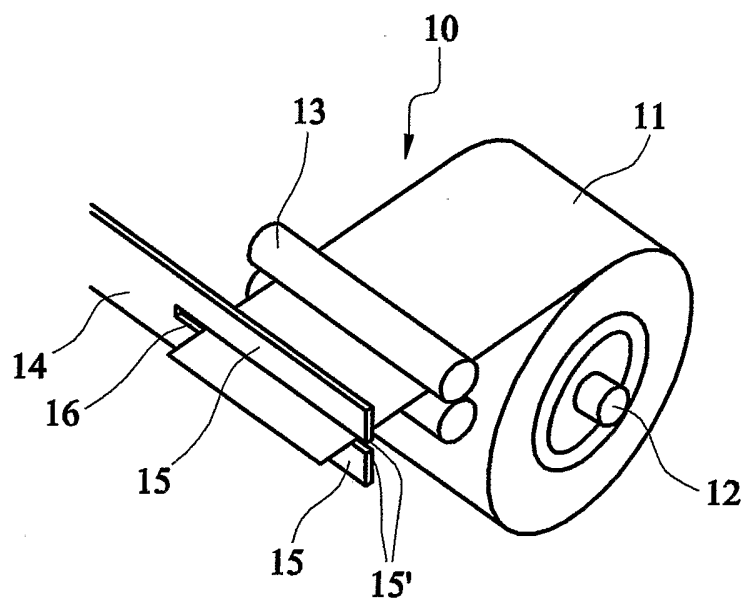
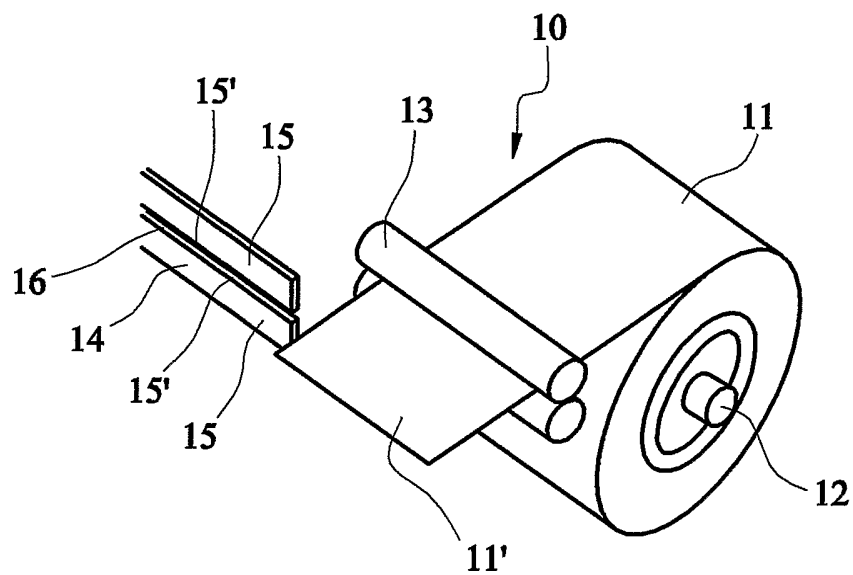


