(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 888 811 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.10.2021 Bulletin 2021/40

(51) Int Cl.:
B21C 37/12 *(2006.01)*

(21) Application number: **21020146.3**

(22) Date of filing: **14.03.2021**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **18.03.2020 IT 202000005728**

(71) Applicant: **Zeffiro S.r.l.**
50031 Barberino di Mugello (FI) (IT)

(72) Inventor: **Guasti, Gino**
50031 Barberino di Mugello (FI) (IT)

(74) Representative: **Conti, Riccardo**
Via Imbriani 85
50019 Sesto Fiorentino (FI) (IT)

(54) APPARATUS FOR MANUFACTURING PRE-COLORED METAL CONDUITS AND RELATED CONDUIT

(57) Apparatus (1) for the manufacturing a conduit (10) from a metallic strip (2) comprising an at least partially decorated surface finishing layer (12) comprising shaping rollers (3), driving rollers (5) and seaming rollers (7) wherein the seaming rollers (7) comprising a first seaming roller (7') which comes into contact with the surface finishing layer (12) comprising three portions:
- a first cylindrical portion (9a) having a first diameter (d1);
- a second cylindrical portion (9b) having a second diameter (d2);
- a third cylindrical portion (9c) having a third diameter (d3);
wherein said first diameter (d1) is greater than said second diameter (d2), said third diameter (d3) is greater than said second diameter (d2), said first diameter (d1) is greater than said third diameter (d3), said second cylindrical portion (9b) is arranged between said first and third cylindrical portions (9a, 9c) and said third cylindrical portion (9c) is arranged towards the side of the apparatus (1) from which the seamed conduit (10) comes out; and wherein said second cylindrical portion (9b) is joined to said first and third cylindrical portions (9a, 9c) by means of tapered sides (11', 11");
wherein a first driving roller (5') that comes into contact with the surface finishing layer (12) comprises a surface coating made of a polymeric material, preferably elastomeric, even more preferably polyurethane.

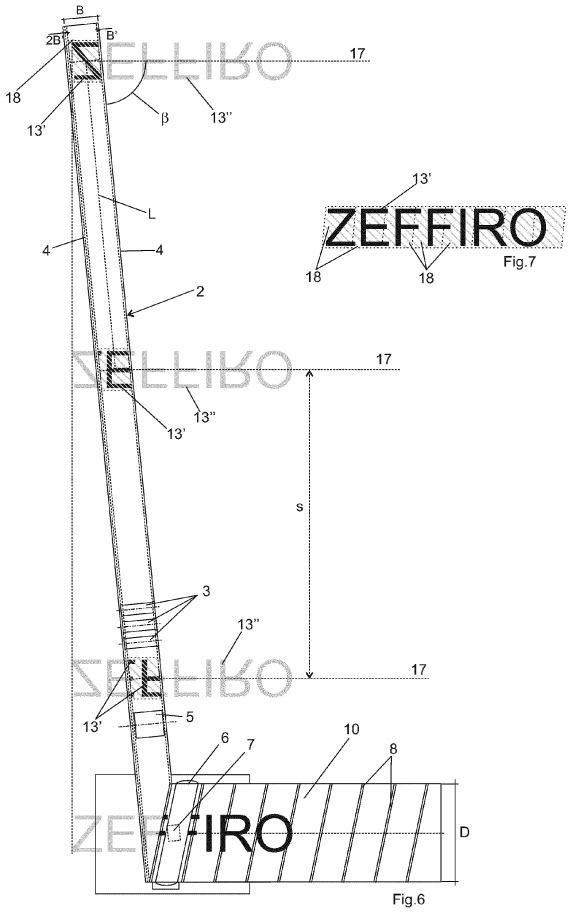


Fig.6

Fig.7

EP 3 888 811 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to the sector of air conduits. In particular, it concerns the sector of air conduits for commercial or residential construction.

BACKGROUND ART

[0002] Various machines are known in the state of the art for making conduits obtained by spiraling metal strips of various length and width. Some of these machines, in addition to winding the strip in a spiral, comprise shaping rolls capable of bending the longitudinal edges of the strip so that further seaming rollers can seam the edges and seal the conduit hermetically and firmly. Examples of these types of machine are known from patent documents GB2213748 or EP0885071.

[0003] The conduits thus made are normally made of galvanized steel and can be spray painted on their outer side. This type of painting process is extremely expensive since the conduits are normally of a certain length and are difficult to maneuver and transport. Furthermore, given their size, these tubes can only be painted in painting booths having suitable dimensions. Finally, after painting, these conduits must also be protected so as not to damage the painting during transport.

[0004] The undersigned company has tried to obtain spiral conduits from painted metal strips using traditional unmodified machines, but the coating breaks. In particular, where the sheet of the strip is bent to make the seam, the paint breaks, revealing the underlying metal. Sometimes, these seaming can also trigger exfoliation of the paint layer.

[0005] There are no known solutions for obtaining spiral seamed conduits made from pre-painted strips without tears or cracks in the paint previously deposited on the strip, especially across the seam.

[0006] Furthermore, there are no known solutions for obtaining spiral seamed conduits from strips covered by colored adhesive films which are free from tears or ruptures of the film, especially in correspondence with the seam.

[0007] Finally, there are no known solutions for obtaining air conduits having pre-printed customized colored writings or images on the strip that allow an orderly and precise reproduction of the text or image on the spiral-wound conduit.

SUMMARY

[0008] The aforementioned drawbacks of the prior art are now solved by an apparatus for manufacturing a conduit from a metal strip covered with a surface finishing layer comprising: shaping rollers configured to shape the longitudinal edges of the metal strip; driving rollers configured to feed the strip into a forming head having a cylindrical development to bring the longitudinal shaped edges of the strip to engage with each other; seaming rollers configured to seam the longitudinal engaged edges together and to form a spiral lock-seam. Said surface finishing layer can comprise a layer of paint or a film, and be partially decorated. Said seaming rollers comprise a first seaming roller which comes into contact with the surface finishing layer comprising three portions: a first cylindrical portion having a first diameter; a second cylindrical portion having a second diameter; a third cylindrical portion having a third diameter. Said first diameter is greater than said second diameter. Said third diameter is greater than said second diameter. Said first diameter is greater than said third diameter, so that the strip comes out more easily from the first seaming roller. Said second cylindrical portion is arranged between said first and third cylindrical portions. Said third cylindrical portion is arranged towards the side of the apparatus from which the seamed conduit comes out. Said second cylindrical portion is joined to said first and third cylindrical portions by means of tapered sides. Wherein, a first driving roller, which comes into contact with the surface finishing layer, comprises a surface coating made of polymeric material, preferably elastomeric, even more preferably polyurethane. Said conformation of the first seaming roller allows seaming the opposite longitudinal edges of the painted metal strip or covered with a film, without creating tension on the paint or film such as to tear or damage it. Said driving roller allows to push the strip without damaging it before seaming it.

