



- (51) **International Patent Classification:** Not classified
- (21) **International Application Number:**
PCT/IB2009/005476
- (22) **International Filing Date:**
4 May 2009 (04.05.2009)
- (25) **Filing Language:** Italian
- (26) **Publication Language:** English
- (30) **Priority Data:**
TO2008A000332 5 May 2008 (05.05.2008) IT
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- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) **Title:** METHOD AND SYSTEM FOR ELECTRICALLY CONNECTING PHOTOVOLTAIC CELLS TOGETHER

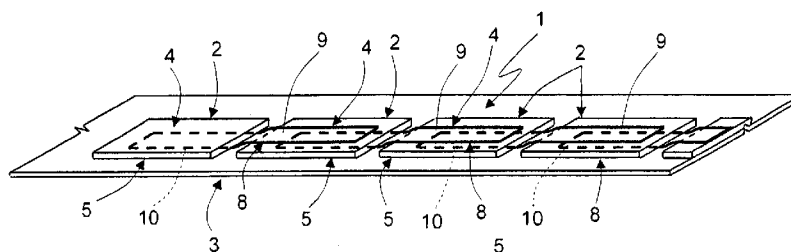


Fig.1

(57) **Abstract:** A method and a system (12) for electrically connecting photovoltaic cells (2) together, whereby, in an orderly succession of photovoltaic cells set with equi-oriented polarities and fed along a path (15) of electrical connection, a first photovoltaic cell (2a) is electrically connected to a second adjacent photovoltaic cell (2b) by soldering a first stretch (9) of an elongated electrical connection element (8) to a first extensive surface (4) of the first photovoltaic cell (2a), allowing a second stretch (10) of the elongated element (8) to project in cantilever fashion along the connection path (15), setting the second photovoltaic cell (2b) on top of the second stretch (10) of the elongated element (8), and soldering the second stretch (10) to a second extensive surface (5) of the second photovoltaic cell (2b), which has a polarity different from that of the first extensive surface (4).



"METHOD AND SYSTEM FOR ELECTRICALLY CONNECTING PHOTOVOLTAIC CELLS TOGETHER"

TECHNICAL FIELD

5 The present invention relates to a method for electrically connecting photovoltaic cells together.

BACKGROUND ART

As is known, a photovoltaic panel comprises a gas-tight
10 external casing, which is permeable to light, in which a plurality of photovoltaic cells is housed. The photovoltaic cells are normally in the form of plate-like elements, the opposite extensive lateral surfaces of which have different polarities and are connected electrically to one another to
15 form rows of photovoltaic cells. In each row of photovoltaic cells, the polarity of a photovoltaic cell is connected to the opposite polarity of the adjacent photovoltaic cell of the row itself.

20 The electrical connection described above is today obtained by setting a first stretch of electrical wiring on a first extensive surface of one of the photovoltaic cells, electrically connecting the first terminal stretch to the first extensive surface, and electrically connecting a second
25 stretch of the electrical wiring to an extensive surface of an adjacent photovoltaic cell having a different polarity from that of the first surface, after the first photovoltaic cell has been turned over and the electrical wiring has been connected to the first photovoltaic cell itself.

30

The mode of connection described above, albeit used, proves to be far from satisfactory, above all in the perspective of increasing the rate of connection of the photovoltaic cells in so far as the connection of the wiring to the extensive
35 surface of the second photovoltaic cell leads to inevitable but, above all, long and complex operations of manipulation of

the photovoltaic cells. Said manipulations must, on the other hand, be made by skilled personnel and with the maximum attention, since the known photovoltaic cells have thicknesses normally of the order of 2-5 tenths of a millimetre and are
5 made of pure or high-purity silicon and, hence, by their very nature, are particularly brittle.

DISCLOSURE OF INVENTION

The aim of the present invention is to provide a method for
10 electrically connecting photovoltaic cells together, which will enable solution in a simple and inexpensive way to the problems set forth above.

According to the present invention, a method for electrically
15 connecting photovoltaic cells together is provided, the method comprising the steps of using an elongated electrical-connection element, of connecting a first stretch of said elongated element to a first extensive surface of a first photovoltaic cell, and of connecting a second stretch of said
20 elongated element to a second extensive surface of a second photovoltaic cell having a different polarity from that of said first extensive surface, said method being characterized in that the connections of said elongated element to said first and second extensive surfaces is obtained by feeding in
25 succession said photovoltaic cells with equi-oriented polarities along a path of electrical connection, connecting said first stretch to the first of said photovoltaic cells by allowing said second stretch to project beyond said first photovoltaic cell in a direction opposite to the direction of
30 advance of the photovoltaic cells, setting the second photovoltaic cell on top of said second stretch, and electrically connecting the second stretch to said second extensive surface.