FIG. 2

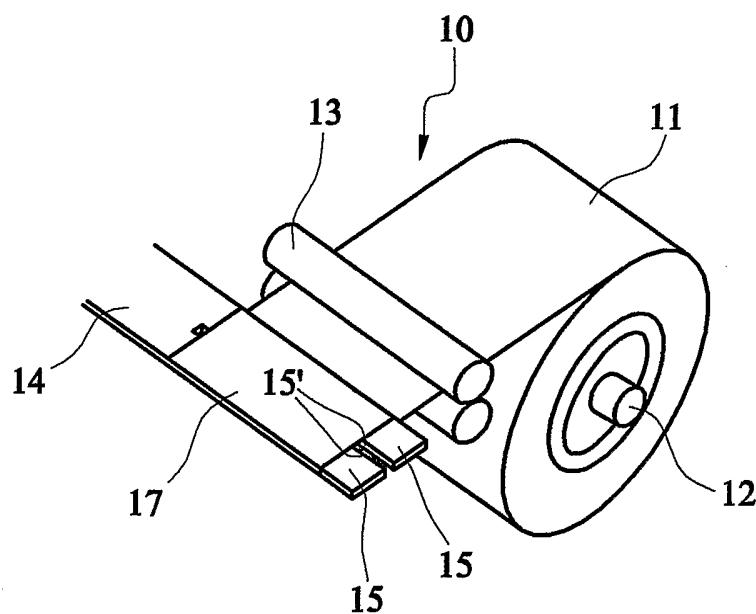
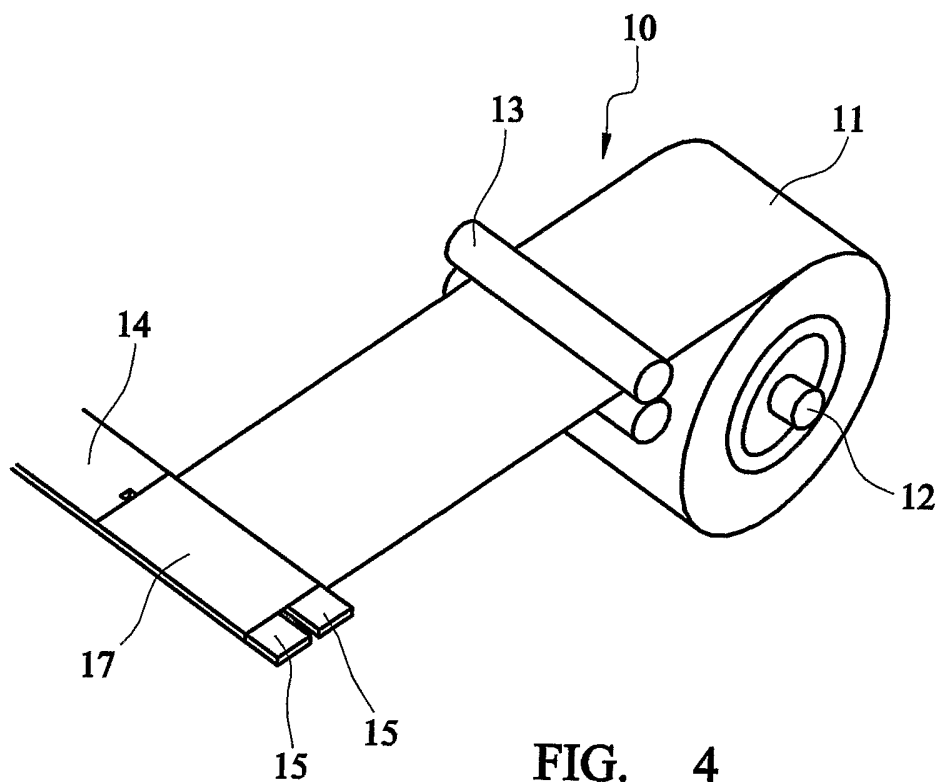
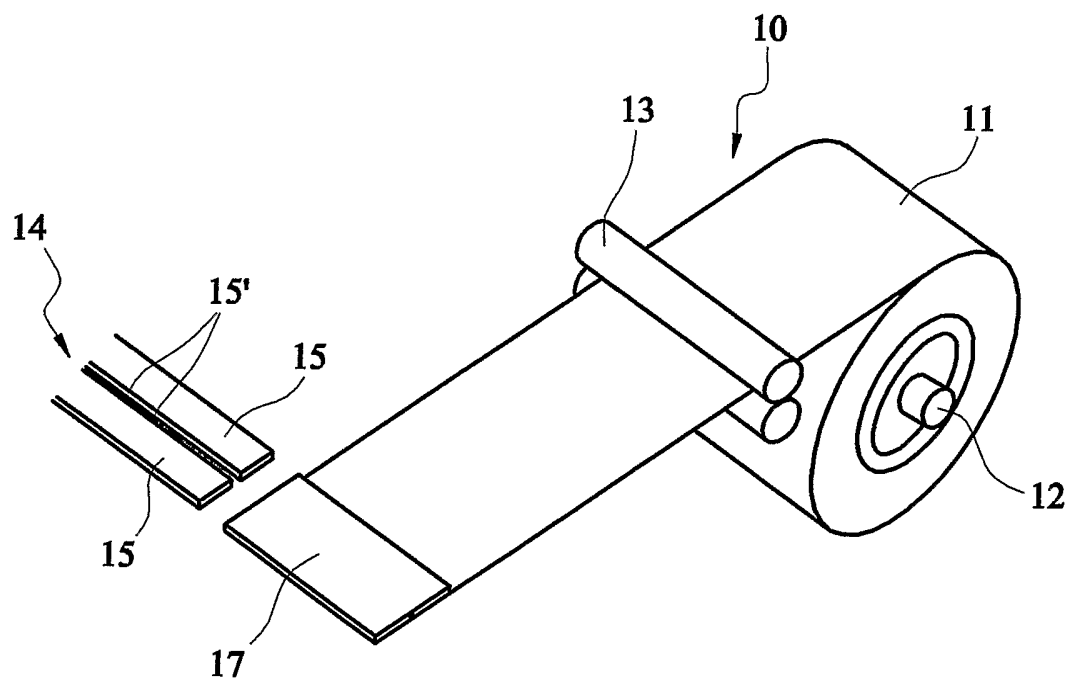
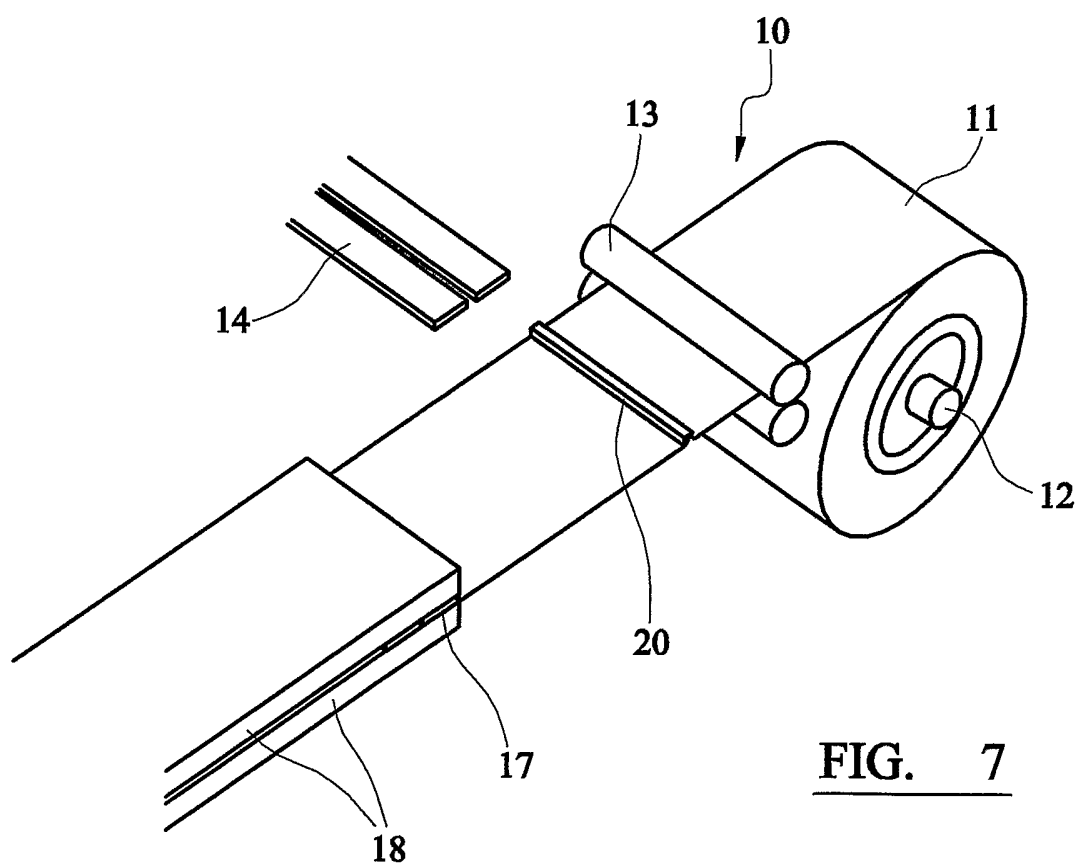
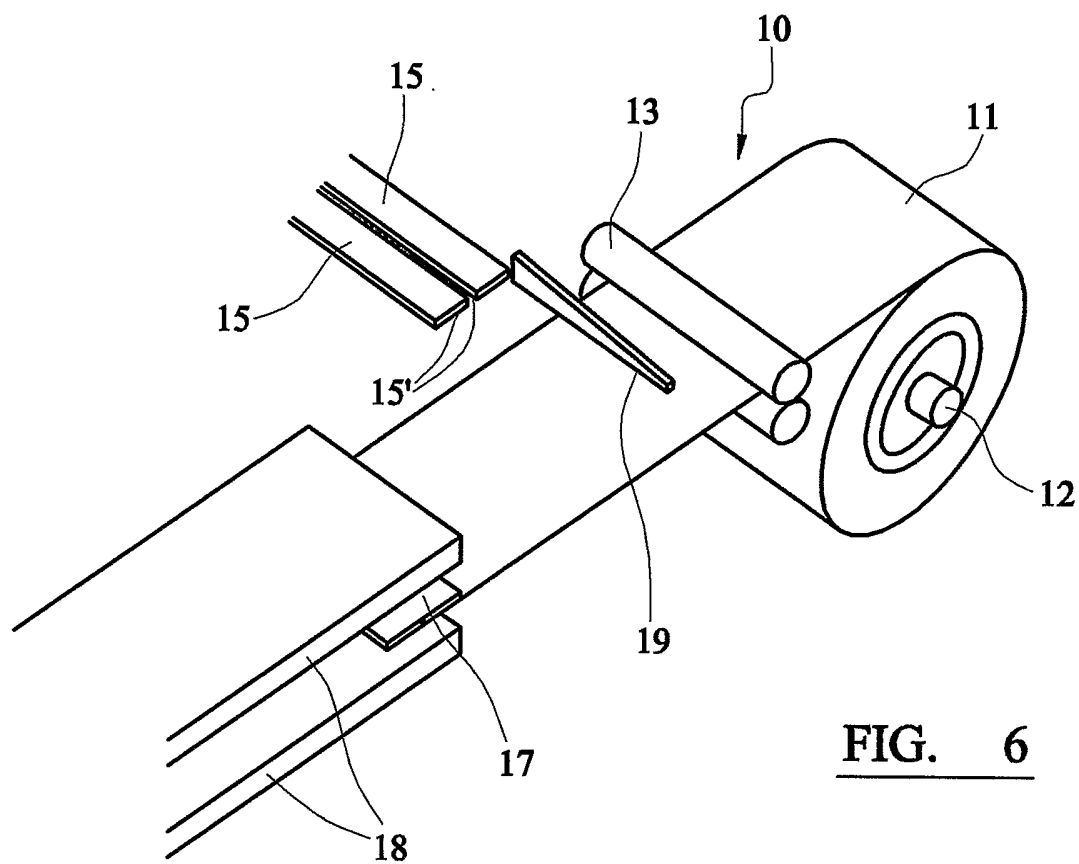


