Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2075142 C 2004/09/28

(11)(21) 2 075 142

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 1992/07/31
(41) Mise à la disp. pub./Open to Public Insp.: 1993/02/06
(45) Date de délivrance/Issue Date: 2004/09/28
(30) Priorité/Priority: 1991/08/05 (2315/91) CH

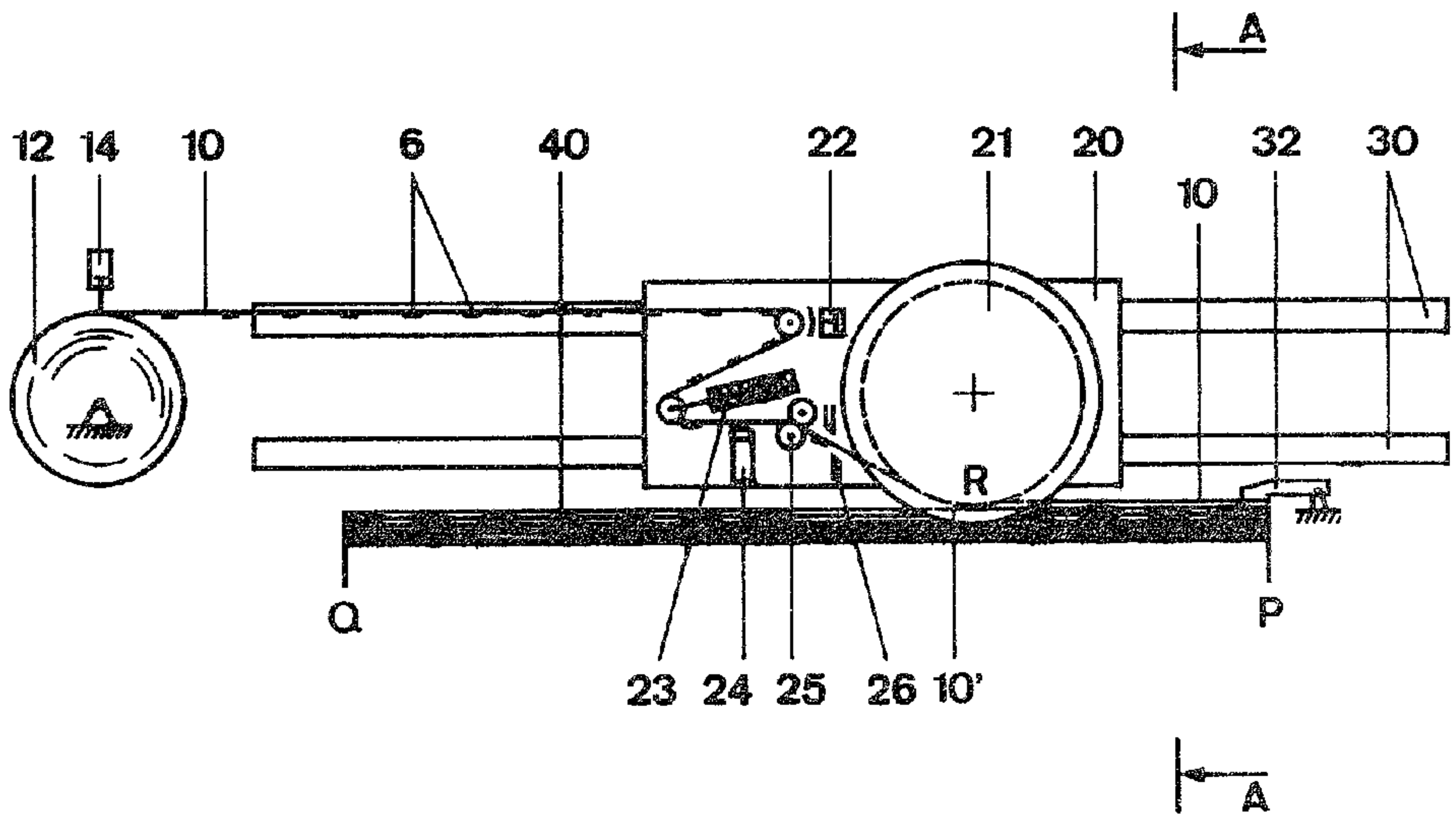
(51) Cl.Int.^{5}/Int.Cl.^{5} B32B 3/12
(72) Inventeur/Inventor:
MEIER, JOHANNES, CH

(73) Propriétaire/Owner:
ALCAN TECHNOLOGY & MANAGEMENT AG, CH

(74) Agent: OGILVY RENAULT

(54) Titre : PROCEDE DE PRODUCTION D'UNE AME ALVEOLEE A PARTIR D'UN FEUILLARD METALLIQUE, MATERIEL CONNEXE, ET UTILISATION D'UNE TELLE AME POUR LA PRODUCTION EN CONTINU DE PLAQUES COMPOSITES

(54) Title: PROCESS FOR THE PRODUCTION OF A HONEYCOMB CORE FROM FOIL STRIP, EQUIPMENT FOR CARRYING OUT THE PROCESS, AND USE OF THE HONEYCOMB CORE FOR THE CONTINUOUS PRODUCTION OF A COMPOSITE PLATE



(57) Abrégé/Abstract:
A foil which is unrolled from a band coil is coated at uniform intervals with strips of adhesive and cut into strips in the direction of uncoiling. The strips are then piled on top of one another with their respective adhesive strips parallel but in staggered positions, and are thereafter adhesively bonded together under pressure to form a stack with ends which is finally expanded. The foil band is cut into strips whose width corresponds to the honeycomb core height desired. One strip is passed over a position detector which, by detecting the adhesive strips, determines its position relative to the first end of the stack and activates an electronic control unit to control a positioning drive and a cutting device. The positioning drive positions the strip relative to the stack at one of its ends in such a way that the adhesive strips on the strip lie between those of the underlying strip and the strip is held fast at the one end. Beginning from the one end, the strip is then progressively bonded to the underlying strip, working towards the direction of the other end; shortly before bonding at the other end, the strip is cut by the cutting device to a preselected length limited by the ends, which correspond to the desired width of the honeycomb core to be made; the process then repeats itself. Equipment for carrying out such process and its application for the continuous production of a composite plate with an expanded honeycomb core and at least one covering layer are also disclosed.

ABSTRACT

A foil which is unrolled from a band coil is coated at uniform intervals with strips of adhesive and cut into strips in the direction of uncoiling. The strips are then piled on top of one another with their respective adhesive strips parallel but in staggered positions, and are thereafter adhesively bonded together under pressure to form a stack with ends which is finally expanded. The foil band is cut into strips whose width corresponds to the honeycomb core height desired. One strip is passed over a position detector which, by detecting the adhesive strips, determines its position relative to the first end of the stack and activates an electronic control unit to control a positioning drive and a cutting device. The positioning drive positions the strip relative to the stack at one of its ends in such a way that the adhesive strips on the strip lie between those of the underlying strip and the strip is held fast at the one end. Beginning from the one end, the strip is then progressively bonded to the underlying strip, working towards the direction of the other end; shortly before bonding at the other end, the strip is cut by the cutting device to a preselected length limited by the ends, which correspond to the desired width of the honeycomb core to be made; the process then repeats itself. Equipment for carrying out such process and its application for the continuous production of a composite plate with an expanded honeycomb core and at least one covering layer are also disclosed.

2075142

PROCESS FOR THE PRODUCTION OF A HONEYCOMB CORE FROM FOIL STRIP, EQUIPMENT FOR CARRYING OUT THE PROCESS, AND USE OF THE HONEYCOMB CORE FOR THE CONTINUOUS PRODUCTION OF A COMPOSITE PLATE

The invention concerns a process for the production of an expanded honeycomb core from foil band unwound from a band roll, coated with uniformly spaced strips of adhesive, and cut into strips in the direction of unrolling; the strips are piled on top of one another with their adhesive strips in a staggered arrangement, and are then adhesively bonded together under pressure. Subsequently the stack is expanded. The invention also concerns equipment for carrying out the process, and the use of the honeycomb core for the continuous production of a composite plate.

In the process conforming to GB-A-1 602 778 for the production of a honeycomb core, the foil is coated with strips of adhesive after unwinding from the band roll and longitudinally, i.e. in the direction of its unwinding. Then, a second foil treated in the same way is unwound from a second band roll and bonded to the first foil under pressure. Subsequently, from this intermittently produced, now two-layered foil band,

strips of equal width are cut transversely to the unwinding direction, the width corresponding to the desired height of the honeycomb core. The strips are stacked with their adhesive strips staggered, bonded under pressure, and finally expanded.
In a similarly known process sheets are cut from the foil after unrolling from the band roll by cutting transversely to the unrolling direction. These are stacked with the adhesive strips applied in the unrolling direction in a staggered arrangement, and adhesively bonded under pressure. From the stacks so formed, strips of a width corresponding to the desired honeycomb core height are once again cut in the direction transverse to the direction of unwinding from the band roll, and these are further processed in the same way as in the previously described process.

To obtain accurate final dimensions of the honeycomb core, in both processes finishing machining by milling or similar is needed.

The honeycomb cores produced by these known processes have a honeycomb core width predetermined by the width of the foil bands and a honeycomb core length limited by the restricted number of strips or sheets to be stacked together. The band width amounts at most to about 180 cm, since wider foil bands are not obtainable, so that honeycomb core widths of only less than about 150 cm can be made. Moreover, particularly because of the need to ensure accuracy of the honeycomb core height by a separate machining operation such as milling or similar, the production is expensive and uneconomical because the above-mentioned cutting of the strips is not sufficiently accurate, since at the places where the adhesive is situated, the width of the strip packs is always narrower than at other points. In addition, from US-A-3 655 475 a honeycomb core production process of the same general type is known, in which the foil width amounts to something more than twice the height of the eventual honeycomb core. The foil is coated on one side with evenly spaced adhesive strips transverse to the longitudinal direction, but with the outer zones and the middle of the foil free from adhesive. The adhesive strips are so arranged that there are strips over one-half of the foil width, while over the other half there are also strips, but in staggered positions with respect to those on the first half. The edge zones and the middle of the foil are free from adhesive strips. At one edge of the foil and close to the middle, but on the side opposite the edge in question, local precisely arranged perforations are made in the direction of unwinding and at the same height. The foil is then cut in the middle. The two resultant foil strips are then passed through an arrangement of rollers in such a way that they come to be positioned over one another with their adhesive strips in the same orientation, i.e. the front side of one foil strip lies against the back side of the other. To do this, the perforations are used to position the two strips so that the adhesive strips on one lie accurately half-way between those of the other. The pairs of strips are then stacked, bonded under pressure, and released by trimming off the adhesive-free edges.