35 The present invention moreover relates to a system for electrically connecting photovoltaic cells together.

According to the present invention a system is obtained for providing photovoltaic cells as claimed in Claim 13.

5 BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to the annexed drawings, which illustrate a non-limiting example of embodiment thereof and in which:

Figure 1 illustrates in perspective view a row of photovoltaic
10 cells electrically joined together;

Figure 2 is a schematic illustration substantially in the form of a block diagram of a system for providing the row of photovoltaic cells of Figure 1 according to a preferred embodiment of the method according to teachings of the present
15 invention; and

Figures 3a to 3d illustrate parts of the system of Figure 2 set in different functional conditions of execution of different steps of the method according to the invention.

20 BEST MODE FOR CARRYING OUT THE INVENTION

In Figure 1, designated by 1 is an orderly row of photovoltaic cells 2 for a photovoltaic solar panel 3, illustrated only partially. Each photovoltaic cell 2, in itself known, is provided in the form of a plate and is delimited laterally by
25 two opposite extensive lateral surfaces 4 and 5, the surface 4 being positively charged and the surface 5 being negatively charged. The photovoltaic cells 2 are aligned with respect to one another with polarities equi-oriented, i.e., with the positive and negative poles facing all one and the same side,
30 as illustrated in Figure 1, and are each connected to the adjacent photovoltaic cell 2 via a conductive element in the form of tape or electrical wiring 8, conveniently made with an alloy of copper and tin and/or silver. Each electrical wiring 8 has a length greater than the longitudinal dimension of the
35 photovoltaic cells 2, in the particular case described

approximately twice the length, and comprises a terminal stretch 9 set on top of and electrically connected by means of soldering to the extensive surface 4 of the corresponding photovoltaic cell 2 and an opposite terminal stretch 10, set
5 on top of and electrically connected by means of soldering to the extensive surface 5 of the photovoltaic cell 2 adjacent to the one to which the stretch 8 is connected.

The row 1 of photovoltaic cells is provided in the system 12
10 schematically illustrated in Figure 2 and partially illustrated in Figure 3.

With reference to Figure 2, the system 12, which is conveniently housed in a controlled-atmosphere chamber,
15 preferably in the absence of oxygen, comprises two linear conveyors 13 and 14, in themselves known and not described in detail, which are aligned to one another along a path of feed and soldering of the photovoltaic cells 2, designated by 15. The conveyor 13 defines a plane contrast or resting surface
20 18, which is set underneath the path 15, and on which a succession of photovoltaic cells 2 set with equi-oriented polarities is rested and made to advance, in the specific case with their negative poles set in contact with the surface 18 and at a given pitch P from one another (Figure 2). The
25 conveyor 13 extends through a station 19 for supply of the electrical wiring 8 and for connection of the electrical wiring 8 itself to the surface 4 of the photovoltaic cell 2 passing through the station 19 itself.

30 Set in the proximity of the feed station 19 is a feeding and cutting unit 20 for forming the electrical wiring 8 and feeding the wiring 8 itself to the station 19 at the same rate of advance of the photovoltaic cells 2. The unit 20 comprises an unwinder device 21 for unwinding a reel 22 of conductive
35 tape 23 and feeding the tape 23 itself to a cutting and feeding unit 24 designed to cut the tape 23 transversely to

provide, for each photovoltaic cell 2, a respective electrical wiring 8 and feed the electrical cables 8 obtained into the station 19.

5 In the station 19, set in the position facing the surface 18, is a motor-driven soldering head 25 designed to displace between a retracted resting position, illustrated in Figures 2 and 3a, in which it enables feed of the photovoltaic cells 2 and of the corresponding wiring 8 along the path 15, and a
10 lowered soldering position, illustrated in Figure 3b, in which it electrically connects the stretch 9 of each wiring 8 in a stable way to the corresponding surface 4.

The conveyor 13 terminates upstream, in the direction of
15 advance of the photovoltaic cells 2, of a superposition station 27 (Figures 2 and 3c), from which the conveyor 14 extends. The conveyor 14 has a contrast or resting surface 28 of its own, which extends parallel to the surface 18 but on the opposite side of the path 15 with respect to the surface
20 18 in a raised position with respect to the surface 18 itself by an amount approximating by excess the sum of the thickness of the photovoltaic cells and that of the electrical wiring 8, as illustrated in Figure 3C.