FIG. 3

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FIG. 4FIG. 5

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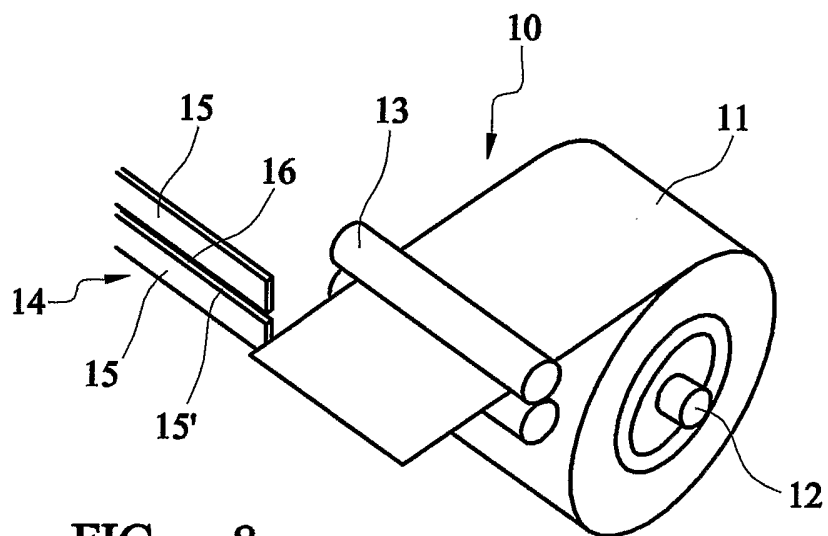


