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(54) Method for constructing a cylindric metal building construction as well as apparatus for carrying out said method.

(57) A method and an apparatus are provided for constructing a cylindric metal building construction, in which the building construction is supported by a number of guidings (5 - 12), such, that always a appropriate support is obtained without the need for additional lifting devices. According to the invention the guidings (5 - 12) are each separately or together movable upwards and downwards.

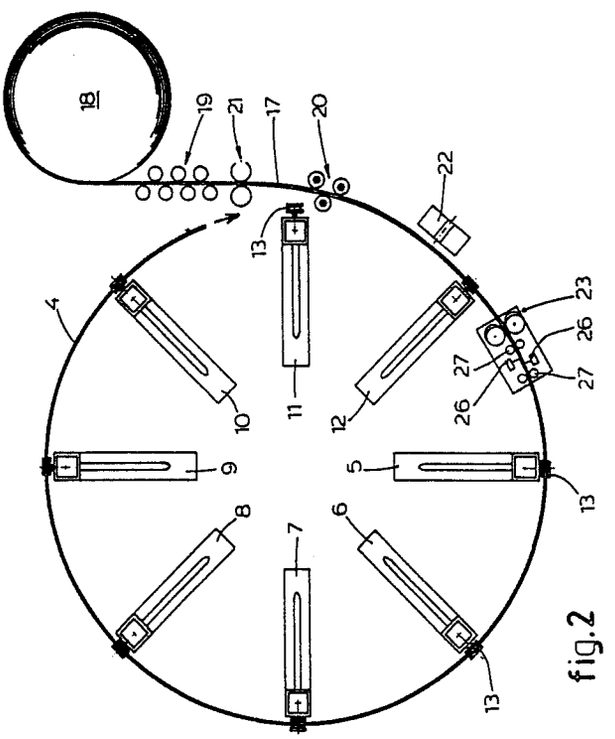

fig.2

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Method for constructing a cylindric metal building construction as well as apparatus for carrying out said method

The invention relates to a method for constructing a cylindric metal building construction by positioning successive rings one on top of the other and interconnecting said rings, said method comprising the steps of:

- in a vertical position supplying the material for constructing the rings, such as metal band or metal plates to be assembled to a metal band, and shaping the material into the desired shape with a shaping device,
- shaping the supplied material into a ring by means of appropriate guidings,
- cutting the metal band or the metal plates assembled to a metal band to a length corresponding to the circumference of the corresponding ring to be shaped,
- connecting the upper edge of the metal band to the lower edge of an already constructed building construction section and interconnecting the beginning and the end of the cut-off metal band section,
- entirely lifting the building construction section constructed like this and supplying further rings underneath until the building construction has reached the desired height, and
- finally placing the building construction onto the ground.

In a known method of this type the supplied metal band is continuously applied to a carrousel comprising a rotating platform of which the rotation velocity corresponds with the supply velocity of the band. When the length of a metal band section is obtained corresponding with the circumference of a ring the metal band is cut loose whereafter winding it onto the carrousel is completed. Next the building construction section that already has been constructed earlier is positioned on top of the ring just constructed and is connected thereto.

This known method has a number of disadvantages. The applied carrousel for winding the supplied metal band for obtaining a ring in principle can be used only for a limited number of diameters of cilindric building constructions to be constructed. If building constructions have to be constructed of which the diameter largely differs from the diameter of the carrousel a completely new carrousel has to be applied. Also the application of thicker materials offers problems in correctly shaping the material. As a further disadvantage of this method it can be mentioned that positioning the already constructed building construction section on top of the upper edge of an already constructed ring calls for a separate lifting device, whereas precise positioning the already constructed building construction section on top of the upper edge of the already constructed ring is very difficult. The reasons for this have to be sought in the low dimensional stability of the already constructed building construction section, the rather high mass thereof and the wind sensibility that can be very important at a building site.

It is an object of the invention to provide a method for constructing a cylindric metal building construction not having the mentioned disadvantages.

Therefore the method according to the invention is characterized in that lifting the building construction already constructed is carried out by synchronously moving the guidings upwards, said guidings comprising supports engaging the lower edge of this building construction section, whereas always that guiding that in the circumferential direction of the building construction section is positioned ahead of the supplied metal band is moved downwards so far shortly before the beginning of the metal band reaches said guiding, that the metal band is moved over said guiding and that the lower edge of the metal band is supported by said guiding.

In constrast with the known method an already constructed building construction section is no longer lifted entirely above a new ring to be constructed, but this already constructed building construction section initially rests totally on the guidings. During the progression of the production of a new ring the support of this already constructed building construction section is progressively taken over by the ring section positioned therebelow, said ring section being supported by the lowered guidings. Like this at each moment a safe and reliable support of the already constructed building construction section is provided wherein too a good positioning of this building construction section relative to the supplied metal band for shaping a new ring is accomplished.