25 Set downstream of the superposition station 27, the conveyor 14 extends through a further soldering station 29, which is substantially the same as the station 19, in which a motor-driven soldering head 30 is set, which is substantially the same as the soldering head 25 and is able to move between a
30 lowered resting position, illustrated in Figures 2 and 3c, in which it enables feeding of the photovoltaic cells 2 and of corresponding electrical wiring 8, and a raised position, illustrated in Figure 3d, in which the stretches 10 of the electrical wiring 8 are electrically soldered to the extensive
35 surfaces 5 of the corresponding photovoltaic cells 2.

The electrical connection of the photovoltaic cells 2 will now be described considering, for simplicity of exposition, just two photovoltaic cells set on the surface at a distance P from one another, as illustrated in Figure 2 and starting from the condition in which the tape extends through the cutting unit 24 and in which the end of the tape 23 itself extends in an entrance of the station 19.

Starting from this condition, as soon as the first photovoltaic cell 2a (Figures 2 and 3a) traverses the station 19, the tape 23 is fed in such a way that the end of the tape 23 itself is set in contact with the surface 4, and during feeding of the photovoltaic cell 2a itself rests progressively on its surface 4. At the moment when the photovoltaic cell 2a enters the station 19 the soldering head 25 is lowered, which during feeding of the photovoltaic cell 2a through the station 19 solders the stretch 9 of the tape 23 to the surface 4.

Before, during, or at the end of soldering the cutting unit 24 is activated, which cuts the tape 23 transversely to provide the electrical wiring 8, the trailing stretch 10 of which during feeding of the photovoltaic cell 2a comes to rest progressively on the surface 18, as may be seen in Figure 3b. At this point, as the photovoltaic cell 2a advances along the path 15, it traverses the superposition station 27, in which the stretch 4 slides in contact with the surface 28, whilst the stretch 5 drops downwards as a result of its own weight moving away from the surface 28 itself, as may be seen in Figure 3c. At this point, the photovoltaic cell 2a is stopped or slowed down so as to enable the photovoltaic cell 2b to reach it and to set itself partially on top of at least the underlying stretch 10. When superposition has occurred, both of the photovoltaic cells 2a and 2b are fed simultaneously to the soldering station 29, causing progressive raising of the stretch 10 and setting thereof against the surface 5. At the moment when the photovoltaic cell 2b enters the soldering

station 28, the head 30 is raised, and the stretch 10 is soldered onto the surface 5, as illustrated in Figure 3d, after which the photovoltaic cells 2a and 2b electrically connected together are fed once again simultaneously to an output of the system 12.

The process of electrical connection described for the photovoltaic cells 2a and 2b is repeated following the same steps described above for all the photovoltaic cells 2 fed along the path 15 and in contact with the surface 18 to obtain the row 1 of photovoltaic cells.

From the above description, it emerges clearly how the connection method described enables electrical connection in a totally automatic way of any orderly succession of photovoltaic cells without ever having to turn round or turn over the photovoltaic cells, which slide remaining in contact with a reference or resting surface that protects the photovoltaic cells themselves preventing any bending thereof, localized or distributed deformations, and/or failures. The system 12 and the modalities of implementation described hence enable electrical connection together in an automatic way and without requiring any intervention on the part of the operator of photovoltaic cells of any shape, size, or material.

As compared to the known solutions, the system 12 and the modalities of embodiment described finally enable drastic reductions in the times for connection and, from what has been said previously, improvement in the quality, reliability, and efficiency of the product of the row of photovoltaic cells.

From the foregoing description it clearly emerges that modifications and variations may be made to the method and system 12 described, without thereby departing from the sphere of protection defined by the claims. In particular, the device 12 for forming the wiring 8 could be set in a remote position

with respect to the soldering station 19, and the electrical wiring 8 formed be first grouped together and only subsequently fed into the station 19 individually.

5 In addition, the modes of superposition of the photovoltaic cell that follows the stretch 10 projecting at the rear in cantilever fashion from the preceding photovoltaic cell could be different from the one described. In particular, the stretch 10 might not be allowed to drop as a result of its own
10 weight then be re-raised but be kept resting on the surface 18 that would proceed to the soldering station 29 or on equivalent supporting devices, and the next photovoltaic cell could be at least partially raised above the stretch 10.