FIG. 8

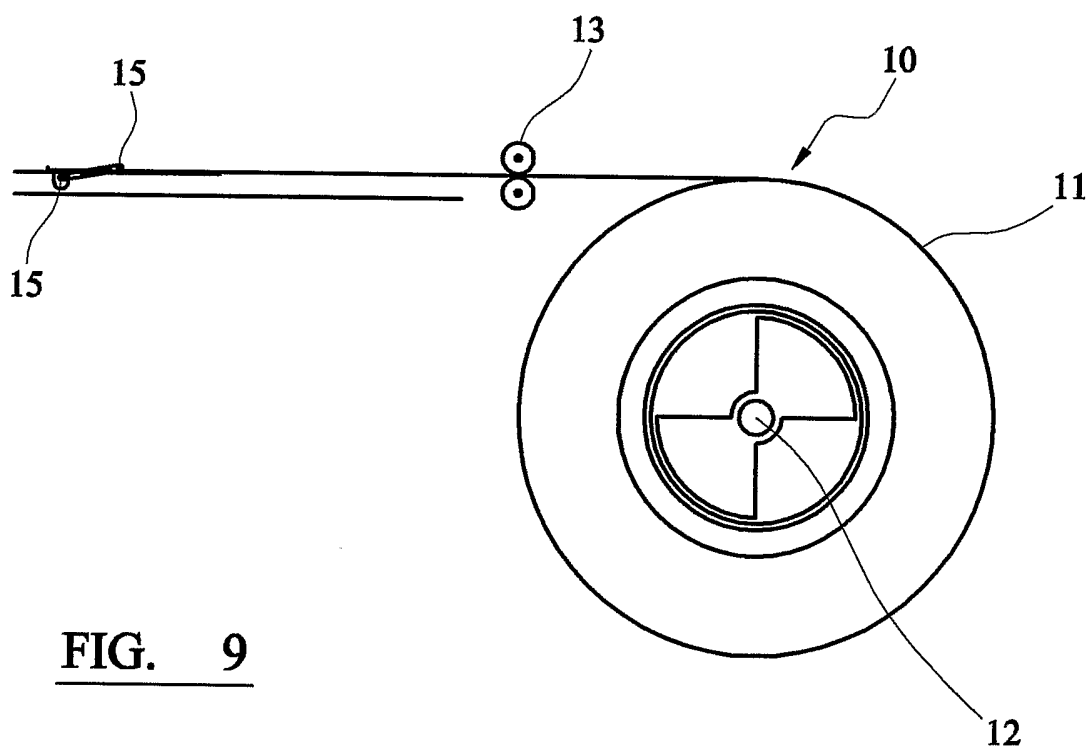


FIG. 9

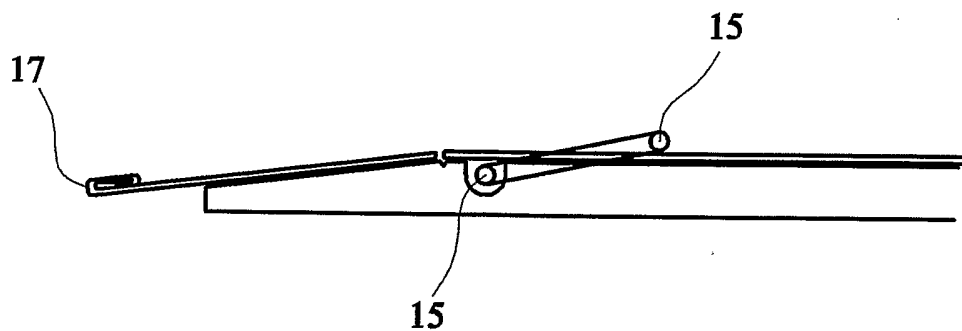


FIG. 10

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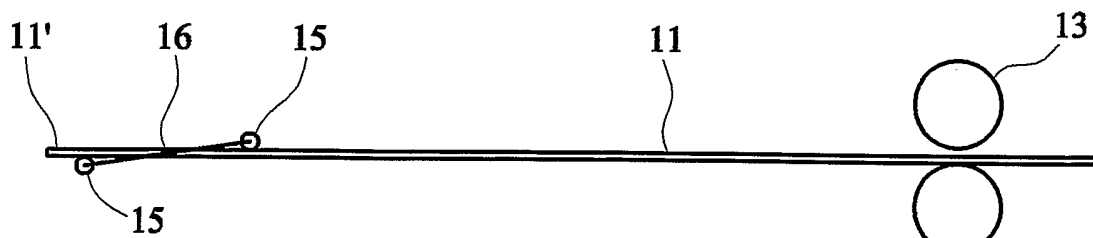


FIG. 11(a)

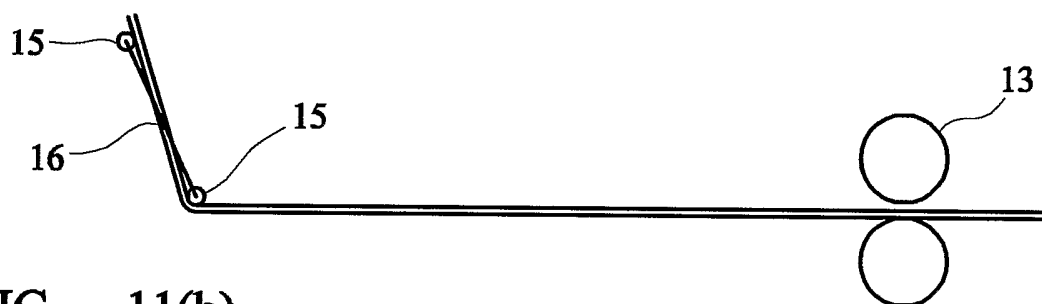


FIG. 11(b)