[0009] Said tapered sides can be truncated-conical surfaces extending from said second cylindrical portion to said first and second cylindrical portions respectively. The surfaces thus shaped allow to guide the seaming of the opposing longitudinal edges of the painted metal strip or covered with a film, facilitating the seaming. In particular, the angles of inclination of truncated-conical surfaces with respect to the axis of revolution of the first seaming roller can be comprised between 30° and 60°, preferably of about 45°, because, with these values, the paint or film does not break by seaming the opposite edges of the strip.

[0010] Preferably said seaming rollers comprise a second seaming roller opposed to said first seaming roller adapted to cooperate for realizing said seaming. Said second seaming roller has a rotation axis parallel to the rotation axis of the first seaming roller. Said second seaming roller comprises a cylindrical portion having a width greater than the sum of the widths of said second cylindrical portion and of said tapered sides of the first seaming roller. This technical feature prevents the edges to be seamed from coming out of the seaming rollers.

[0011] Advantageously, said driving rollers can be opposed to each other with parallel axes and are pushed towards each other, to improve the grip on the strip, by means of a pushing mechanism configured to regulate the distance between said parallel axes. In this way, the thrust of the driving rollers can be adjusted to avoid de-

tachment of the surface finishing layer from the metal strip during its push towards the seaming rollers.

[0012] Preferably said second driving roller, which comes into contact with the side of the strip without the finishing surface layer and used for forming the inner side of the conduit, can comprise a surface coating made of a metal having a hardness lower than 3.5 in Mohs scale or of a polymeric material, preferably elastomeric, even more preferably polyurethane. In this way, the strip is effectively pushed forward by the driving rollers without surface imperfections on the inner side of the conduit that can cause airflow losses.

[0013] Advantageously, said second driving roller can comprise a knurled surface to allow a better grip on the strip. This surface finishing of the second roll further improves the grip on the strip.

[0014] Preferably said driving rollers can be arranged upstream of the seaming rollers with respect to the direction of forward motion of the strip. In this way, the driving rollers push the strip towards the seaming rollers. More preferably, said shaping rollers are arranged upstream of the seaming rollers and of the driving rollers with respect to the direction of forward motion of the strip. With this arrangement of the various types of rollers, the strip is seamed without damaging the surface finishing layer of the strip, which therefore appears as post-painted. In this way, logistic problems of the conduit to and from the painting department are solved and the costs of the conduit are reduced.

[0015] Advantageously, said apparatus can comprise a device for perforating the strip to form holes on the conduit for the air supply and return. In this way, the conduit realized by the apparatus, in addition to being perfectly finished by the surface finishing layer, is ready for installation because it already includes the ventilation holes.

[0016] A second object of the present invention is to provide an air conduit comprising a metal strip, comprising a surface finishing layer, spirally wound and seamed, comprising one or more graphic elements arranged aligned with each other along the conduit, each of which is inclined with respect to one of the longitudinal edges of the strip by an angle that is a function of the width of the strip and of the diameter of the conduit. Preferably, said angle is equal to arccos [(B-3B') / πD], where B is the width of the strip, B' is the width of the seam and D is the diameter of the conduit. This solution allows to obtain conduits having graphic elements aligned and ordered together which, despite the seaming, do not have graphic imperfections such as to make the graphic elements broken, discontinuous or unintelligible.

[0017] Advantageously, said conduits can comprise a plurality of holes for supplying and returning the air. These conduits allow a pleasant aesthetic impact and at the same time an effective ventilation of the rooms.

[0018] Preferably said air conduits can comprise a chemical surface treatment arranged in direct contact with the metal of the strip. This layer allows to avoid an oxidation of the metal strip.

[0019] In particular, the strip can comprise a primer and an overlying layer of colored paint that entirely cover the side of the strip that faces outside of the conduit. This allows the conduit to be painted, even though the conduit has never been subjected to a painting process. Preferably, the strip can comprise a printed layer reproducing said graphic elements and arranged over the colored paint layer. In this way, the conduit appears finished as if it had been painted with an ornamental pattern at a later stage after its shaping. This allows a considerable saving of time and money during the production of the conduit.

[0020] Alternatively, said strip can comprise an adhesive-type film, reproducing said graphic elements, which entirely covers one side of the strip. This solution allows to obtain a conduit in less time.

[0021] Preferably, said graphic elements can comprise letters of a writing to personalize the air conduit with a trademark or a slogan.

[0022] A third object of the present invention is a manufacturing method of a painted or decorated conduit comprising the steps of:

- providing a metal strip that is pre-painted or covered with a film at least partially decorated;
- shaping the longitudinal edges of said metal strip;
- spirally wounding said metal strip;
- seaming said shaped edges together.

[0023] The method thus defined allows to obtain a painted or decorated conduit at low cost and without post-processing steps on the conduit.

[0024] Advantageously, the method can comprise the preliminary phase of reproducing a decoration comprising one or more graphic elements on the film so that each graphic element is inclined with respect to one of the longitudinal edges of the strip by an angle which is a function of the width of the strip and the diameter of the conduit. Preferably said angle being equal to arccos[(B-3B')/πD], where B is the width of the strip, B' is the width of the seam and D is the diameter of the conduit. The method thus defined allows to obtain conduits having graphic elements aligned and straight to each other if the conduit is observed from a side.

[0025] In the following, the term "conduit" refers to the single pipe element, having a generally circular section, and an extension varying from a minimum of a few centimeters to a maximum of tens of meters. As better clarified below, the term "pipeline" means the group of conduits connected to each other to allow the transportation of air from one point to another.

[0026] These and other advantages will become apparent in more detail from the description, given below, of an example of embodiment given by way of non-limiting example with reference to the attached drawings.

DESCRIPTION OF DRAWINGS

[0027] In the drawings:

Fig. 1 shows a schematic overall view of an apparatus for manufacturing a seamed spiral conduit;
Fig. 2 shows a schematic view of the main elements of an apparatus for manufacturing a seamed spiral conduit;
Fig.3 shows a schematic detailed view of the seaming rollers and of the related seamed spiral conduit;
Fig. 4 shows a sectional view of a first embodiment of the seaming rollers shown in Fig.3;
Fig. 5A shows a schematic view of the layers constituting a strip comprising a painted surface finishing layer used in the apparatus of the present invention;
Fig. 5B shows a schematic view of the layers constituting a strip comprising an at least partially decorated film used in the apparatus of the present invention;
Fig. 6 shows a schematic top view of the strip comprising a partially decorated surface finishing layer and the related apparatus for manufacturing a seamed spiral conduit;
Fig. 7 shows a schematic detailed view of the sectioning step of the decoration to be reproduced on the metal strip.

DETAILED DESCRIPTION

[0028] The following description of one or more embodiments of the invention refers to the attached drawings. The same numerical references in the drawings identify the same or similar elements. The object of the invention is defined by the attached claims. The technical details, structures or characteristics of the solutions described below can be combined with each other in any way.

[0029] With reference to Figs. 1 and 2, an apparatus 1 for manufacturing a spiral seamed conduit 10 is shown. The apparatus 1 object of the present invention is substantially known apart from some technical modifications required to solve the technical problem of seaming a painted or film-coated strip without damaging or ruining the surface finishing layer 12, in particular in correspondence with the seaming 8. The main elements of an apparatus 1 for manufacturing the spiral seamed conduit are therefore described below, since the other not described technical elements can be easily found in the state of the art by an expert in the field of machinery of this type.