In a preferred embodiment of the method according to the invention after completing the last, lowermost ring and connecting it to the already constructed building construction section, the building construction is lowered by synchronously lowering all guidings and is positioned onto support blocks whereafter the guidings are removed from under the lower edge of the lowermosts ring and wherein the building construction is slightly lifted by means of auxiliary means for removing the support blocks and wherein finally the building construction is lowered onto the ground.

Like this also during the last phase of the construction of the building construction, namely

positioning it onto the ground, no additional hoisting unit or the like is necessary. The guidings that initially are positioned underneath the lower edge of the lowermost ring, can, if the building construction rests on the support blocks, be removed in an easy way, whereafter the building construction is finally positioned onto the ground by means of the auxiliary means.

The invention further relates to an apparatus for carrying out the method according to the invention. This apparatus is characterized in that it comprises a number of lifting units each having a guiding that can be moved upwards and downwards and wherein the lifting units are positioned such that the location of their guidings corresponds with the diameter of the building construction to be constructed. By the presence of a number of lifting units the apparatus according to the invention is very versatile, for the location of the liftings units always can be chosen corresponding with the diameter of the building construction to be constructed. Therefore the same apparatus can be used for constructing building constructions having every desired diameter. Only the number of applied lifting units should vary, wherein by building constructions having a very large diameter a larger number of lifting units should be applied.

In a handy embodiment of the apparatus according to the invention it comprises at least a drive unit for circumferentially moving the already constructed building construction section wherein said drive unit, as seen in the direction of motion, is positioned shortly ahead of the location where the upper edge of the metal band is connected to the lower edge of the already constructed building construction section. Like this a synchronous motion of the building construction section and the metal band is obtained.

Further it is advantageous if the drive unit for circumferentially moving the already constructed building construction section comprises two pairs of drive rolls positioned one on top of the other, wherein the drive rolls of the upper pair of drive rolls engage both sides of the lower edge of the already constructed building construction section whereas the drive rolls of the lower pair of drive rolls engage both sides of the upper edge of the metal band.

If the drive rolls are inclined such, that the rotation axes of drive rolls positioned at one side of the building construction wall diverge into the direction of motion of the building construction, the already constructed building construction section and the metal band are pushed towards each other as can be important for a good positioning of both parts.

Hereafter the invention will be elucidated with reference to the drawing, in which an embodiment of the method and apparatus according to the invention is illustrated.

Fig. 1 shows schematically a side elevational view of an apparatus according to the invention for carrying out the method according to the invention;

Fig. 2 shows the apparatus of fig. 1 in a top plan view at an earlier moment but only showing the latest ring, and

Fig. 3 - 6 show a part of the apparatus during a number of successive steps of the method according to the invention.

The fig. 1 and 2 show an apparatus that can be used for constructing a cylindric metal building construction by positioning successive rings one on top of the other and interconnecting said rings. In fig. 1 it can be seen clearly that already a number of rings 1, 2 and 3 are positioned one on top of the other. Fig. 2 shows the construction of a new ring 4.

If a roof construction has to be positioned on top of the cylindric building construction this roof construction is mounted in a way known perse after the production of a first ring.

As appears from fig. 1 the apparatus comprises a number of lifting units 5 - 12 that are positioned corresponding to the diameter of the building construction to be constructed, or in the present case the diameter of the ring 4 to be constructed. Although in the shown embodiment the number of lifting units amounts eight (see fig. 2), this number of lifting units can be varied dependent on the diameter of the building construction to be constructed. The lifting units 5 - 12 are attached to a foundation constructed earlier, for example of concrete. It is possible too that, if the building construction to be constructed is a tank with a welded bottom, this bottom is firstly constructed whereafter the lifting units are positioned on top thereof. Especially when dealing with heavy and very high constructions it is necessary to support the lifting units for obtaining enough stability, but this is not shown in the fig. 1 and 2. Moreover it is important that the lifting units are leveled.

The lifting units 5 - 12 each comprise a guiding 13 that is connected to a carriage 16 that can be moved upwards and downwards along a guide track 14. This upward and downward motion can be obtained by means of a motor 15 driving a screwed spindle or the like. The upward and downward motion of the guidings 13 too can be obtained by any appropiate means, such as mechanical, electrical or hydraulic or pneumatic solutions.

Further it is possible that the lifting units are activated such, that they all can move upwards and downwards synchronously, and that each lifting unit can be moved downwards independently and advantageously with an increased speed.