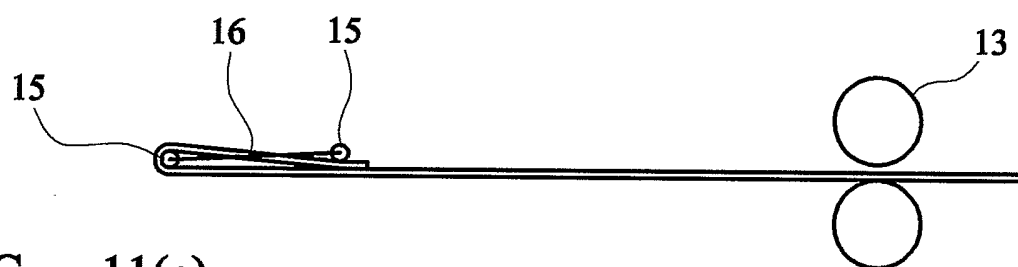


FIG. 11(c)

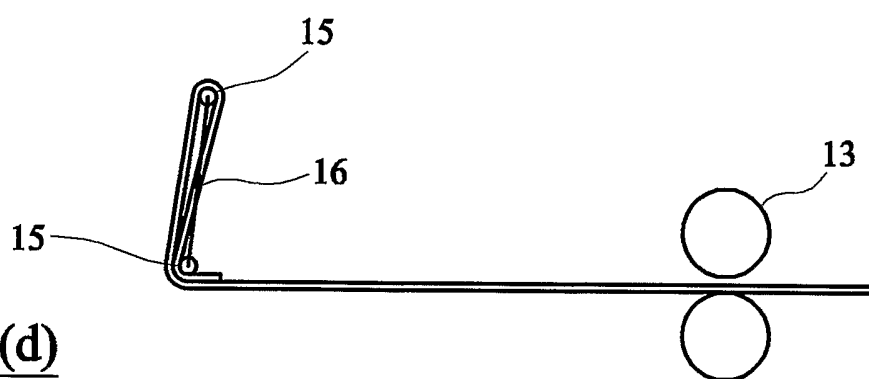


FIG. 11(d)

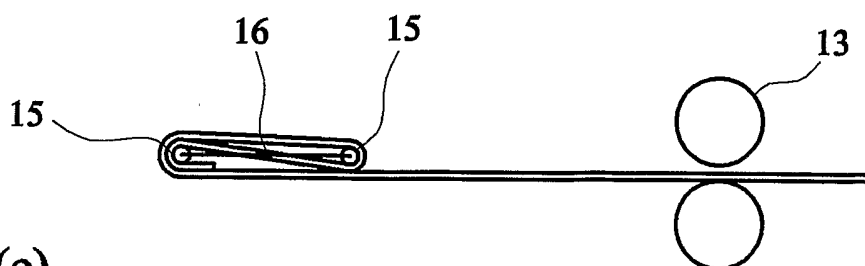


FIG. 11(e)

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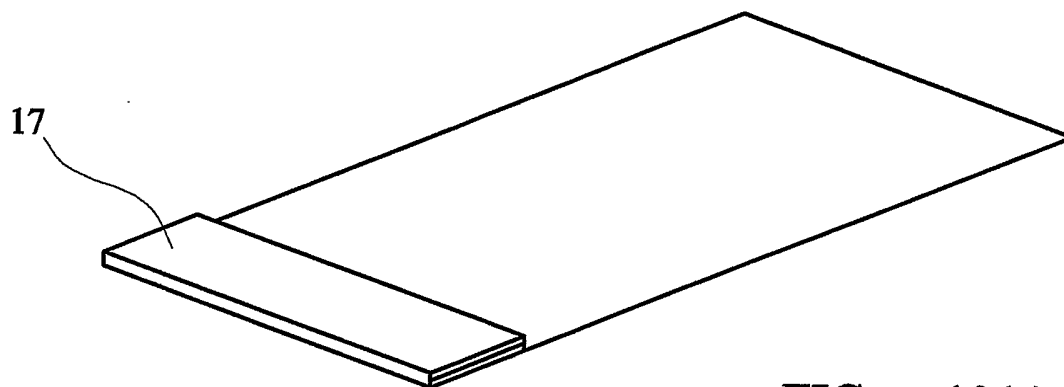


FIG. 12(a)