15 Alternatively, the aforesaid supporting devices could be of a motor-driven type so as to lower in a controlled way the stretch 10 carried by the previous photovoltaic cell underneath the next photovoltaic cell and subsequently
20 displace the stretch 10 in contact with the next photovoltaic cell itself.

CLAIMS

1.- A method for connecting photovoltaic cells electrically together, the method comprising the steps of using an elongated electrical-connection element, connecting a first stretch of said elongated element to a first extensive surface of a first photovoltaic cell, and connecting a second stretch of said elongated element to a second extensive surface of a second photovoltaic cell having a different polarity from that of said first extensive surface, said method being characterized in that the connections of said elongated element to said first and second extensive surfaces is performed by feeding in succession said photovoltaic cells with polarities equi-oriented along a path of electrical connection, connecting said first stretch to the first of said photovoltaic cells allowing said second stretch to project beyond said first photovoltaic cell in a direction opposite to the direction of advance of the photovoltaic cells, setting the second photovoltaic cell on said second stretch, and electrically connecting the second stretch to said second extensive surface.

2.- The method according to Claim 1, characterized in that the superposition of said second photovoltaic cell to said second stretch is made by causing said second photovoltaic cell to slide over said second stretch.

3.- The method according to Claim 1 or Claim 2, characterized in that the superposition of said second photovoltaic cell to said second stretch is made by varying the rate of feed of said photovoltaic cells along said electrical-connection path.

4.- The method according to Claim 3, characterized in that the superposition of said second photovoltaic cell to said second stretch is made by stopping said first photovoltaic cell along said path and feeding said second photovoltaic cell during

arrest of said first photovoltaic cell.

5.- The method according to any one of the preceding claims, characterized in that the superposition of said second photovoltaic cell on said second stretch is made allowing said second stretch to drop by gravity with respect to said first stretch before said second stretch is reached by said second photovoltaic cell.

6.- The method according to Claim 5, characterized in that the connection of said second stretch to said second extensive surface is made by raising said second stretch in contact with said second extensive surface.

7.- The method according to any one of the preceding claims, characterized in that feeding of said photovoltaic cells along said path comprises the operations of feeding the photovoltaic cells in contact with a first resting surface and subsequently in contact with a second surface of contrast so that they are set on opposite sides of said path and at a distance apart from one another in a transverse direction; at least the electrical connection of said first stretch of said elongated element to said first extensive surface being made by bringing said first photovoltaic cell into contact with said first contrast surface, and the superposition of said second photovoltaic cell to said second stretch of said elongated element being made after said first photovoltaic cell has disengaged said first surface of contrast.

8.- The method according to Claim 7, characterized in that the electrical connection of said second stretch to said second extensive surface of said second photovoltaic cell is made by pushing said second photovoltaic cell against said second surface of contrast.

9.- The method according to any one of the preceding claims,

characterized in that the electrical connection of said first and second stretches comprises a soldering operation.

10.- The method according to any one of the preceding claims,
5 characterized in that it comprises the further step of feeding a tape of electrically conductive material towards said path, setting a free stretch of said tape on said first extensive surface and withholding it there, and cutting said tape transversely so as to obtain said elongated electrical-
10 connection element.

11.- The method according to Claim 10, characterized in that said transverse cut is made after electrical connection of said free stretch to said first extensive surface.

15 12.- The method according to any one of the preceding claims, characterized in that an orderly succession of photovoltaic cells set all with polarities equi-oriented is fed along said electrical-connection path and each of the photovoltaic cells
20 is connected to the adjacent photovoltaic cells according to the steps described in one of the preceding claims so as to obtain a continuous row of photovoltaic cells electrically connected to one another.

25 13.- A system for electrically connecting photovoltaic cells together, the system comprising: feed means for feeding along an electrical-connection path at least one first photovoltaic cell and at least one second photovoltaic cell, maintaining the photovoltaic cells themselves with polarities equi-
30 oriented along all said electrical-connection path; feed means for feeding an elongated electrical-connection element to said electrical-connection path; first connection means for connecting a first stretch of said elongated element to a first extensive surface of said first photovoltaic cell; and
35 second connection means for connecting a second stretch of said elongated element to a second extensive surface of said

second photovoltaic cell having a different polarity from that of said first extensive surface.

14.- The system according to Claim 13, characterized in that said feed means comprise a first contrast surface and a second contrast surface of said photovoltaic cells; said contrast surfaces being set on opposite lateral sides of said path and extending parallel to one another.