Though, in contrast to the previously described processes, this procedure has the advantage of producing honeycomb cores of any desired width in principle, it suffers from the essential disadvantage that the trimming operation results in higher wastage of foil material. Moreover, as in the previous cases, this additional machining makes it impossible to produce accurate final dimensions, for reasons already explained.

It is also known for honeycomb cores of the described type in the expanded condition to be joined together with covering layers on both sides, to form a composite material characterized by light weight and comparatively high strength. However, hitherto it has only been possible to produce such composites one piece at a time. Yet, there is a need to have stocks of a cheap honeycomb core with accurate final dimensions in a form that will allow the continuous production of composite plates. This necessitates at least a one-piece honeycomb core of practically any desired length.

Thus, the invention is based upon the task of creating a process for the production of an expanded honeycomb core which will supply a honeycomb core of practically any desired dimensions with a very accurate honeycomb height, cheaply, and with the fullest possible utilization of the foil material, i.e. with practically no waste, and to propose equipment for carrying out the process in question. Furthermore, the honeycomb core should enable the continuous production of composite plates.

In accordance with the invention, there is provided a method for the production of an expanded honeycomb core from a foil web which is unwound from a web roll, provided at regular intervals (A) with adhesive strips and cut into strips in the direction of unwinding (F), the strips being stacked with their respective adhesive strips parallel and offset from one another, then being bonded together under pressure to form a stack with ends (P, Q) and expanded, wherein the foil web is cut into strips having a width corresponding to the desired honeycomb core height (T), one strip is guided via a position detector which, by way of the adhesive strips, determines its position relative to a first end (P) of the stack and controls a positioning drive and a cutting unit via an electronic control unit, the positioning drive positions the strip relative to the stack at the end (P) in such a manner that the adhesive strips of the strip are then situated between the adhesive strips of an underlying strip and the strip is held at the end (P), beginning at the end (P) and working in the direction of the other end (Q), the strip is then successively bonded to the previously stacked underlying strip and, shortly before it is bonded to the other end (Q), the strip is cut with the aid of the cutting unit to a preselected length (L_u) delimited by the ends (P, Q) and corresponding to the desired width (L) of the honeycomb core to be produced, after which the process is repeated.

In another aspect of the invention there is provided a device for carrying out the method of the invention wherein the position detectors, at least one positioning drive, at least one cutting unit and a liftable sealing roller for bonding the strip/s to the uppermost strip of the stack are mounted on a slide which is arranged to move on guides in such a manner that the sealing roller can sweep over the entire width (L_u) of a honeycomb collecting unit arranged below it via its vertex (R), the pressure and the elevated temperature act on the strip/s and at least the uppermost strip by means of the sealing roller and a clamping element for holding the strip/s is arranged at least at one end of the honeycomb collecting unit.

In another aspect the invention relates to a method for the continuous production of a composite panel with at least one outer panel comprising the steps of: continuously producing an expanded honeycomb according to the afore-mentioned method of the invenetion and continuously joining the homeycomb core with at least one outer panel, for example, of aluminium or an aluminium alloy.

A particular advantage is that by appropriate selection of the ratio between the strip width and the foil band roll width transverse to the unrolling direction, the process of the invention enables the foil to be cut into strips without any waste at all.

The strips, which can be accurately cut to the size of the honeycomb core height in familiar ways and without any special difficulty or expense, are transferred to intermediate storage before further processing. It is appropriate to do this by winding the strips onto strip spools, and later, in accordance with the process, unrolling them, stacking them in a staggered arrangement, bonding them under the action of elevated temperature and a pressing force, and finally cutting to the desired length transversely to the direction of unrolling.

A further advantage of the process conforming to the invention is that practically any desired honeycomb core width can be obtained, because the strips are unrolled from the strip spools and can be cut to practically any freely chosen length corresponding to the desired honeycomb core width, cutting transversely to the unrolling direction. Once pressed together, the stack obtained can be transferred to intermediate storage, which minimizes the cost of storage space, or it can be expanded immediately after pressing. Thus, using the process of the invention, if necessary with the equipment of the invention, to carry out the process in question, honeycomb cores of practically any desired dimensions can be produced continuously. A continuously produced honeycomb core produced in this way can advantageously be used for the continuous production of a composite plate with the expanded honeycomb as its core and at least one covering layer.

Further features of the invention are described below with reference to the schematic drawings. These show, by way of examples, in:

Fig. 1	a perspective view of the production of the strips from a band of metal foil,
Figs.2a,2b	a perspective view and a side view of the staggered arrangement of the adhesive strips, the stack and the strips,
Figs.3a, 3b	perspective views of a section of an expanded honeycomb core and an individual cell from it,
Fig. 4	a design example of the equipment for producing the honeycomb core, in side view,
Fig. 5	a section A-A through Fig. 4 showing further details,
Figs. 6, 7	further design examples of equipment for the production of a honeycomb core, in side view, and
Fig. 8	the application of the honeycomb core for the continuous production of a composite plate.

According to Fig. 1 a metal foil 4 is unwound from a coil 2 in the direction of the arrow F and coated with strips of adhesive 6 at uniform intervals A lying transversely to the unrolling direction. The adhesive strips 6 may, for example, be dried at a drying station 8. They adhere firmly to the foil 4, but show no tendency to stick on further surface contact with more of the metal foil. By means of a cutting tool (not shown) the foil 4 is cut at 11 into strips 10 of equal width T. These are rolled onto strip spools 12 and sent for storage. It is advantageous to choose the width of the metal foil band 4 and the width T of the strips 10 such that there is no waste when the foil 4 is cut up into strips 10. Obviously, strips 10 of any desired length can be cut and rolled onto the strip spools 12.

As shown in Fig. 2a, a piece of the strip 10 is unrolled from a strip spool 12 and positioned on top of the topmost strip 10' of a stack of strips 10' in such a way that the adhesive strips 6 on the strip 10 are staggered with respect to those on the topmost strip 10' of the stack, preferably so that the adhesive strips 6 of strip 10 lie exactly in the middle of the adhesive-free gaps of the topmost stack strip 10'. The strip 10 is then cut to the desired length L_u at 15. Several repetitions of this procedure produce a stack 40 with the adhesive strips 6 on successive strips 10' staggered in alternation. Then the strip 10 or the individual stack strips 10' are bonded by the adhesive strips 6 to the stack strips 10' in contact with them, under pressure and depending on the adhesive used, at an elevated temperature as well if necessary. For preference, the adhesive used should be a melting adhesive which requires the action of elevated temperature to bond the strips 10 and 10' together. In its pressed condition, the stack 40 can now be stored.

If, as shown in Fig. 2b, the adhesive strips 6 of uniform width a are so arranged on the strip 10 that the adhesive-free intervals A are three times as wide as a, i.e. A = 3a, and if the individual strips 10 and 10' are stacked in the preferred way described above, then when the stack 40 is expanded a honeycomb core 41 with hexagonal cells will be formed, as shown in Fig. 3a. Fig. 3b shows an individual hexagonal cell 80. When the stack 40 is expanded its width, originally equal to the strip length L_u, is reduced to a value L. The length W of the honeycomb core depends upon the number of strips 10' in the stack, and can therefore be chosen at will. This enables the continuous production of composite plates 90 with expanded honeycomb cores 41 and a covering layer 42 on at least one side, in that for example the stack 40, still pressed together, can be retrieved from intermediate storage and used for the continuous production of composite plate, as described in detail later on with reference to Fig. 8.

The device pictured in Fig. 4 can be used to bring about the staggered positioning of the adhesive strips 6 on the stack 10' and the strip 10. A sliding carriage 20 is mounted on guideways 30 that allow it to move. The carriage 20 carries a position detector 24, a positioning drive 25, a cutting device 26 and a liftable sealing roller 21 for bonding the strip 10 to the topmost of the stack strips 10'. The mobility of the carriage 20 is such that the sealing roller 21 with its low-point R can travel along the entire width L_u of a honeycomb holder device 60 in which the strips 10' and 10 are held together in a stack 40, i.e. at least between the end-points P and Q. At one end P of the stack 40 is a clamp 32 for holding the strip 10 fast. The sealing roller 21 can be lifted vertically and can preferably also be heated. As it moves under control between the ends P and Q and over strip 10 and at least the topmost stack strip 10', if necessary being heated at the same time, it exerts a uniform pressure whereby the strip 10 becomes adhesively bonded to the topmost strip 10'. As already mentioned, the heating is necessary in the case of adhesives which become effective only after heating or at elevated temperatures.