[0030] An apparatus 1 for manufacturing a spiral seamed conduit 10 of the classic type comprises a coil 15 of a strip arranged upstream of a series of shaping rollers 3 arranged near the entrance of the strip 2 into the apparatus 1. Said shaping rollers 3 can be of the type shown in Fig. 2, thus opposed two by two, or of the type with vertical axis of revolution (not shown), according to what is already known in the state of the art.

[0031] The strip 2 then comes into contact with one or more driving rollers 5 which pull the strip 2 through the shaping rollers 3 and push it towards the seaming rollers 7. The driving rollers 5 according to the present invention are modified compared to the state of the art to allow a better adhesion to the strip 2, since it has a surface finishing layer 12. Since the surface finishing layer 12 considerably reduces the grip of the driving rollers 5 on the strip 2, the driving rollers 5 are superficially covered with a coating of polymeric material, preferably elastomeric, even more preferably polyurethane. In particular, the polyurethane coating, due to its hardness and its elasticity, allows a better grip on the strip 2 and therefore a better dragging of the strip 2 painted or covered by the surface finishing layer 12. The driving rollers 5 are motorized and push the strip 2 towards the seaming rollers 7. The driving rollers 5 are opposite each other with parallel axes and are pushed towards each other by a pushing mechanism (not shown) to improve the grip on the strip 2. Said pushing mechanism allows to change the distance of said parallel axes. The apparatus can comprise a single pair of driving rollers 5 opposite each other, as shown in Fig. 2, but can also comprise several pairs of driving rollers 5 arranged in series with each other (not shown). For the sake of clarity, the lower roller in Fig. 2, thus the one in contact with the side of the strip 2 used to form the outer surface of the conduit 10 and comprising the surface finishing layer 12, is called the first driving roller 5'; while the upper roller in Fig. 2, thus the one in contact with the side of the strip 2 used to form the inner side of the conduit 10 is called the second driving roller 5". In an alternative embodiment (not shown), a second 5" upper driving roller can comprise a knurled surface to allow a better grip on the strip 2. In a further alternative embodiment (not shown), said upper second driving roller 5" comprises a relatively soft metal knurled surface coating, i.e. having a hardness of less than 3.5 on the Mohs scale. In these last two embodiments, the first lower driving roller 5' comprises a polymeric surface coating as described above.

[0032] The strip 2 guided by the driving rollers 5 enters inside a forming head 6 with a cylindrical development of a known type. This forming head 6 can be made of metal or cast iron and has a cylindrical or spiral shape. The forming head 6 also has an inlet and an outlet of a known type. The strip 2 enters, in a known manner, inside the forming head 6 and thanks to its spiral-shape bends the strip 2. The forming head 6 is configured to carry the longitudinal edges 4, shaped by the shaping rollers 3, to engage with each other.

[0033] The apparatus 1 also comprises seaming rollers 7 configured to seam the edges engaged by the forming head 6. Said seaming 8 also has a longitudinal spiral development.

[0034] Said seaming rollers 7 comprise a first seaming roller 7' which has an improved profile. As shown in Fig. 3 and in detail in Fig. 4, the first seaming roller 7' com-

prises three cylindrical portions connected to each other: a first cylindrical portion 9a, a third cylindrical portion 9c and a second cylindrical portion 9b arranged between the first two. The first cylindrical portion 9a has a first diameter d1 and the third cylindrical portion 9c has a third diameter d3 which are both greater than the diameter d2 of the second cylindrical portion 9b. To allow the edges 4 of the strip 2 painted or covered by the surface finishing layer 12 to be seamed, the first cylindrical portion 9a is connected to the second cylindrical portion 9b by means of a first tapered side 11', and the third cylindrical portion 9c is connected to the second cylindrical portion 9b by means of a second tapered side 11". The tapered sides 11', 11" are truncated-conical surfaces, as shown in Fig. 4. To better understand their shape, the truncated-conical surface connecting the first cylindrical portion 9a and the second cylindrical portion 9b is the lateral surface of a truncated-cone having a larger base with a diameter equal to d1 and a smaller base with a diameter equal to d2. Similarly, the truncated-conical surface connecting the third cylindrical portion 9c and the second cylindrical portion 9b is the lateral surface of a truncated-cone having a larger base with a diameter equal to d3 and a smaller base with a diameter equal to d2. These tapered sides allow seaming rollers without sharp edges. The sharp edges of the traditional seaming rollers generate more squared seaming, but, in the case of painted or film-covered strips, they break or damage the paint or film in correspondence the squared bending. The tapered sides, in particular if truncated-conical, allow to obtain seaming 8 having softer and tapered profiles, so to avoid damages or breaks of the paint / film in correspondence with them.

[0035] Said first tapered side 11' having a truncated-conical surface defines a first angle of inclination α' with the axis of revolution R1, and said second tapered side 11" having a truncated-conical surface defines a second angle of inclination α" with the axis of revolution R1. With inclination angles α', α" between 30 and 60 degrees, preferably of about 45 degrees, the strip 2 comprising the surface finishing layer 12 does not undergo surface stress such as to trigger cracks in the surface finishing layer 12 itself.

[0036] As illustrated in Fig. 4, the first diameter d1 of the first cylindrical portion 9a is greater than the third diameter d3 of the third cylindrical portion 9c. Preferably, said third cylindrical portion 9c is arranged towards the side of the apparatus 1 from which the finished conduit 10 comes out. Since the diameter of the output side of the first seaming roller 7' is smaller, the exit of the seamed strip from the seaming rollers 7 is facilitated and the seaming 8 is less exposed to damage.

[0037] In a further embodiment (not shown) the first cylindrical portion 9a can comprise two contiguous cylindrical sub-portions, the sub-portion closest to the second cylindrical portion 9b has a reduced diameter with respect to d1 by a value between 0,1 and 0,2 mm, while the other sub-portion has a diameter equal to d1. This small step of the first cylindrical portion 9a allows to reduce the pressure of the first seaming roller 7' on the strip 2 astride the second cylindrical portion 9b.

[0038] The seaming rollers 7 also comprise a second seaming roller 7" opposed to the first seaming roller 7' which cooperates with the first one to achieve said seaming 8 of the strip 2. These seaming rollers 7',7" have respectively rotation axes R1, R2 parallel to each other. The second seaming roller 7" comprises a cylindrical surface 9d, which cooperates with the cylindrical surfaces 9a, 9b, 9c of the first roller 7' in order to bend and seam the edges 4 of the strip 2. In order to achieve this, the width L2 of the cylindrical portion 9d is greater than the sum of the widths L3, L4, L5 of the second cylindrical portion 9b and of the tapered sides 11', 11". The diameter d4 of the second seaming roller 7" is smaller than said first diameter d1 of the first cylindrical portion 9a. The seaming rollers 7', 7" are aligned with each other when viewed from the front as shown in Fig. 4.