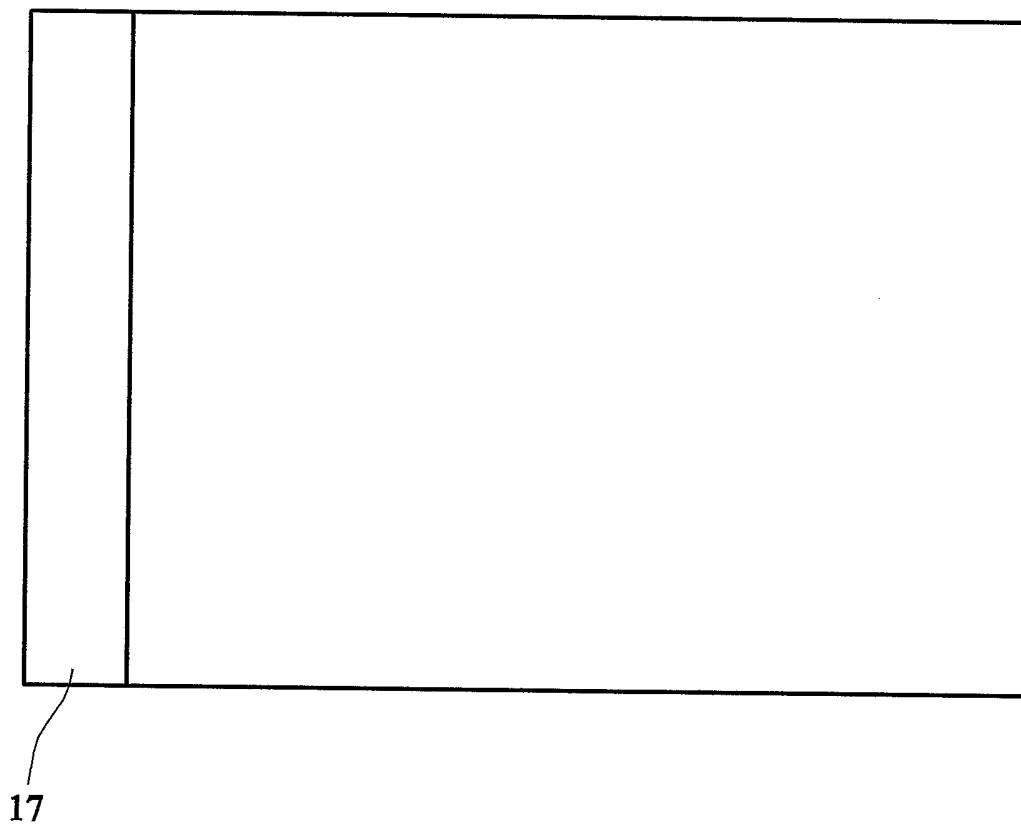


FIG. 12(b)



FIG. 12(c)

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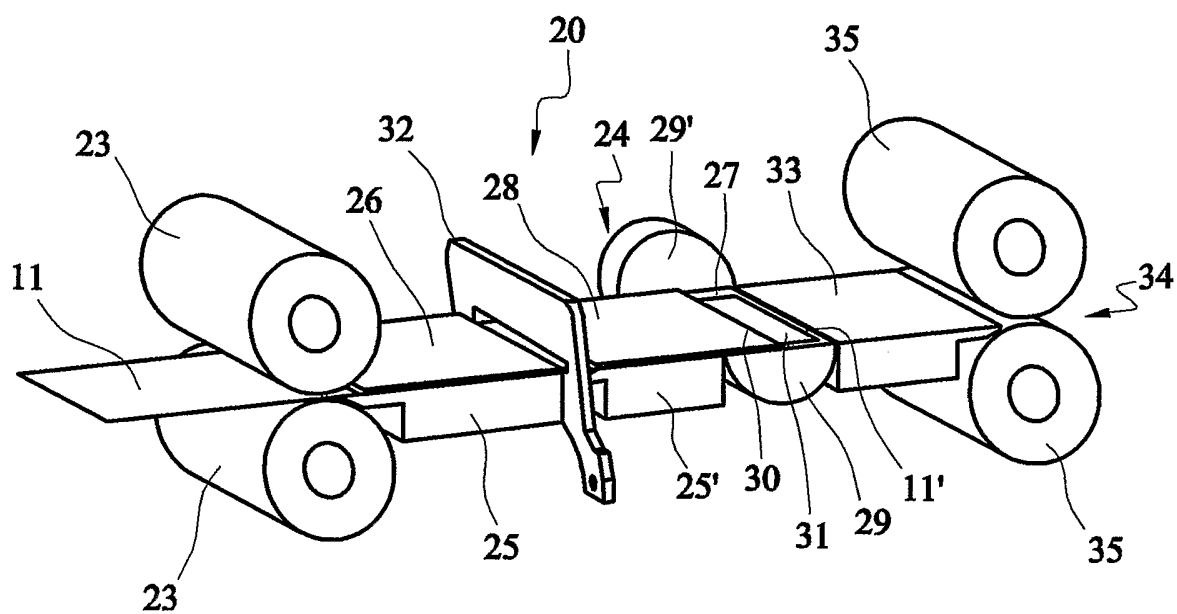