A strip 10 is unwound from the strip spool 12 and the position detector 24 accurately determines the position of its adhesive strips 6. The adhesive strips 6 serve at the same time as benchmarks for the staggered positioning of the strip 10 relative to the topmost strip 10' of the stack 40. The positioning drive 25 now pushes the strip 10 a distance under the clamp 32 such that its adhesive strips 6 are displaced exactly an amount 2a away from those of the underlying strip 10'. The clamp 32 holds the strip 10 fast in this position. This position then determines that of the next strip to be stacked on top. Before, during or after the positioning of the strip 10, the sliding carriage 20 moves in the direction of the end P until the low point R of the sealing roller 21 is over the end P, when the sealing roller 21 is lowered and exerts pressure upon the strip 10 or the stack 40, if necessary while being heated at the same time. With the sealing roller 21 in the lowered position, the sliding carriage 20 moves towards the other end Q until its low point R reaches that end. Shortly before this happens, the cutting device 26 is used to cut the strip 10 to its preselected length L_u limited by the ends P and Q, which depends on the desired width L of the honeycomb core 41 to be made. This pressure and heat transfer process bonds the strip 10 to the topmost strip 10' of the stack. The strip 10 has now become part of the stack 40, namely its topmost strip 10'. The entire process is then repeated from the beginning, i.e. starting with the detection of the position of the adhesive strips 6 on the new strip 10 from the strip spool 12 and conveyance of the strip to end P. Continual repetition of these processes produces a continually growing stack 40, which leads to an expanded honeycomb core 41 of practically any desired length W and width L.

Fig. 5 shows the section A-A from Fig. 4 in greater detail. The honeycomb holder device 60 and the sealing roller 21 are shown. The honeycomb holder 60 consists of a sinking table 33 and clamp jaws 34. With the aid of a pressure cylinder 35, the sealing roller 21 presses down upon the stack 40 lying on the sinking table 33. The plane of the table 33 runs parallel to the movement direction of the sliding carriage 20, but it is only needed in the early stages of carrying out the process by means of this equipment. As soon as the repeated bonding of strips 10' has built up a stack 40 of a certain height such that the clamping jaws 34, which can be moved in and out by a force transverse to the pressing direction of the sealing roller 21, can be pressed against the stack 40, the table 33 is no longer needed. The clamping jaws 34 pressed against the stack 40 then hold the latter in position by themselves so that the pressing force of the sealing roller 21 can act upon the stack 40 or the strip 10 and the topmost strip 10' of the stack. As the process progresses, the height of the stack 40 increases. To guarantee a constant pressure by the sealing roller 21, the pressure exerted by the pressure cylinder 35 is reduced in a controlled way and/or the stack 40 is gradually lowered by loosening the clamping jaws 34 (not shown). In the early stages the table 33 can also be used for this lowering.

In the procedure described so far using equipment as illustrated schematically by Fig. 4, as the sliding carriage 20 moves repeatedly, for example, from the end Q to the end P and back to the original end Q, the sealing roller 21 performs an active function only during half of this movement - as described, namely only during its movement from P to Q. To utilize the sealing roller 21 actively throughout its motion and thus increase the efficiency of the equipment, a mechanism as shown in Fig. 6 is provided. At least the necessary aggregates 24, 25 mounted on the sliding carriage 20 and described earlier, are now fitted on it in duplicate. Seen from the middle of the carriage, they are arranged each on one side l or r in mirror-image formation. The left-hand side l is used when bringing in the strip 10 from the strip spool 12. Associated with this is the clamp 32 at the end P. The right-hand side r is used when bringing in the strip 10* from the strip spool 12* . Associated with this side r is the clamp 32* at the end Q. As the carriage moves in the described way, while exerting pressure and if necessary at an elevated temperature, over the stack 40 or the overlying strip 10 and from end P to end Q, the carriage also takes up the strip by means of the same aggregates arranged on the right-hand side r and positions it at end Q in a manner analogous to the previously positioned strip 10. After raising the sealing roller 21 briefly at end Q the strip 10* is held fast there by the clamp 32* , and a new strip 10 is then taken up as the carriage 20 moves back from end Q towards end P with the sealing roller 21 lowered to bond the strip 10*, i.e. exerting pressure and heat so that the strip 10* becomes bonded to the underlying strip 10' of the stack 40 (not shown). In this way, a strip 10 or 10* is bonded into place at each traverse of the carriage 20 from end P to end Q and from end Q back to end P.

The principle of increasing the efficiency of the equipment just explained with reference to Fig. 6 can be designed even more economically in another version (not shown), in which the positioning of the strips 10 at the two ends P and Q is carried out by several position detectors 24 and positioning drives 25 mounted on each of the two sides l and r of the sliding carriage. When the carriage 20 moves from one end P or Q to the other end Q or P, the strips 10 on one side l, r of the carriage 20 are taken up and successively positioned and held fast at the corresponding end P,Q. As the carriage 20 then moves off while exerting pressure and if necessary an elevated temperature via the lowered sealing roller 21, the strips 10 are then bonded to the topmost strip 10' of the stack 40. With such an arrangement of the equipment it is necessary for the sealing roller 21 to exert a sufficiently high pressure upon the stack 40 or on the overlying strips 10, and if necessary to be at a sufficiently high temperature to heat the strips 10 and the topmost strip 10' of the stack 40 enough, to ensure that the strips 10 and the topmost strip 10' of the stack 40 are bonded together. Moreover, with at least partially simultaneous positioning of the strips 10, some adjustment of the strips 10 under one another is necessary to ensure that the adhesive strips 6 of neighbouring strips 10 are in staggered positions.

Another arrangement based upon the principle of increasing the efficiency of the equipment is shown in Fig. 7, in greatly simplified form. From a stand of strip spools 111, a first number 101 of strips 10 with a staggered arrangement of their adhesive strips 6 are led simultaneously over a position detector 241 towards the end P as the carriage 20 moves towards it, positioned, and held fast, and when the carriage 20 moves back in the direction of the other end Q a second number 102 of strips 10 with a staggered arrangement of their adhesive strips 6 are led simultaneously over a second position detector 242 towards the end Q, positioned there, and held fast. Except for the brief lifting of the sealing roller 21 to allow the positioning and clamping, the sealing roller 21 is continuously in the pressing position during the movement of the carriage, so that both the number 101 of strips 10 and the number 102 of strips become adhesively bonded to one another and to the topmost strip 10' of the stack 40. As is also apparent from Fig. 7, a further number 121, 122 of strips 10 can again be taken respectively to the two ends P. Q in an analogous way. Obviously, the sealing roller 21 must be correspondingly equipped so that the number 101 and 121 or 102 and 122 of strips 10 and at least the topmost strip 10' of the stack are pressed and if necessary heated sufficiently to ensure adequate adhesive bonding.

Fig. 8 illustrates the application of the stack 40 produced by the process of the invention, preferably using the equipment of the invention, for the production of a composite plate 90 with an expanded honeycomb core 41 and covering layers 42. The meander-shaped stack 40 passes through an expander device 48 consisting essentially of two rollers 50 arranged on either side of the stack 40, the surfaces of these rollers being covered with brushes 49. The brushes act on the strips 10' of the stack 40 transversely to the stacking direction, in that a drive mechanism (not shown) carries the stack 40 past the rollers 50 at high speed as the stack leaves the honeycomb holder device 60. This can advantageously happen in a simple way since before the stack 40 is moved past the rollers 50, a restraining force acts upon it, which brakes the pulling force exerted by the drive mechanism of the rollers 50. This restraining force is exerted by a braking device 52 arranged on both sides of the stack 40, specifically by two strips of brush mounted on either side. After passing through the rollers 50 the stack 40 has been stretched to an expanded honeycomb core 41. This expanded honeycomb core 41 is covered on the front edges 82 of the honeycomb cells 80 on both sides with an adhesive, preferably in the form of adhesive foil 84, and the covering layers are laid on top of this. The sandwich consisting of the honeycomb core 41 with adhesive foils 84 on both sides and covering layers 42, especially ones made of aluminium, lying on top of these, passes into a continuous press 70 and is there bonded to form a composite plate 90. Adjustment of the running speed of the continuous press 70 and of the drive mechanism of the rollers 50 allows continuous production of the composite plate to be achieved. By appropriately slightly increasing the running speed of the continuous press 70, the expansion of the honeycomb core 41 can advantageously be supported, at least in part. For optimum preparation of the adhesive on the front edges 82 of the honeycomb cells 80, it is particularly advantageous to treat the adhesive foil 84 with a hot gaseous medium, especially hot air, after it has been positioned over the expanded honeycomb core 41, as shown in Fig. 8. This can be done simply by hot-air blowers 86 arranged on either side of the expanded honeycomb core 41. This treatment causes the adhesive foil 84 to soften or melt, so that it remains stuck only to the front edges 82 of the honeycomb cells 80. The process takes place in such a way that the adhesive foil 84 spread over the inside 81 of the honeycomb cells 80 bursts, and because of the tension in the foil 84 or the surface tension of the adhesive, draws back from the inside of the honeycomb cells 80 to their front edges 82.

The continuously fabricated composite plate 90 can be cut to the desired size by a cutting device 72, in any familiar way.

2075142

Summary

The process for the production of an expanded honeycomb core from strips (10) coated at uniform intervals with strips of adhesive (6), in which the strips (10) with their adhesive strips (6) parallel and in staggered positions are stacked on top of one another and adhesively bonded together under pressure and if necessary at an elevated temperature, the stack (40) so formed being subsequently expanded, consists in the following: a strip (10) passes over a position detector (24), which from the adhesive strips (6) determines its position relative to a first end (P) of a stack (40), and which controls a positioning drive (25) and a cutting device (26). The positioning drive (25) positions the strip (10) relative to the stack (40) at its end (P), and the strip (10) is held fast. Beginning from end (P), the strip (10) is progressively bonded in the direction of the other end (Q) to the previously stacked and underlying strip (10') in such a way that the adhesive strips (6) on strip (10) lie in-between those on the underlying strip (10'). Shortly before being bonded at the other end (Q), the strip (10) is cut by the cutting device (26) to a predetermined length limited by the ends (P. Q), which determines the desired width of the honeycomb core to be produced. The process is then repeated.

The equipment for carrying out the process comprises in particular a sliding carriage (20) that moves along guideways (30) as far as the ends (P, Q), upon which are mounted the position detector (24), the positioning drive (25), the cutting device (26) and a movable sealing roller (21) which is used to apply the pressure and if necessary the elevated temperature required for the bonding of the strip (10) to the underlying strip (10').