[0039] All the rollers of the apparatus 1, or some of them, are kinematically connected to each other, so that the shaping rollers 3 and the seaming rollers 7 help to drive the strip 2. Furthermore, in this way, a single motor is enough to drive, by means of a chain of gears, all the rollers of the apparatus 1. The control of the apparatus 1 takes place by means of a control unit 16 configured for the purpose.

[0040] The apparatus 1 may further comprise a device for perforating in line the strip 2, thus capable of perforating the strip 2 while it passes through the apparatus 1. This perforation device (not shown) is configured to punch or cut with a laser the strip 2 and can make one or more holes 14 having the same or different shape and size.

[0041] To realize the conduits according to the present invention, metal strips 2 comprising surface finishing layers 12 can be used. Specifically, the surface finishing layer 12 can be a paint layer 12' or a film 12", as schematically shown in Fig. 5A and 5B. Fig. 5A shows an exploded view of the metal strip 2 equipped with a painted surface finishing layer 12', wherein the metal strip 2 is covered on the upper and lower side by a chemical surface treatment 2b,2c to increase the grip of the other layers. Under the lower chemical treatment 2b, a protective internal coating 2a of the strip 2 is also arranged. The painted surface finishing layer 12' is deposited over the surface chemical treatment 2c, thus a primer 12a and then a colored paint 12b which gives the strip 2 the desired color. A printed layer 12c is arranged over the colored paint layer 12b, for example a wood-effect decoration. In the latter case, a layer of transparent flatting 12d is further arranged over the printed layer 12c.

[0042] As an alternative to the painted surface finishing layer 12', it is possible to use a metal strip on which a 12' film is laid down. This film 12" can be of the adhesive type. On the lower and upper layer of the metal strip, it can be arranged surface chemical treatments 2b, 2c for allowing a better adhesion of the film 12", and a possible

internal protective coating 2a.

[0043] As illustrated in Figs. 3 and 7, the air conduit 10 comprises a surface finishing layer 12, wherein said strip 2 is spirally wound and seamed.

[0044] The main difference of the conduits according to the present invention with respect to the spiral wound and seamed conduits subsequently painted known in the state of the art, lies in the fact that the known conduits are painted only after being seamed. Once the traditional conduit is formed, the conduit becomes bulky and cannot be dip painted, but only spray painted. For this reason, the paint can only be deposited on the outer side of the conduit. On the contrary, using a pre-painted strip 2, strip 2 can be painted by dipping or through other techniques and consequently painted on both sides. In this case, the conduit 10 is painted both internally and externally. This allows a better protection of the conduit 10 from corrosive or oxidizing agents of the metal of the strip 2.

[0045] Furthermore, since it is the strip 2 to be painted, the paint is also present inside the seaming. Consequently, small slips of the edges 4 on each other, for example in the event of expansion or narrowing of the conduit 10 as a result of temperature changes, do not lead to a breaking of the paint. In the case of traditional painted conduits after being seamed, these small movements lead to the breakage of the paint in correspondence of the seaming.

[0046] A further aspect of the present invention is represented by the possibility of reproducing graphic elements 13 aligned on the conduit 10 without the need for an artisanal painting of the already formed conduit. In particular, the possibility of reproducing images or writings such as the one in Fig. 6 is completely unknown without post-painting process of the conduit. For this purpose, a conduit suitable for solving this problem and the relative method are described below.

[0047] The conduit 10 of Fig. 6 can be obtained from a strip 2 equipped with a surface finishing layer 12. This surface finishing layer 12 is decorated with graphic elements 13 in accordance with a geometric rule which is a function of the diameter D of the conduit 10 to be realized and the width B of the strip 2. For example, when the graphic element 13 is a writing 13', to allow the writing 13' to be aligned and without interruptions or defects on the conduit 10, it needs be reproduced on strip 2 according to the following rule.

[0048] The writing 13' needs to be inclined with respect to one of the longitudinal edges 4 of the strip by an angle β. This angle β is a function of the width B of the strip 2 and the diameter D of the conduit 10. Preferably, in the case of conduits obtained from a wound and seamed strip, the angle β is also a function of the width B' of the seaming 8. The angle β is substantially calculated with the following formula: $\beta = \arccos [(B-3B') / \pi D]$, where B is the width of the strip 2, B' is the width of the seaming and D is the diameter of the conduit 10. The term "substantially" indicates that the value of the angle β may need corrections of the order of a tenth or hundredth of a degree, due to possible misalignments caused by the thickness of the strip 2.

[0049] In order to be aligned on the conduit, the writing 13' needs also to be reproduced at a regular interval which is a function of the width B of the strip 2 and the diameter D of the conduit 10. In the case of seamed conduits, the distance between the graphic elements of the writing 13' is also a function of the width of the seaming 8. The distance L between the graphic elements of the writing 13' is substantially calculated with the following formula: $(\pi D)^2 / [(\pi D)^2-(B-3B')^2]^{(1/2)}$, where B is the width of the strip 2, B' is the width of the seaming and D is the diameter of the conduit 10. The term "substantially" indicates that the distance value L may need adjustments of the order of a couple of millimeters due to possible misalignments caused by the thickness of the surface finishing layer 12.

[0050] Specifically, the portions of writing 13' are reproduced on the surface finishing layer 12 of the strip 2 according to the following rule, in order to render the overall writing 13' appearing on the conduit in an aligned and orderly manner. Fig. 6 represents fictitious writings 13" (in black) aligned horizontally with each other (for example left-aligned as in Fig. 6). In Fig. 6 the fictitious writing 13" are overturned as they are reproduced on the lower side of the strip 2, so that by wounding the strip 2, the writing appears on the outer side of the conduit 10. The fictitious writing 13" are also vertically spaced and follow reference lines 17. The reference lines 17 have a distance S from each other that depends on the angle β and the length L. The distance S between the reference lines 17 is equal to πD. In this way, the fictitious writings 13" are horizontally aligned and parallel to each other, each at a distance πD from the next or previous. The portion of the fictitious writings 13" that falls on the strip 2 (striped) is the portion of the graphic element 13 to be reproduced on the surface finishing layer 12. Specifically, since a part of the strip 2 used for seaming 8 does not contribute to the external appearance of the conduit 10, since it is used to block the edges 4 of the strip 2 together, these portions of the strip 2 do not need to be decorated. Even if they were, the decoration would not be visible on the conduit 10. This portion of strip 2 involved in the seaming, and not visible, is wide 2B' on one side and B' on the opposite side of the strip 2, where B' is the width of the seaming 8 measurable on the conduit 10 or obtainable from the width L3 of the second cylindrical portion 9b of the first seaming roller 7'. In the case shown in Fig. 6, the outer edge 4 (towards the left of the image) is involved in the seaming 8 for a width equal to twice the width of the seaming itself, that is 2B'. The inner edge 4 (towards the right of the image) is involved in the seaming 8 for a width equal to once the width of the seam itself, that is B'. A conduit and a process of this type allow to reproduce on the surface finishing layer 12 a writing 13' or any other graphic element 13, for example a cloud or a logo, in order to be aligned on the conduit 10.