15.- The system according to Claim 14, characterized in that it comprises: a first connection station, in which said first stretch of said elongated element is connected to the first extensive surface of said first photovoltaic cell; a second connection station distinct from said first connection station for connecting the second stretch of said elongated element to the second extensive surface of said second photovoltaic cell; and a superposition station intermediate between said connection stations for setting said second photovoltaic cell on a stretch of said elongated connection element.

16.- The system according to Claim 15, characterized in that said first contrast surface extends through said first connection station, and in that said second contrast surface extends through said second connection station.

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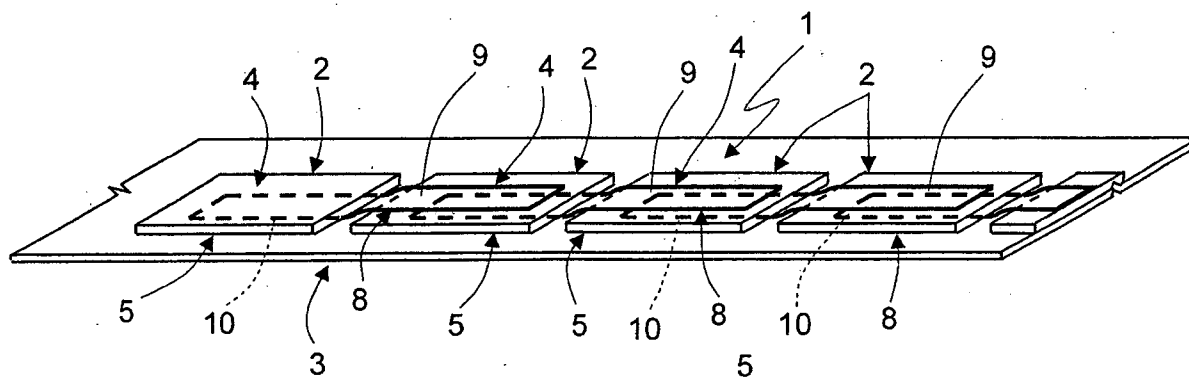