The process is used together with the equipment, for the fabrication of composite plates with metallic covering layers. The fabrication method involved makes use, in particular, of a double-strip press.

(Fig. 4)

CLAIMS

1. A method for the production of an expanded honeycomb core from a foil web which is unwound from a web roll, provided at regular intervals (A) with adhesive strips and cut into strips in the direction of unwinding (F), the strips being stacked with their respective adhesive strips parallel and offset from one another, then being bonded together under pressure to form a stack with ends (P, Q) and expanded,

wherein the foil web is cut into strips having a width corresponding to the desired honeycomb core height (T),

one strip is guided via a position detector which, by way of the adhesive strips, determines its position relative to a first end (P) of the stack and controls a positioning drive and a cutting unit via an electronic control unit,

the positioning drive positions the strip relative to the stack at the end (P) in such a manner that the adhesive strips of the strip are then situated between the adhesive strips of an underlying strip and the strip is held at the end (P),

beginning at the end (P) and working in the direction of the other end (Q), the strip is then successively bonded to the previously stacked underlying strip and, shortly before it is bonded to the other end (Q), the strip is cut with the aid of the cutting unit to a preselected length (L_u) delimited by the ends (P, Q) and corresponding to the desired width (L) of the honeycomb core to be produced, after which the process is repeated.

2. A method according to claim 1, wherein the positioning drive is mounted on a slide movable substantially parallel to the surface and at least over the entire length (L_u) of the stacked strips and, during a first movement of the slide in the direction of the first end (P), first moves the strip to the vicinity of the end (P) while simultaneously determining the position of the adhesive strips relative to the end (P),

the end of the strip being positioned at the end (P) and held, then during a subsequent second movement of the slide in the direction of the other end (Q), a pressure is exerted on the strip and at least the last strip stacked in such a manner that the strip is bonded to the last strip stacked over the length Lu of the stacked strips, after which the movements of the slide are repeated.

3. A method according to claim 1 or 2, wherein a plurality of strips are guided simultaneously via one position detector with an offset arrangement of the adhesive strips and are simultaneously positioned on top of one another, held and bonded.

4. A method according to claim 1 or 2, wherein a plurality of strips are each guided simultaneously via respective position detectors associated with each strip and are simultaneously positioned on top of one another, held and bonded with a spaced offset arrangement of the adhesive strips.

5. A method according to claim 1 or 2, wherein that a first strip or a first number of strips with a spaced

offset arrangement of the adhesive strips is guided simultaneously via a first position detector or a number of position detectors corresponding to or less than the first number of strips when the slide moves in the direction of the end (P) and is positioned and then held and a second strip or a second number of strips with a spaced offset arrangement of the adhesive strips is guided simultaneously via a second position detector or a number of position detectors corresponding to or less than the second number of strips when the slide moves in the direction of the other end (Q) and is positioned, the number of strips already positioned and held being bonded together and to the underlying strip or the positioned and held strip being bonded to the underlying strip over the length (L_u).

6. A method according to any one of claims 1 to 5, wherein in that the strips are unwound from a strip reel.

7. A method according to any one of claims 1 to 6, wherein that an adhesive with lower reflectivity than the strip material is used to produce the adhesive strips.

8. A method according to claim 7, wherein the adhesive contains a dye to reduce reflection.

9. A method according to any one of claims 1 to 8, wherein bonding is effected at an elevated temperature.

10. A method according to any one of claims 1 to 9, wherein the adhesive strips of the strip are then

situated in the centre between the adhesive strips of the underlying strip.

11. A method according to any one of claims 1 to 10, wherein a web or a foil of aluminium or an aluminium alloy is used as the foil web.

12. A method according to any one of claims 1 to 11, wherein in that the honeycomb core is expanded to form hexagonal honeycomb cells.

13. A device for carrying out the method according to any one of claims 1 to 12, wherein the position detectors, at least one positioning drive, at least one cutting unit and a liftable sealing roller for bonding the strip/s to the uppermost strip of the stack are mounted on a slide which is arranged to move on guides in such a manner that the sealing roller can sweep over the entire width (L_u) of a honeycomb collecting unit arranged below it via its vertex (R), the pressure and the elevated temperature act on the strip/s and at least the uppermost strip by means of the sealing roller and a clamping element for holding the strip/s is arranged at least at one end of the honeycomb collecting unit.

14. A device according to claim 13, wherein the slide is provided upstream of the position detector with a strip stopper for holding the strip during the idle phase of the positioning drive and with a web tension controller.

15. A device according to claim 14, wherein a web tension controller and, if a strip reel is present, optionally a band brake acting on the latter, are arranged between the position detector and the strip stopper in order to keep the tension of the strip constant.

16. A device according to any one of claims 13 to 15, wherein the honeycomb collecting unit consists of at least one pair of clamping jaws arranged parallel to the direction of the stack being formed, wherein at least one clamping jaw can be pulled open.

17. A device according to any one of claims 13 to 16, wherein for starting, the honeycomb collecting unit consists of a table which is arranged parallel to the guides and can be lowered transversely thereto.

18. A device according to any one of claims 13 to 17, wherein the sealing roller can be heated.

19. A device according to any one of claims 13 to 18, wherein the pressure of the sealing roller for bonding the strip/s and the uppermost strip of the stack is produced and controlled by at least one pressure cylinder.

20. A device according to any one of claims 13 to 18 wherein the pressure of the sealing roller for bonding the strips and the uppermost strip of the stack is produced and controlled by at least one pressure roller in association with lowering of the table.

21. A device according to any one of claims 13 to 20, wherein the position detector is a photocell.

22. A device according to any one of claims 13 to 21, wherein the strip reel/s is/are also situated on the slide.

23. A device according to any one of claims 13 to 22, wherein at least one rotating roller provided on its surface with brushes and engaging the entire length (L_u) of the stack is provided to expand the stack leaving the honeycomb collecting unit to form an expanded honeycomb core, said brushes pulling on the strips of the stack transversely to the stacking direction and a braking device being situated between the roller/s and the stack and exerting a restraining force on the stack which is smaller than the tensile force of the roller/s provided with the brushes.

24. A device according to claim 23, wherein the roller is provided with a drive.

25. A device according to claim 24, wherein the braking device is a strip of brushes engaging the entire length (L_u) of the strips at least on one side.

26. A method for the continuous production of a composite panel with at least one outer panel comprising the steps of continuously producing an expanded honeycomb core according to any one of claims 1 to 12, and continuously joining the honeycomb core with at least one outer layer.

27. A method for the continuous production of a composite panel with at least one outer panel comprising the steps of: continuously producing an expanded honeycomb core according to the method of any one of claims 1 to 12, and continuously joining the honeycomb core with at least one outer panel consisting of aluminium or an aluminium alloy.

28. Apparatus for the production of an unexpanded honeycomb core from foil band unrolled from a band coil, which is coated at uniform intervals with strips of adhesive and cut into strips in the direction of uncoiling, the strips then being piled on top of one another with their respective adhesive strips parallel but in staggered positions, and thereafter adhesively bonded together under pressure to form a stack with ends which is finally expanded, which comprises: position detectors which determine the position of the adhesive strips, at least one positioning drive to obtain a staggered adhesive strip arrangement based on the adhesive strip location, at least one cutting device and one liftable sealing roller for applying heat and pressure to the stack for the bonding of the strips to a topmost strip of the stack, said position detectors, positioning drive, cutting device and sealing roller being mounted on a sliding carriage, which can move along guideways in such a way that the sealing roller with its low point can sweep along a honeycomb holder device positioned underneath it over its entire width, wherein pressure and elevated temperature is applied by the sealing roller to the strips and at least a topmost underlying strip, and including a clamp for holding fast

the strips at least at one end of the honeycomb holder device.

29. Apparatus according to claim 28, wherein the sliding carriage incorporates a strip stopper downstream of the position detector for holding the strip steady while the positioning drive is inactive, as well as a strip tension control device.

30. Apparatus according to claim 29, including a strip tension control device to keep the tension of the strip constant between the position detector and the strip stopper.

31. Apparatus according to claim 30, including a strip spool for feeding the uncut strips and a strap brake acting on the strip spool.

32. Apparatus according to claim 28, 29, 30 or 31, wherein the honeycomb holder device consists of at least one pair of clamping jaws arranged parallel to the direction of the stack being built up, with at least one of the clamping jaws capable of being pulled open.

33. Apparatus according to claim 28, 29, 30 or 31, wherein at the beginning of the honeycomb holder device a table is arranged parallel to the guideways capable of being lowered transversely with respect to the guideways.

34. Apparatus according to claim 33, wherein the pressure of the sealing roller for the adhesive bonding

of the strips to the topmost strip of the stack is exerted and controlled by at least one pressure cylinder.