[0051] The process for reproducing said writing 13' or

graphic element 13 on a conduit 10, comprises a first step of decorating the strip 2 and a second step of realizing the conduit 10 with said decorated strip.

[0052] The step of decorating the strip 2 comprises the sub-steps of:

1) dividing a writing 13', or a graphic element 13, into sections 18 having at least two opposite sides parallel to each other and inclined by an angle β with respect to the longitudinal axis of the writing 13', or of the graphic element 13. Said longitudinal axis being the development axis of the graphic element, for example the median axis of the writing 13' itself or the axis passing through the base of each letter of the writing 13'. Said parallel sides of the sections 18 being distant from each other of a value equal to (B-3B')/sin(β), that is $[\pi D^*(B-3B')]/[(\pi D)^2-(B-3B')^2]^{(1/2)}$. Said angle β being a function of the width B of the strip 2, the diameter D of the conduit 10 and, in the case of seamed conduits, the width B' of the seaming 8. Said section 18 having a height lower than the diameter D of the conduit 10.
2) reproducing in sequence said sections 18 on strip 2 at a distance L from each other. So that said inclined sides are parallel to the edges 4 of the strip 2. Said distance L being the distance between common reference points of said sections 18, for example the center or a specific apex of the sections 18. Said sections 18 can be reproduced on 12' painted surface finishing layer or film 12".

[0053] The predicted angle β is substantially equal to arccos [(B-3B')/πD], where B is the width of the strip 2, B' is the width of the seam 8 and D is the diameter of the conduit 10.

[0054] The aforementioned distance L is substantially equal to $(\pi D)^2/[(\pi D)^2-(B-3B')^2]^{(1/2)}$.

[0055] Fig. 7 shows a writing 13' sectioned into sections 18 in accordance with what has been described above, wherein each section 18 has a parallelogram shape with a base equal to (B-3B')/sin(β), and a height lower than conduit 10 diameter.

[0056] The step of manufacturing the conduit 10 comprises the sub-steps of:

1) shaping the longitudinal edges 4 of the decorated strip 2;
2) wounding said strip 2 in a spiral;
3) seaming the shaped edges 4 together.

[0057] Preferably, said seaming step is carried out by means of seaming rollers as described above. Preferably, said wounding step is carried out by pulling a strip 2 with driving rollers 5 comprising a surface coating in polymeric material as described above.

[0058] Proceeding in accordance with what has been described above, the writing 13' is reproduced both on the strip 2 and on the outer side of the seaming 8 without discontinuity or misalignment, as if it had been painted on the finished conduit in a second moment, but without the complications of case. In this way, the surface finishing layer 12 can be printed by means of a machine suitable for the purpose and attached to a traditional metal strip. Subsequently this strip 2 with the surface finishing layer 12 can be processed by an apparatus, according to the present invention, in order to realize a conduit 10 having a writing 13' visible on the outer side obtained by means of said surface finishing layer 12 joined to the strip 2. The same happens when one or more graphic elements 13 are reproduced, instead of a writing 13'.

[0059] Various aspects and embodiments of the present invention are defined by the following numbered sentences:

I. Manufacturing method of a painted or decorated conduit 10 comprising the steps of:

- providing a metal strip 2 covered with an at least partially decorated surface layer;
- shaping the longitudinal edges 4 of said metal strip 2;
- wounding said metal strip 2 in a spiral;
- seaming said shaped edges 4 together.

II. Method according to the preceding sentence, further comprising a preliminary step of reproducing a decoration comprising one or more graphic elements 13 on said finishing surface 12 so that each graphic element 13 is inclined with respect to one of the longitudinal edges 4 of the strip 2 by an angle β that is a function of the width B of the strip 2 and the diameter D of the conduit 10, preferably said angle β being equal to arccos[(B-3B')/πD], where B is the width of the strip 2, B' is the width of the seaming 8 and D is the diameter of the conduit 10.

III. Method according to the previous sentence, wherein said preliminary step of reproducing a decoration further comprises the step of dividing the graphic element 13 into sections 18 having at least two opposite sides parallel to each other and inclined by said angle β with respect to a longitudinal axis of the graphic element 13, said longitudinal axis being a development axis of the graphic element; wherein each section 18 has a parallelogram shape with a base equal to (B-3B')/sin(β) and a height less than the diameter of the conduit 10.

IV. Method according to the preceding sentence or the preceding one, comprising the step of reproducing in sequence said sections 18 on the strip 2 at a distance Lfrom each other, said distance L being the distance between common reference points of said sections 18, for example the center or a specific apex of the sections 18, preferably said aforesaid distance L is substantially equal to $(\pi D)^2/[(\pi D)^2-(B-3B')^2]^{(1/2)}$.

[0060] Concluding, the invention so conceived is sus-

ceptible to many modifications and variations all of which fall within the scope of the inventive concept; furthermore all features can be substituted to technically equivalent alternatives. Practically, the quantities can be varied depending on the specific technical exigencies.

Claims

1. Apparatus (1) for the manufacturing a conduit (10) from a metallic strip (2) comprising an at least partially decorated surface finishing layer (12) comprising:

- shaping rollers (3) configured to shape the longitudinal edges (4) of the metal strip (2);
- driving rollers (5) configured to feed the strip (2) into a forming head (6) having a cylindrical development for bringing the shaped longitudinal edges (4) of the strip to engage with each other;
- seaming rollers (7) configured to seam the engaged edges each together and form a spiral lock-seam (8);

wherein said seaming rollers (7) comprising a first seaming roller (7') which comes into contact with the surface finishing layer (12) comprising three portions:

- a first cylindrical portion (9a) having a first diameter (d1);
- a second cylindrical portion (9b) having a second diameter (d2);
- a third cylindrical portion (9c) having a third diameter (d3);

wherein said first diameter (d1) is greater than said second diameter (d2), said third diameter (d3) is greater than said second diameter (d2), said first diameter (d1) is greater than said third diameter (d3), said second cylindrical portion (9b) is arranged between said first and third cylindrical portions (9a, 9c) and said third cylindrical portion (9c) is arranged towards the side of the apparatus (1) from which the seamed conduit (10) comes out; and
wherein said second cylindrical portion (9b) is joined to said first and third cylindrical portions (9a, 9c) by means of tapered sides (11', 11");
wherein a first driving roller (5') that comes into contact with the surface finishing layer (12) comprises a surface coating made of a polymeric material, preferably elastomeric, even more preferably polyurethane.

2. Apparatus (1) according to claim 1, wherein said tapered sides (11', 11") are truncated-conical surfaces extending from said second cylindrical portion (9b) to said first and third cylindrical portions (9a, 9c) respectively.

3. Apparatus (1) according to claim 2, wherein the angles of inclination (α', α") of the truncated-conical surfaces with respect to the axis of revolution (R1) of the first seaming roller (7') are comprised between 30° and 60°, preferably about 45°.