Fig.1

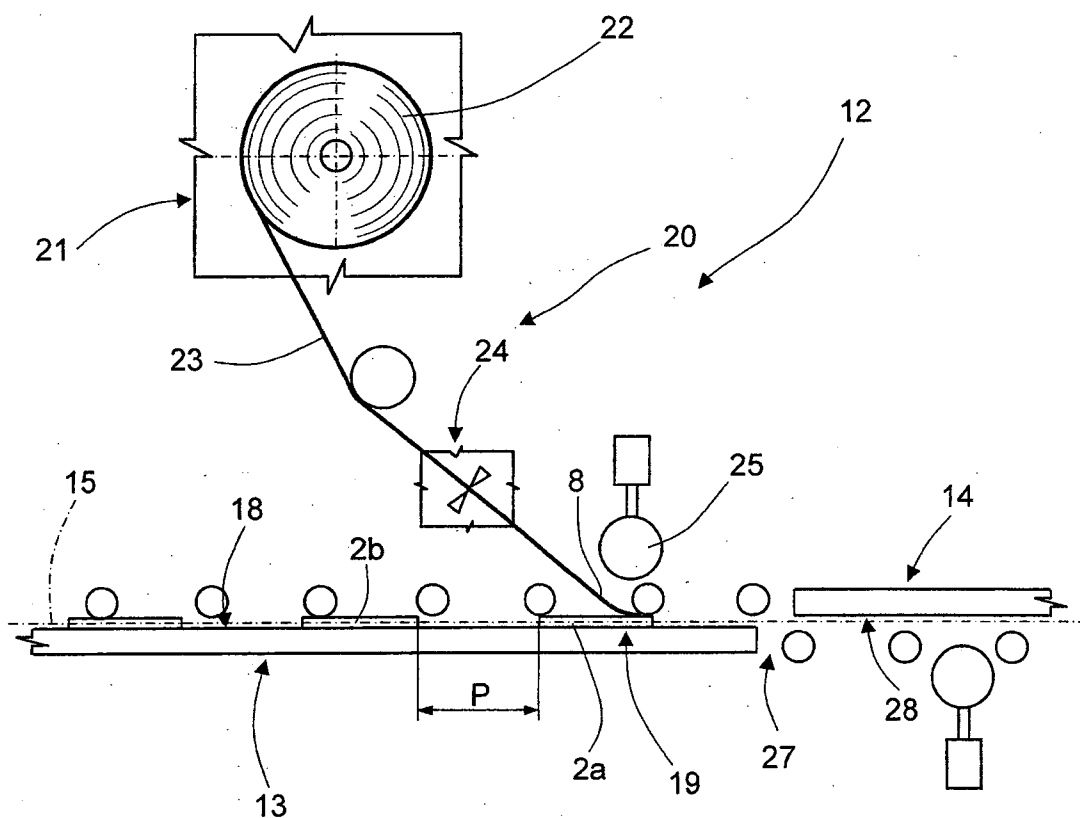


Fig.2

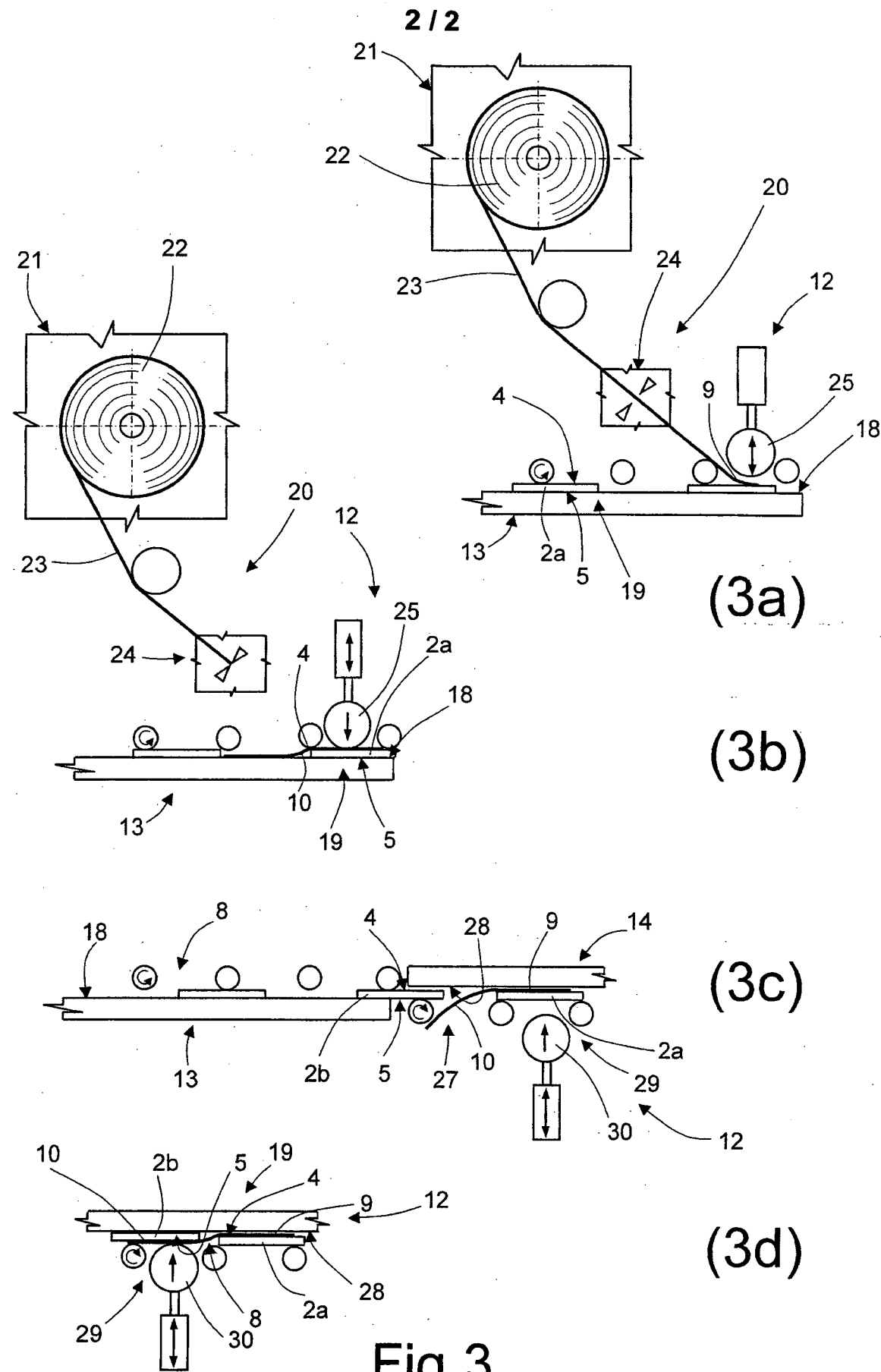


Fig.3