35. Apparatus according to any one of claims 28 to 34, wherein the sealing roller includes means for heating same.

2075142

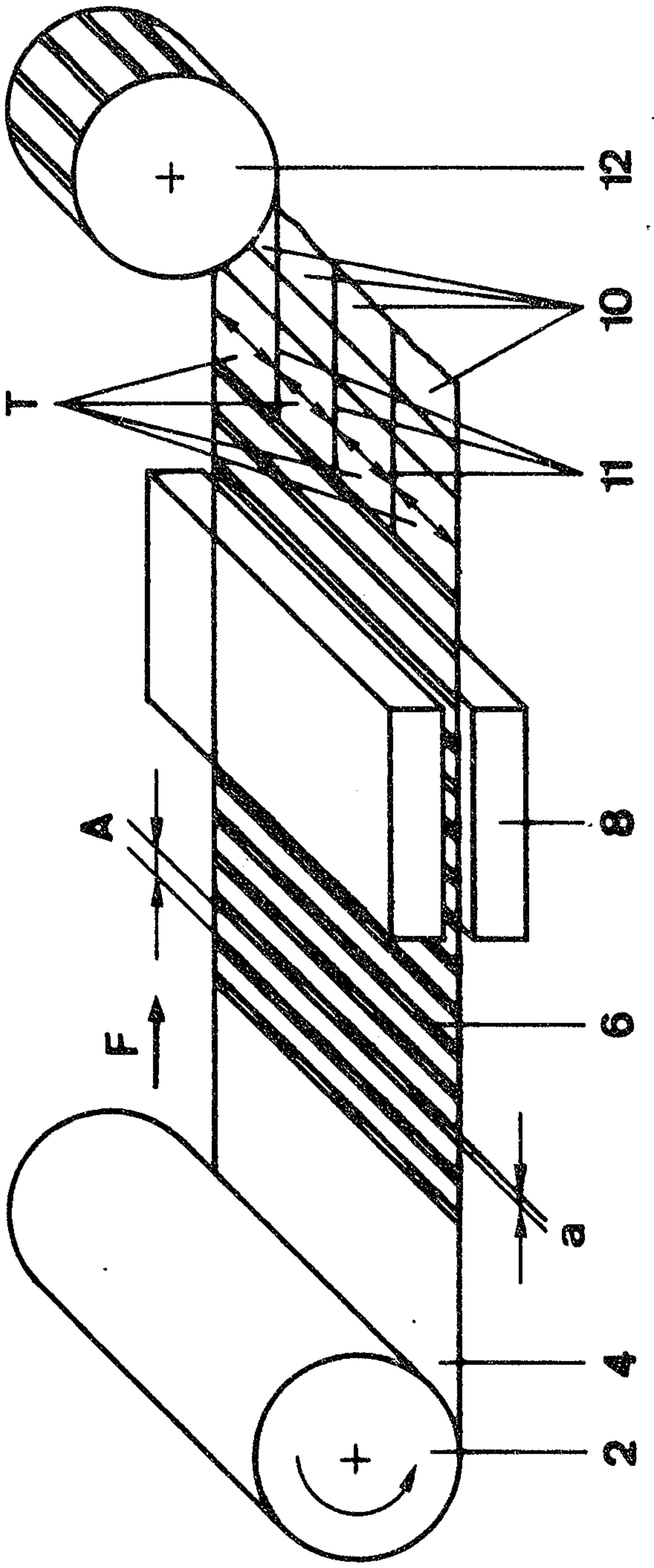


Fig. 1

PATENT AGENTS

Swabey Ogilvy Renault

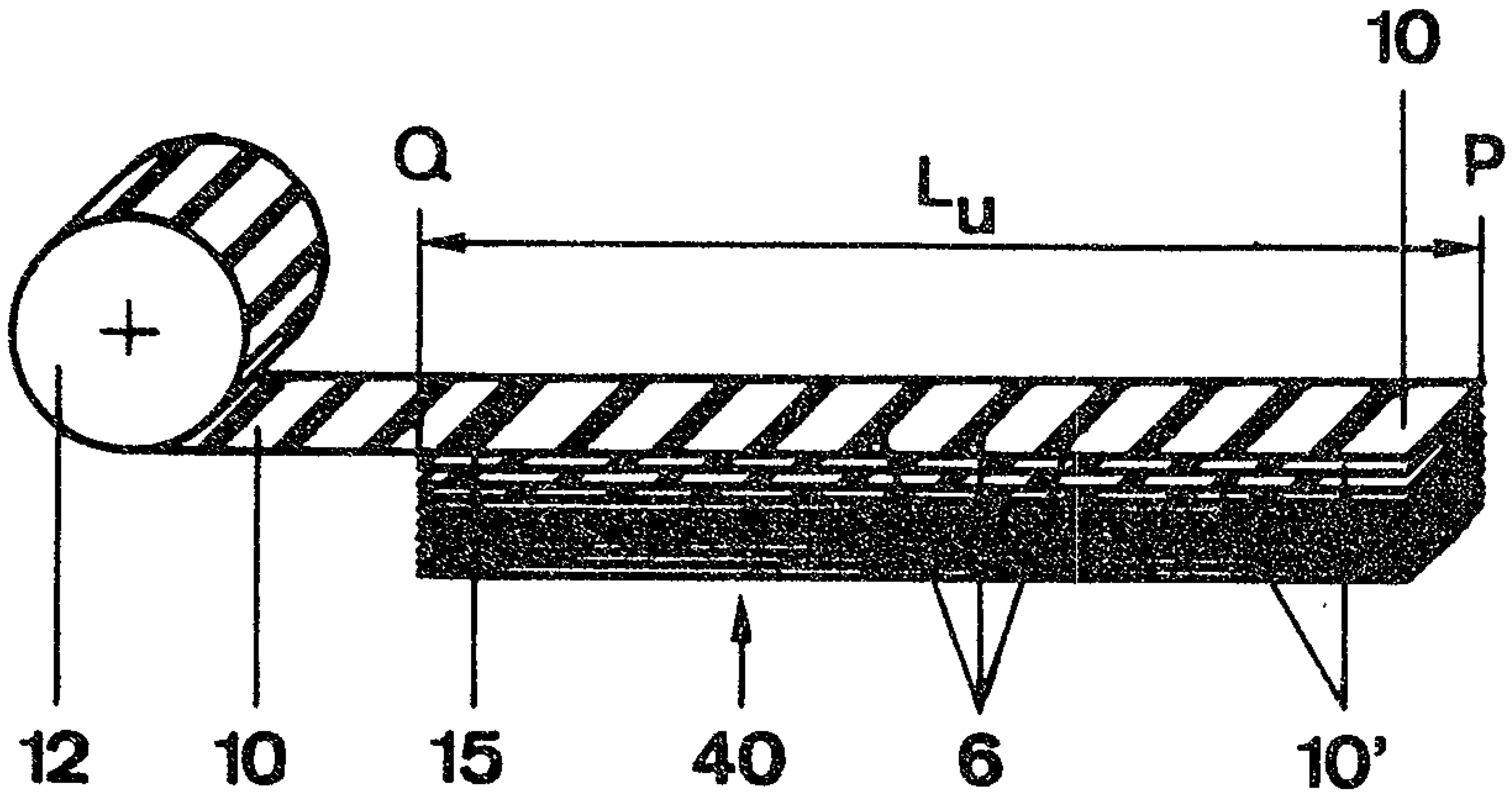


Fig. 2a