4. Apparatus (1) according to any one of the preceding claims, wherein said seaming rollers (7) comprise a second seaming roller (7") opposed to said first seaming roller (7'), having an axis of rotation (R2) parallel to the rotation axis (R1) of the first seaming roller (7'), and adapted to cooperate with it for realizing said seaming (8), wherein said second seaming roller (7") comprises a cylindrical portion (9d) having a width (L2) greater than the sum (L1) of the widths (L3, L4, L5) of said second cylindrical portion (9b) and of said tapered sides (11', 11") of the first seaming roller (7').

5. Apparatus (1) according to any one of the preceding claims, wherein said driving rollers (5) are opposed to each other with parallel axes and are pushed towards each other, to improve the grip on the strip (2), by means of a pushing mechanism configured to regulate the distance between said parallel axes.

6. Apparatus (1) according to any one of the preceding claims, wherein a second driving roller (5"), which comes into contact with the side of the strip (2) devoid of the surface finishing layer (12) and used to form the inner side of the conduit (10) comprises a surface coating made of a metal having a hardness lower than 3.5 on a Mohs scale or made of a polymeric material, preferably elastomeric, even more preferably polyurethane.

7. Apparatus (1) according to the previous claim wherein said second driving roller (5") comprises a knurled surface to allow a better grip on the strip (2).

8. Apparatus (1) according to any one of the preceding claims, wherein said driving rollers (5) are arranged upstream of the seaming rollers (7) with respect to the direction of forward motion of the strip (2), preferably said shaping rollers (3) are arranged upstream of the seaming rollers (7) and of the driving rollers (5) with respect to the direction of forward motion of the strip (2).

9. Apparatus (1) according to any one of the preceding claims, comprising a device for perforating the strip (2) to form holes (14) on the conduit (10) for the air supply and return.

10. Air conduit (10) comprising a metal strip (2) compris-

ing a surface finishing layer (12), spirally wound and seamed, comprising one or more graphic elements (13) arranged aligned with each other along the conduit (10), each of which is inclined with respect to one of the longitudinal edges (4) of the strip (2) by an angle (β) depending on the width (B) of the strip (2) and the diameter (D) of the conduit (10), preferably said angle (β) being substantially equal to arccos[(B-3B')/πD], where B is the width of the strip (2), B' is the width of the seam (8) and D is the diameter of the conduit (10).

11. Air conduit (10) according to claim 10, comprising a plurality of holes (14) for supplying and returning air.

12. Air conduit (10) according to claim 10 or 11, wherein the strip (2) comprises a chemical surface treatment (2b, 2d) arranged in direct contact with the metal of the strip (2).

13. Air conduit (10) according to any one of claims 10 to 12, wherein the strip (2) comprises a primer (2e) and an overlying layer of colored paint (2f) that completely covers the side of the strip (2) facing towards the outside of the conduit (10), preferably the strip (2) comprises a printed layer (2g) reproducing said graphic elements (13) and arranged on top of the colored paint layer (2f).

14. Air conduit (10) according to any one of claims 10 to 12, wherein the strip (2) comprises an adhesive-type film reproducing said graphic elements (13).

15. Air conduit (10) according to any of the preceding claims, wherein said graphic elements (13) comprise letters of a writing (13').