FIG. 13

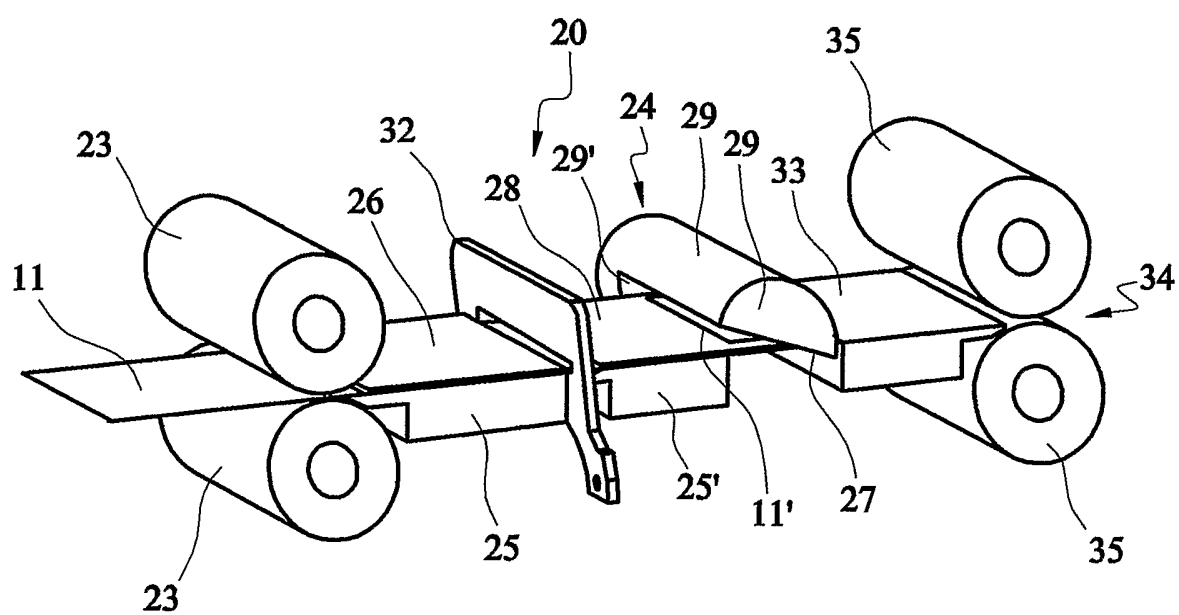


FIG. 14

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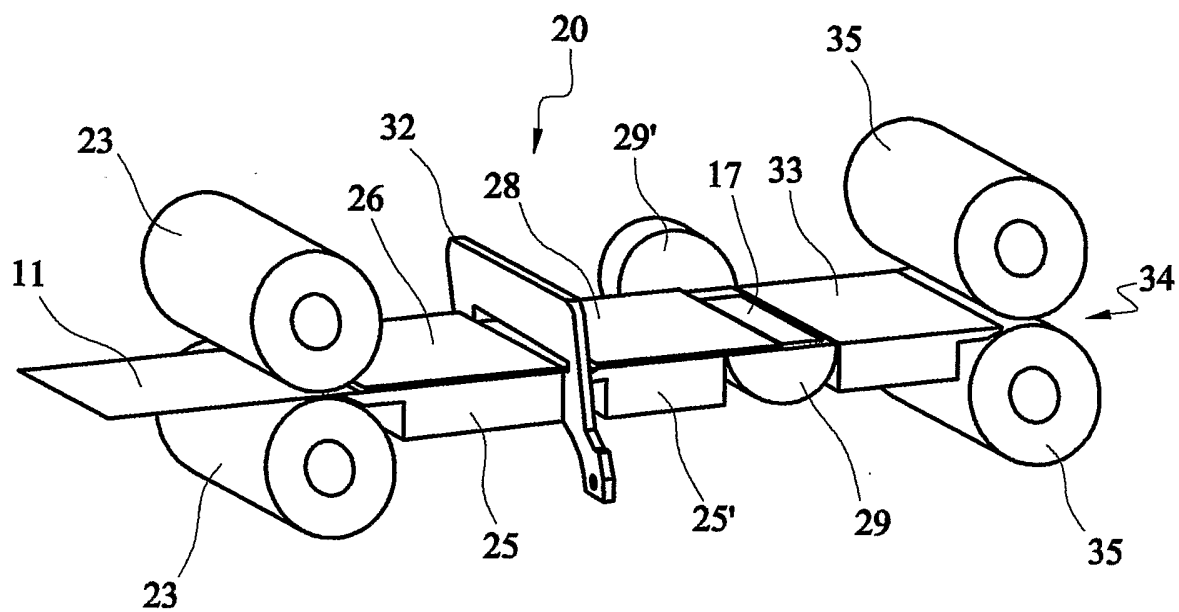


FIG. 15

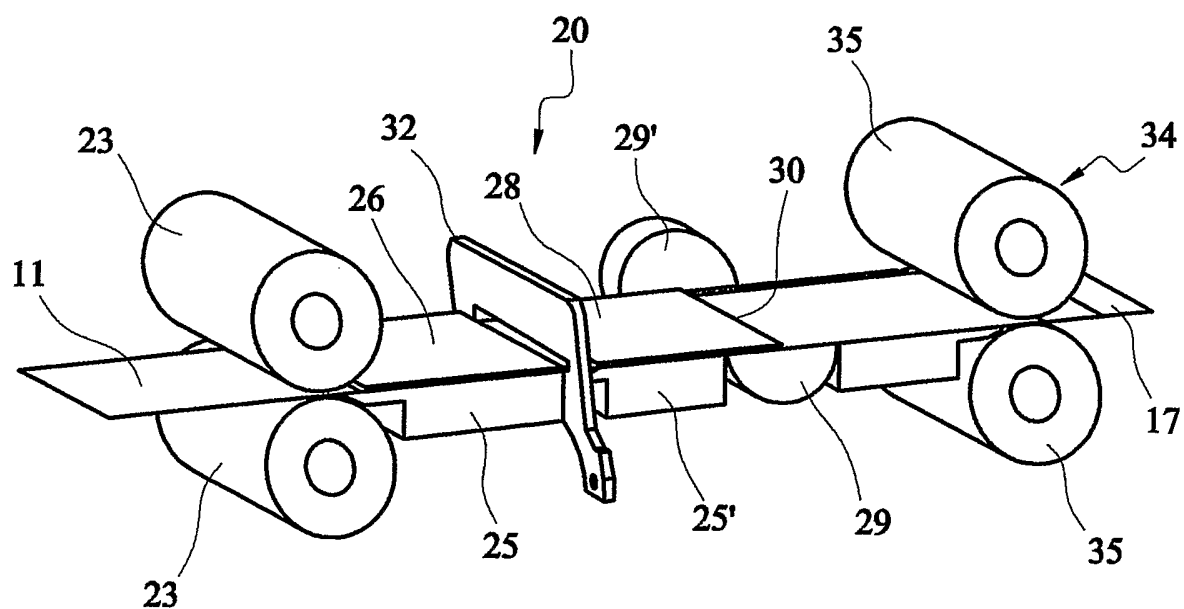


FIG. 16

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FIG. 17(a)