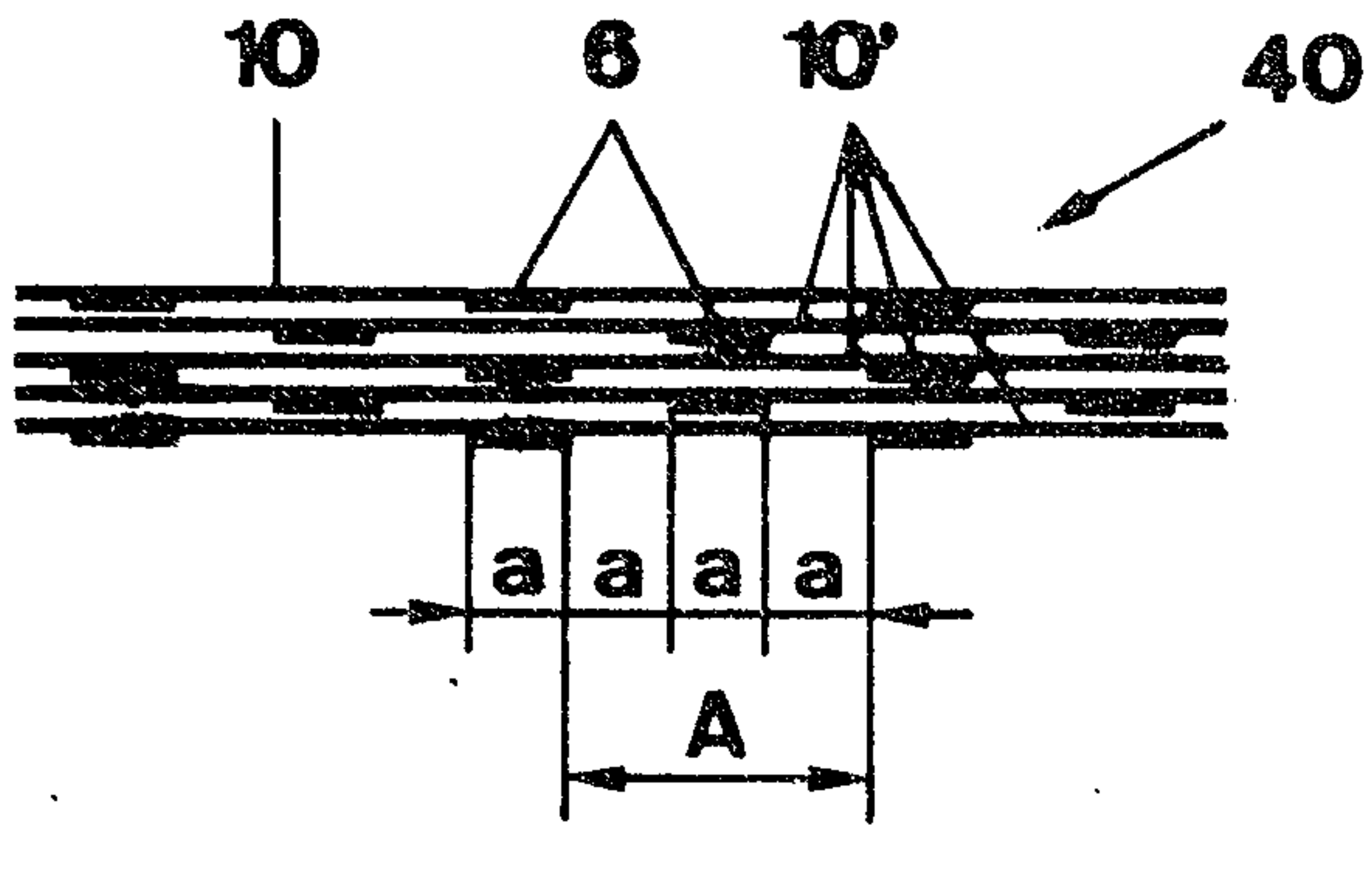


Fig. 2b

PATENT AGENTS

Swabey Ogilvy Renault

2075142

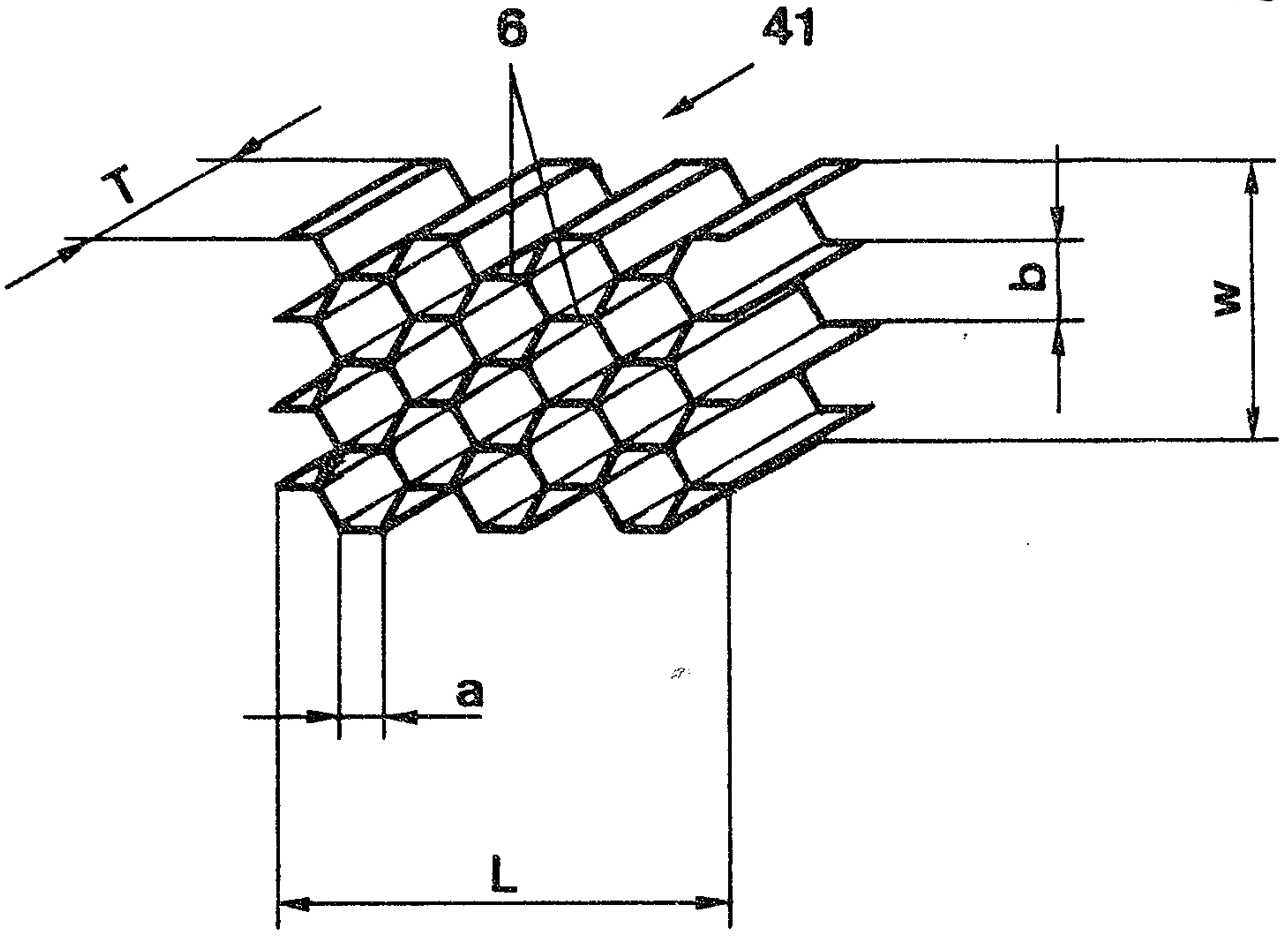


Fig. 3a

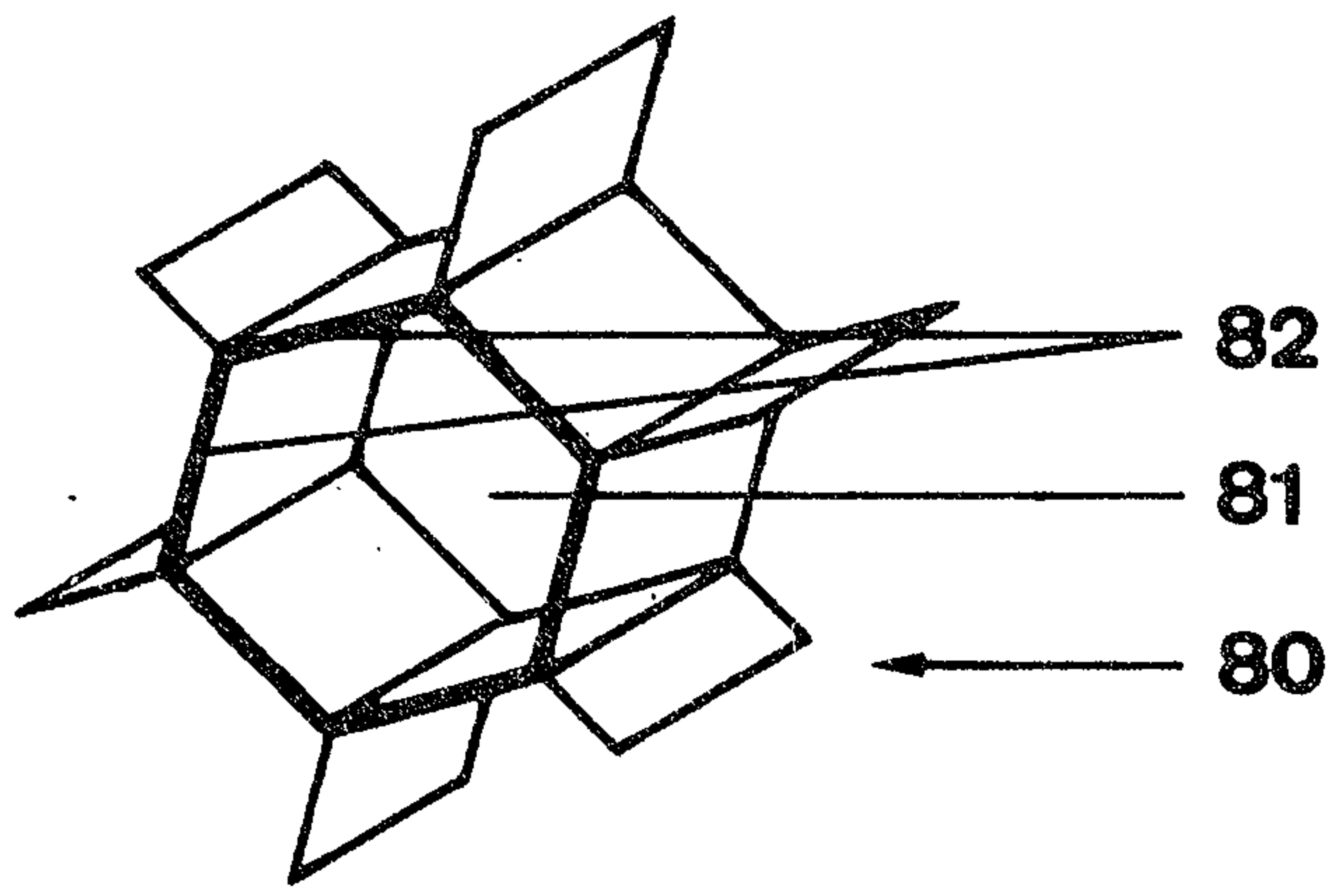


Fig. 3b

PATENT AGENTS

Swabey Ogilvy Renault

2075142

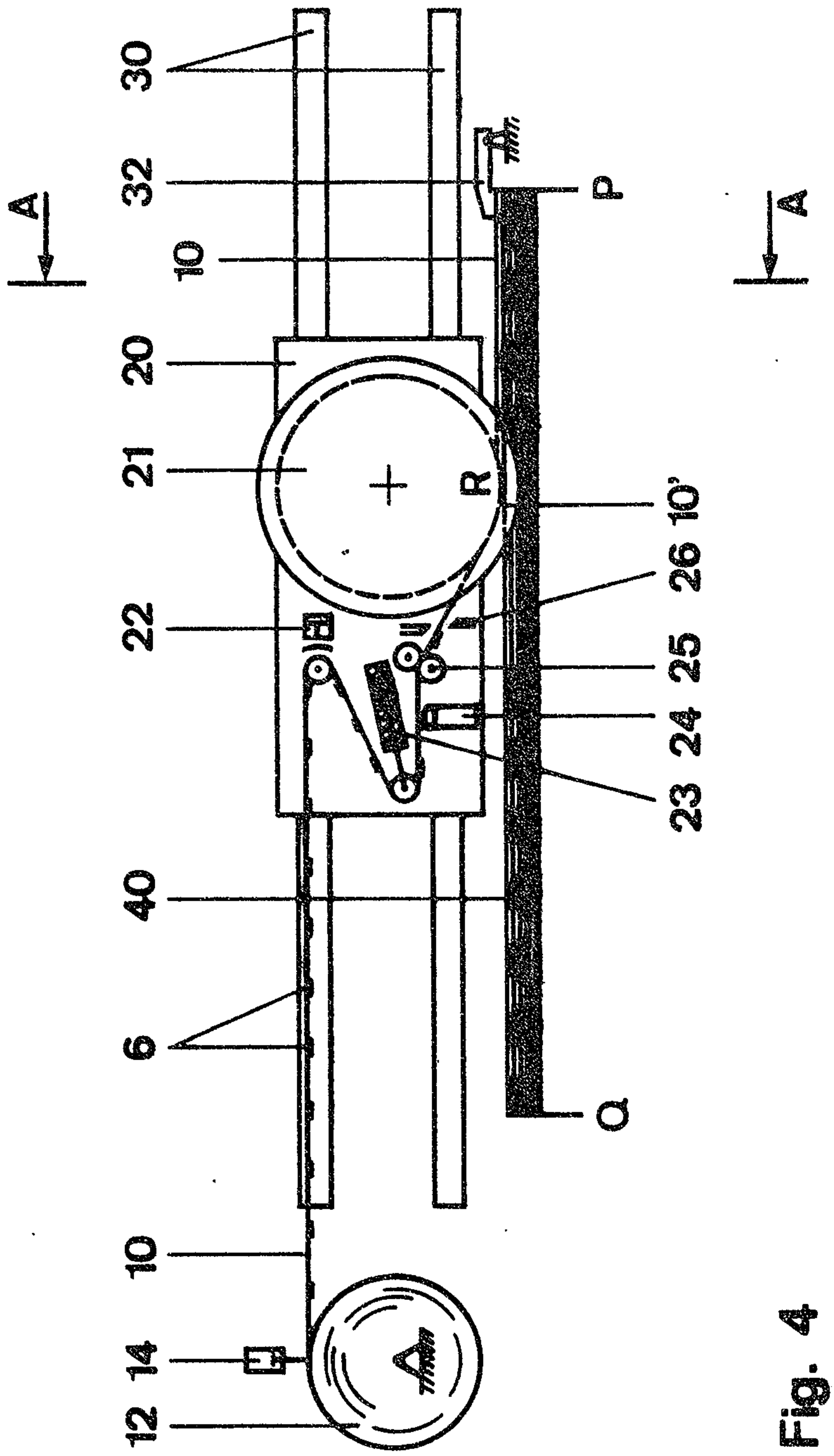