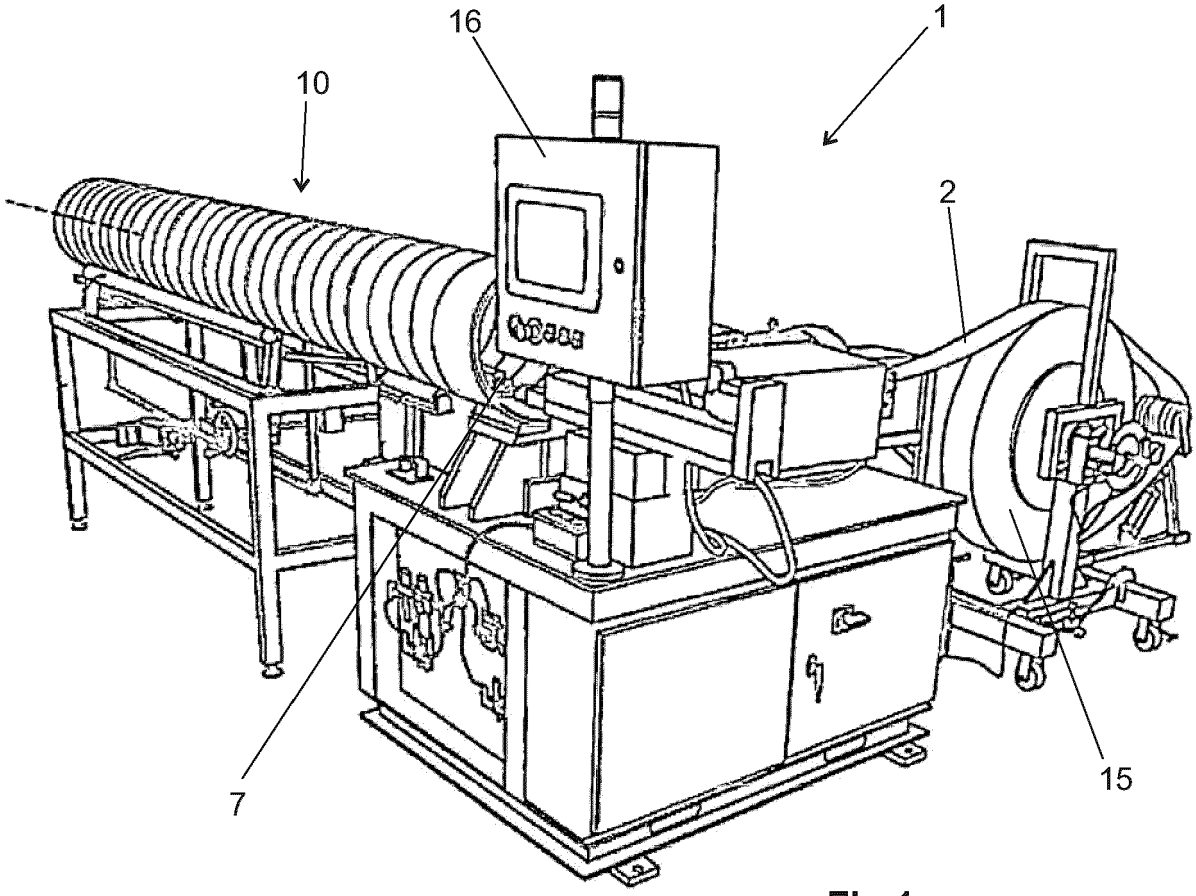


Fig.1

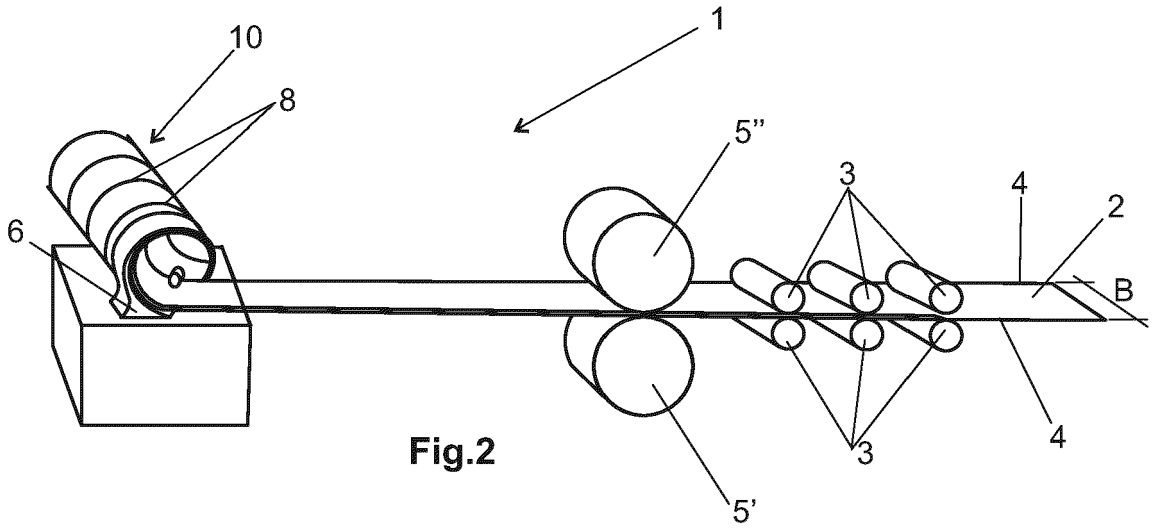


Fig.2

Fig.3

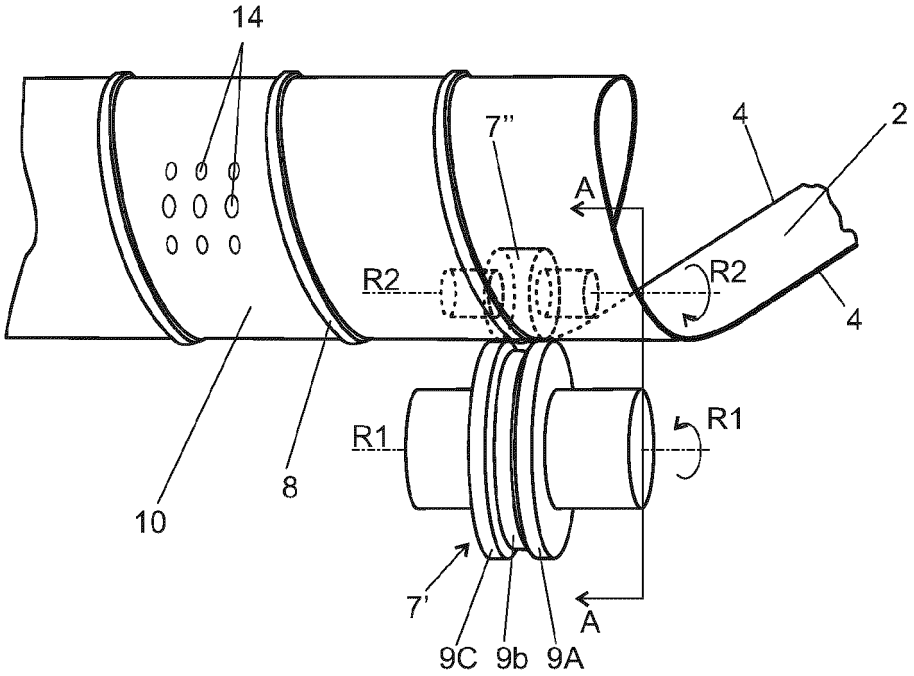
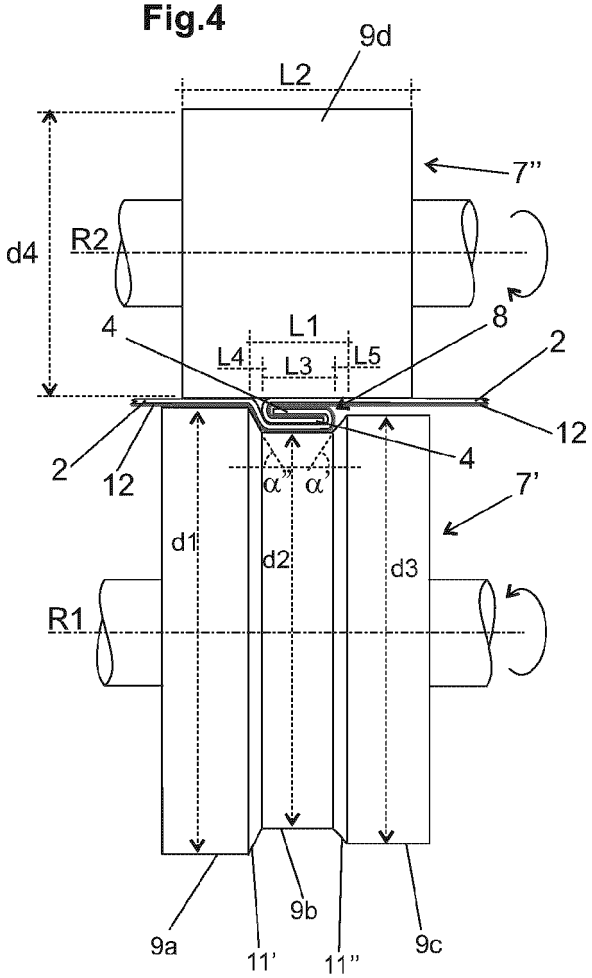