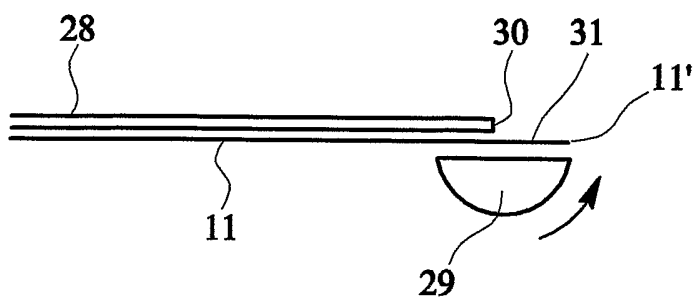


FIG. 17(b)

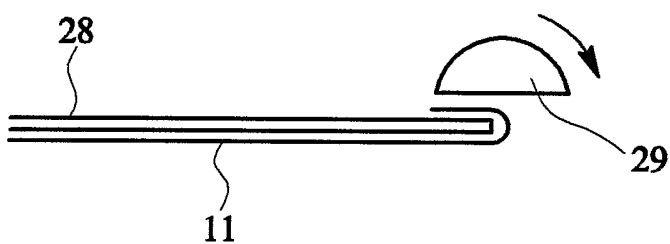


FIG. 17(c)

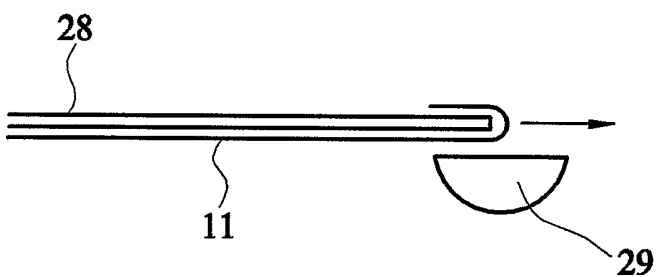


FIG. 17(d)

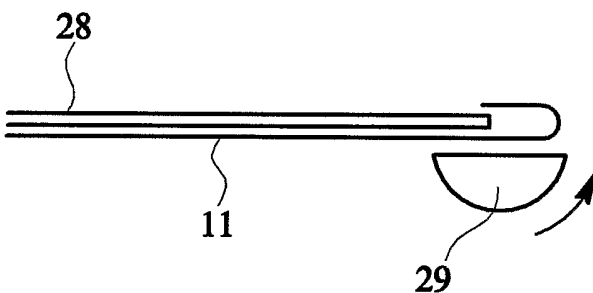


FIG. 17(e)

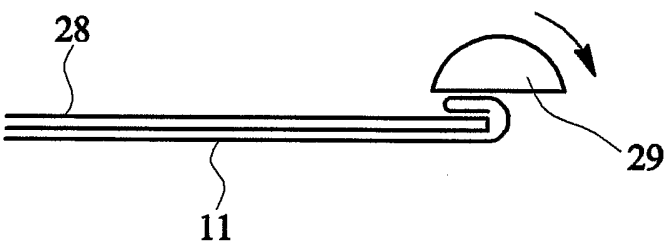
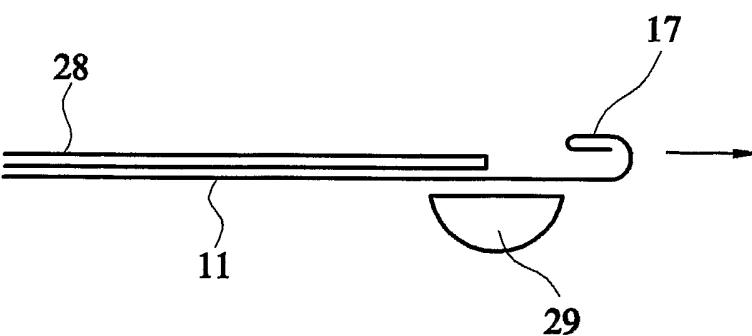


FIG. 17(f)



INTERNATIONAL SEARCH REPORT

PCT/GB 20/04000446

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B65H35/00 A45D44/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B65H A45D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/003157 A1 (MUIR) 10 January 2002 (2002-01-10) cited in the application the whole document ----	1,20
A	US 6 237 608 B1 (KARI) 29 May 2001 (2001-05-29) column 3, line 60 -column 6, line 20; figures ----	1,20
A	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 05, 30 June 1995 (1995-06-30) -& JP 07 047011 A (YAMAKI SEISAKUSHO:YUGEN;OTHERS: 01), 21 February 1995 (1995-02-21) abstract -----	1,20

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

28 May 2004

Date of mailing of the international search report

07/06/2004

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Raven, P

INTERNATIONAL SEARCH REPORT

PCT/GB 20/04000446

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 30, 31
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this International application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 30,31

The subject-matter of claims 30 and 31 were so unclear as to render a meaningful search impossible. Refer also to Rule 6.2(a) PCT.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

PCT/GB 20/04000446

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
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US 6237608	B1	29-05-2001	NONE		
JP 07047011	A	21-02-1995	JP	2684509 B2	03-12-1997