Fig. 4

PATENT AGENTS

Swabey Ogilvy Renault

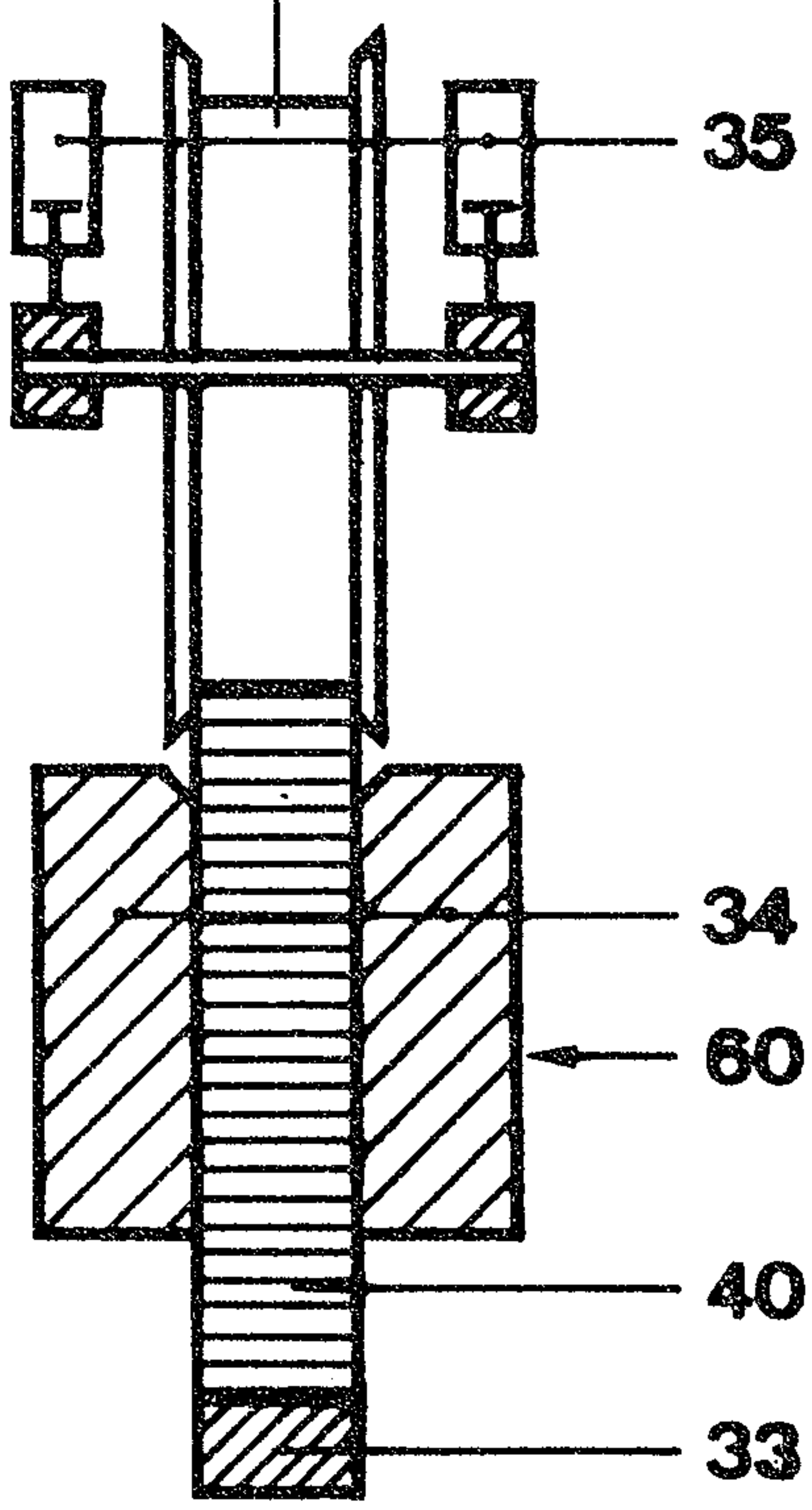


Fig. 5

PATENT AGENTS

Swabey Ogilvy Renault

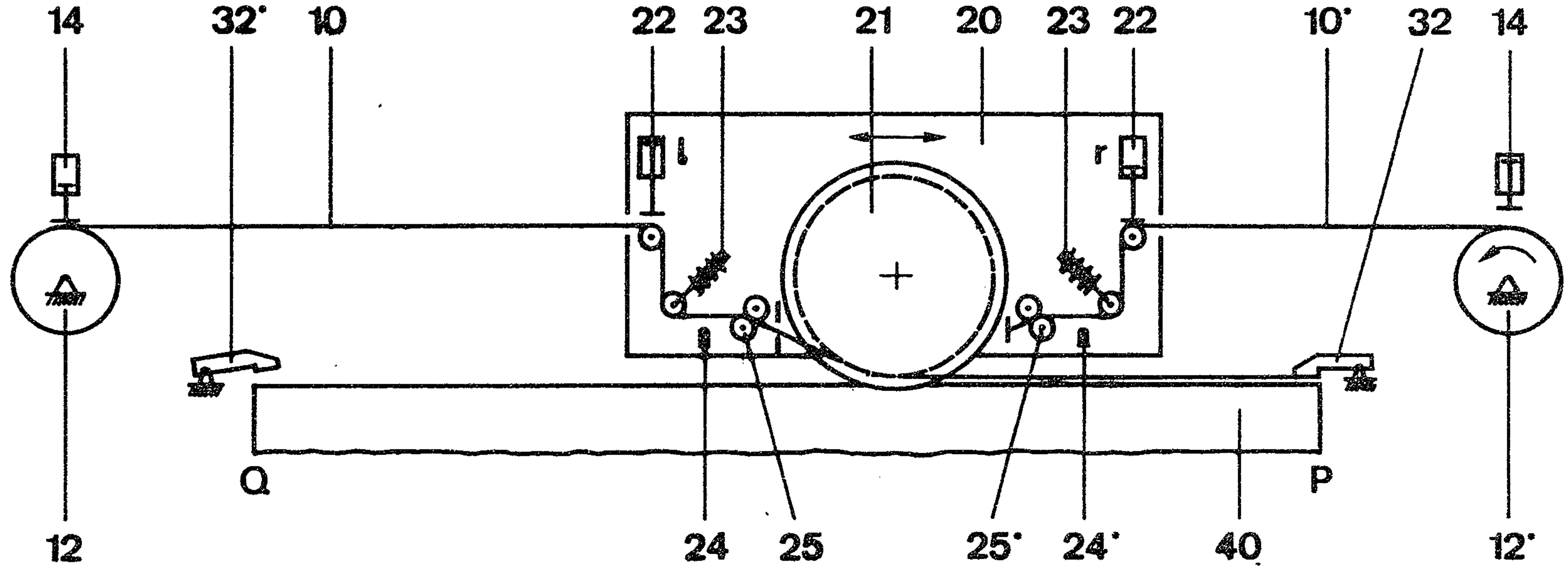


Fig. 6

PATENT AGENTS

Swabey Ogilvy Renault

2075142

2075142