14
7"
4
2
A
R2
R2
4
R1
R1
10
8
7'
A
9C
9b
9A

Fig.4


9d
L2
7"
d4
R2
4
L1
L4
L3
L5
8
2
12
2
12
4
α"
α'
7'
d1
d2
d3
R1
9a
11'
9b
11"
9c

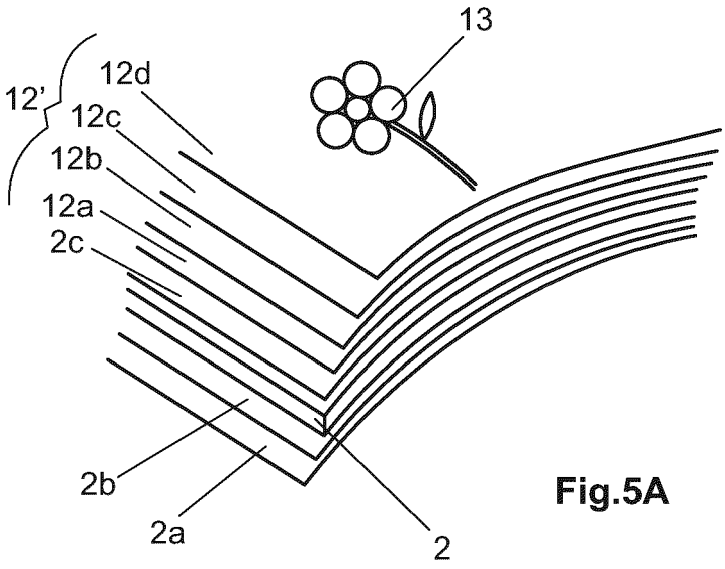


Fig.5A

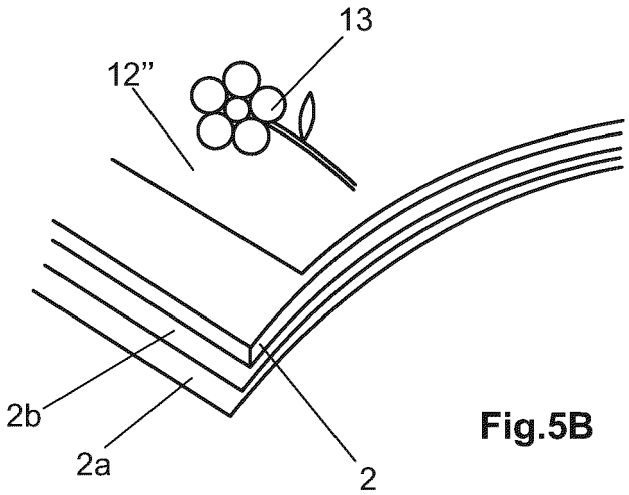


Fig.5B

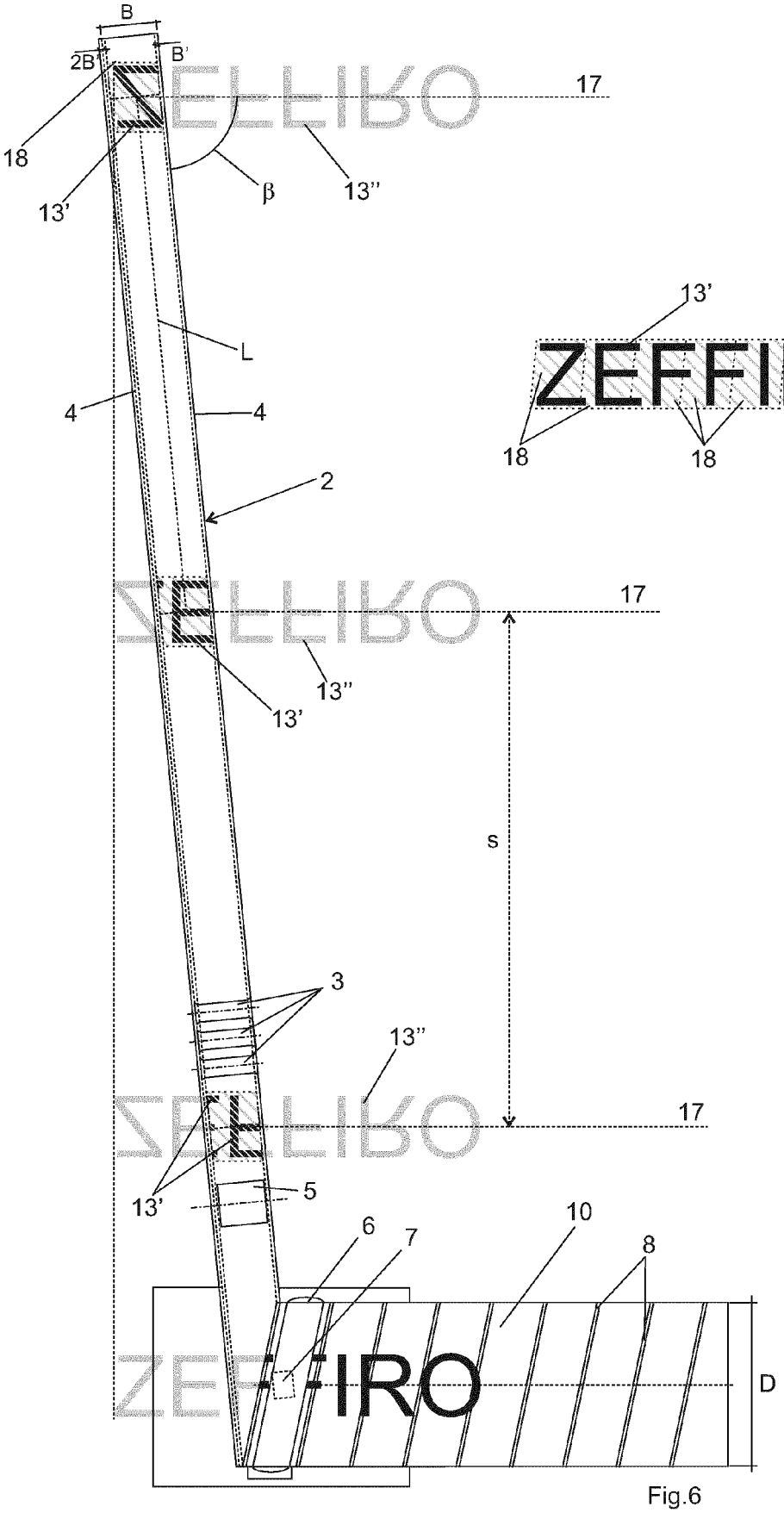


Fig.6

Fig.7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 02 0146

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	FR 1 279 153 A (SIEGWART EMIL) 15 December 1961 (1961-12-15) * page 1, column 2, lines 35-40; figure 1 * * page 2, column 2, lines 32-37; figures 2-3 *	1	INV. B21C37/12
A	US 4 481 978 A (ESCANDELL MANUEL [DE]) 13 November 1984 (1984-11-13) * column 6, lines 15-17; figure 4 *	1	
A	US 3 220 234 A (LAFFIE HARPER) 30 November 1965 (1965-11-30) * figure 3 *	1	
A	GB 951 570 A (DRIAM S A) 4 March 1964 (1964-03-04) * page 1, lines 31-35; figure 1 *	1	
X	IT 2018 0000 5813 A1 (ZEFFIRO) 29 November 2019 (2019-11-29) * paragraphs [0045], [0046], [0055] *	10-15	TECHNICAL FIELDS SEARCHED (IPC) B21C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 August 2021	Augé, Marc

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 02 0146

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-08-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 1279153 A	15-12-1961	BE 740827 A	01-04-1970
		CH 384511 A	30-11-1964
		DE 1121568 B	11-01-1962
		FR 1279153 A	15-12-1961
US 4481978 A	13-11-1984	AT 378924 B	25-10-1985
		BE 877489 A	05-11-1979
		CA 1135487 A	16-11-1982
		CH 639182 A5	31-10-1983
		DE 2829283 A1	17-01-1980
		DK 277979 A	05-01-1980
		ES 483717 A1	16-05-1980
		FR 2430560 A1	01-02-1980
		GB 2027369 A	20-02-1980
		IE 48162 B1	17-10-1984
		IT 1122019 B	23-04-1986
		LU 81462 A1	30-10-1979
		NL 7905179 A	08-01-1980
		SE 442091 B	02-12-1985
		US 4481978 A	13-11-1984
US 3220234 A	30-11-1965	GB 974097 A	04-11-1964
		US 3220234 A	30-11-1965
GB 951570 A	04-03-1964	NONE	
IT 201800005813 A1	29-11-2019	----------	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- GB 2213748 A **[0002]**
- EP 0885071 A **[0002]**