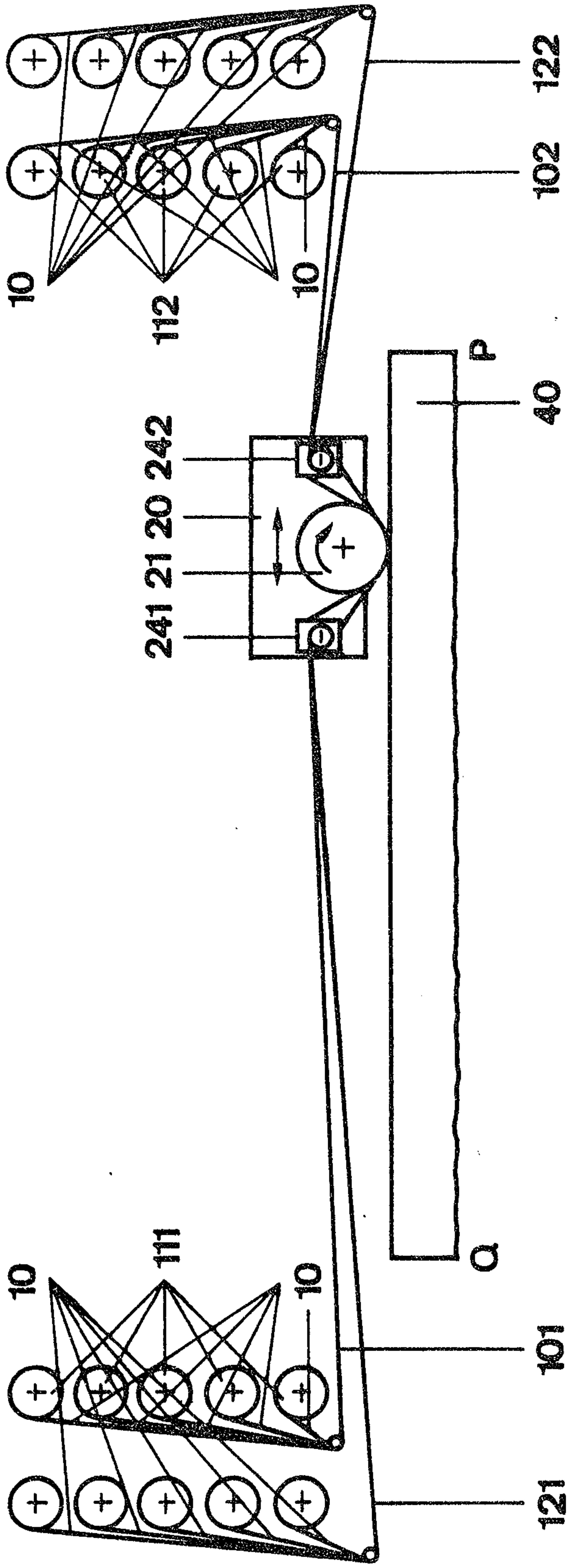


Fig. 7

PATENT AGENTS

Swabey Ogilvy Renault

2075142

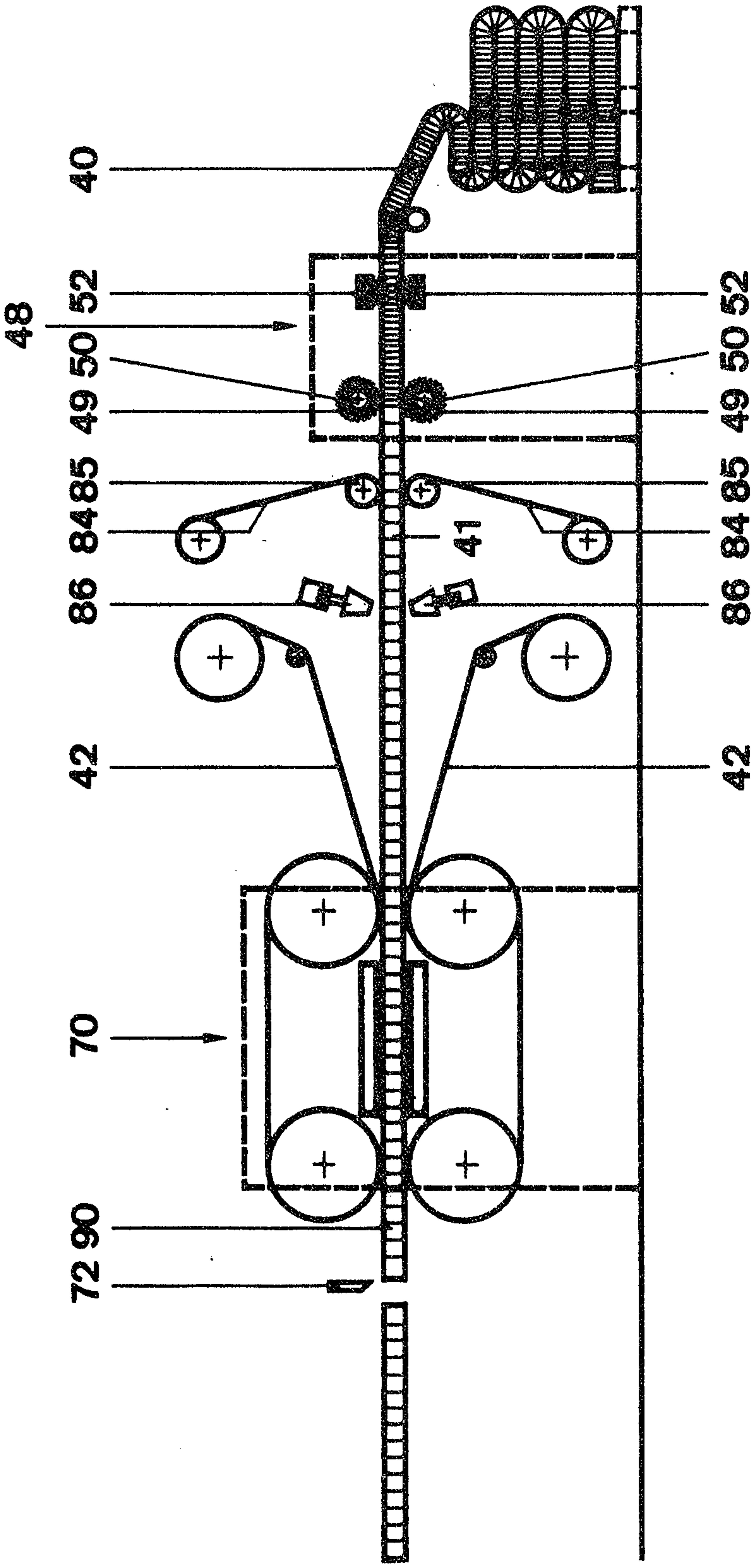
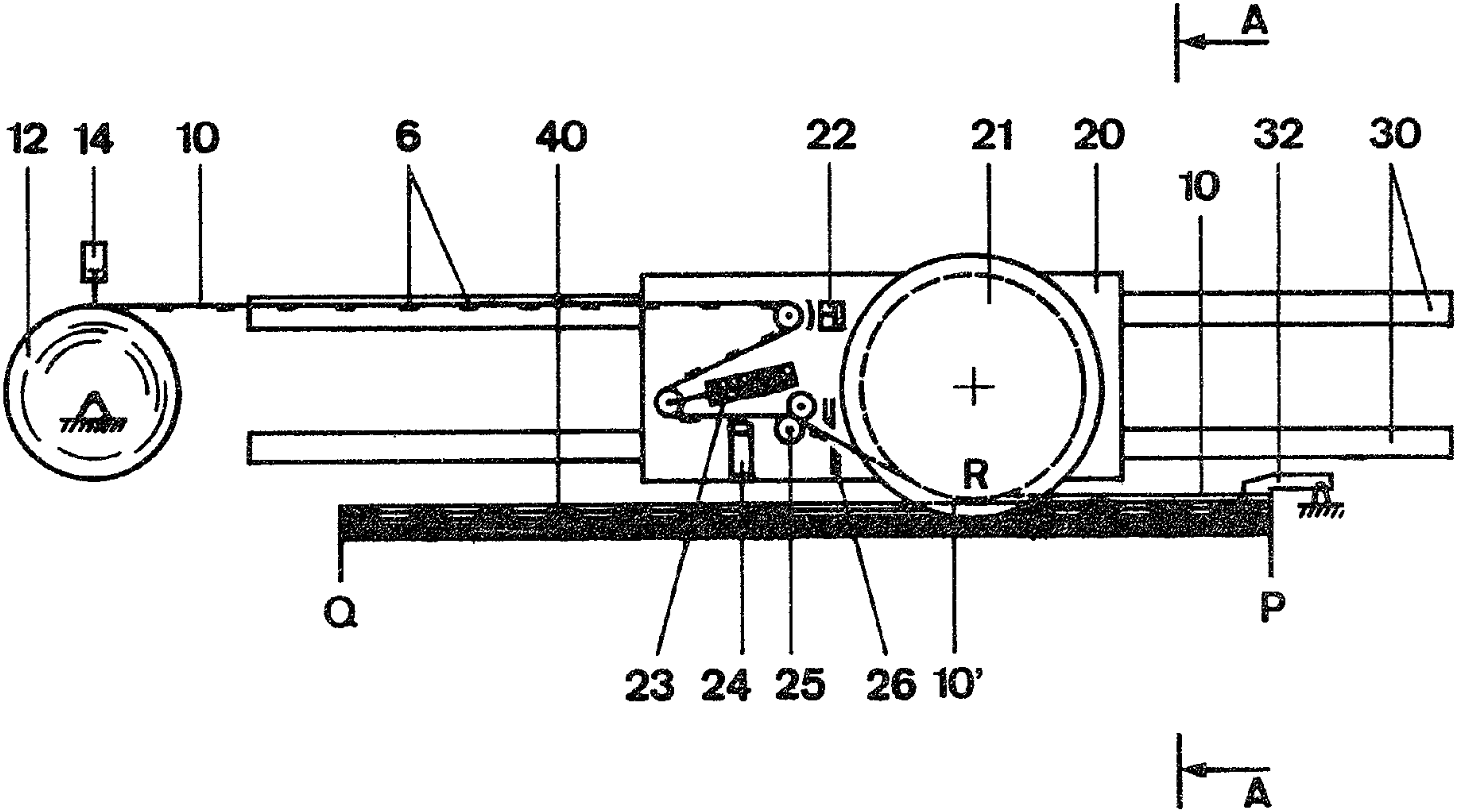


Fig. 8

PATENT AGENTS

Marks & Clerk Renault


A
12
14
10
6
40
22
21
20
32
30
10
R
Q
P
23
24
25
26
10'
A