During constructing a cylindric metal building

construction a metal band 17 is wound of a coil 18 and is supplied in a vertical position. The metal band 17 firstly is shaped into the desired shape by means of a shaping device for shaping the ring four to be produced. As appears from fig. 2 the shaping device in the present case comprises a stretching unit 19 for stretching the metal band wound of the coil 18 as well as a rolling machine 20 for rolling the metal band to the desired diameter. It is mentioned that by the application of a thicker material it is possible that this does not come from a coil 18 but that it exists of separate metal plates that are interconnected before reaching the rolling machine 20.

During shaping the first ring of a metallic building construction to be constructed all guidings 13 of the lifting units 5 - 12 are in their lowermost position. The end of the metal band 17 that has passed the rolling machine 20 is moved onwards (clockwise as seen in fig. 2) by means of a drive unit 21 and is successively moved over the guidings 13 of the lifting units 5 - 12. For correctly guiding the metal band 17 the guidings each comprise a support wall with flanged edges. It is possible to apply lockings or additional guidings for holding the construction in case of a strong wind or the like.

In another embodiment of the guidings not shown each guiding comprises a number of lower rolls combined with vertical guiding means.

When the metal band 17 is led around the guidings 13 of the liftings units 5 - 12 like this the metal band 17 is, by means of a cutting device 22, cut off to a length that corresponds with the circumference of the ring 4 to be shaped. This cutting device 22 can comprise a cutting torch, a plasma cutting device, a slitting disc, a pair of shears or the like. Finally the beginning and the end of the cut off metal band section are interconnected for producing a complete ring 4.

After the first ring 4 has been formed the guidings 13 of the lifting units 5 - 12 are synchronously moved upwards for which reason the motors 15 are activated. The distance over which the guidings 13 are moved upwards equals the width of the supplied metal band 17. This stroke of the guidings 13 can be preset.

Next via the stretching unit 19, through the drive unit 21 and along the rolling unit 20 the metal band 17 is supplied again. If the forward end of this metal band 17 has reached the vicinity of the lifting unit 12 the guiding 13 of this lifting unit 12 is moved downwards, for example with an increased speed, such that the metal band 17 can pass above said guiding. As a result the upper edge of this metal band 17 contacts the lower edge of the already constructed building construction section, as appears clearly from fig. 1, in which the upper edge of the metal band 17 contacts the lower edge of ring 3. Next the mentioned upper edge can be attached to the mentioned lower edge, whereafter the already constructed building construction section is rotated synchronously with the supplied metal band 17. During said rotation always that guiding 13 that in the circumferential direction of the building construction section is positioned ahead of the supplied metal band 17 is moved downwards so far, shortly before the beginning of the metal band 17 reaches said guiding 13, that the metal band 17 is moved over said guiding 13 and that the lower edge of the metal band 17 is supported by said guiding 13. In fig. 1 the situation is represented in which the guiding 13 of the lifting unit 5 is shortly before moving downwards towards the position of said guiding represented in dotted lines.

Like this the already constructed building construction section is always appropiately supported. After reaching the desired length of the metal band 17 this is cut off again by means of the cutting device 22, whereafter the ends are interconnected and whereafter the previously described steps are repeated until the desired hight of the building construction has been achieved.

For moving the metal band 17 and the already constructed building construction section a further drive unit 23 is applied. This drive unit 23 is, as seen in the direction of motion, positioned shortly ahead of the location where the upper edge of the metal band 17 is attached to the lower edge of the already constructed building construction section. As indicated in fig. 1 the drive unit 23 comprises two pairs of drive rolls 24, 25 positioned one on top of the other. The drive rolls 24 of the upper pair of drive rolls engage both sides of the lower edge of the already constructed building construction section, whereas the drive rolls 25 of the lower pair of drive rolls engage both sides of the upper edge of the metal band 17. Further the drive rolls 24, 25 are inclined such that the rotation axes of the drive rolls positioned at one side of the building construction wall diverge into the direction of motion of the building construction. Consequently the driving force comprises a component forcing the metal band 17 and the already constructed building construction section towards each other.

It is emphasized that it is not necessary to incline the drive rolls 24, 25 as indicated in the figures. Other solutions can be presented for correctly positioning and holding together the metal band 17 and the already constructed building construction section.

In constructing a metal building construction the gauge of the applied material often increases downwards from ring to ring. Therefore it is advantageous if of each pair of drive rolls 24, 25 at

least one roll is settable spring-loaded, so that an automatic setting is possible in reaction to several material gauges. For automatically welding different materials having different gauges a variable circumferential velocity of the building construction is obliged. The driving units 21 and 23 as well as the rolling device applied in this embodiment therefore have to be tuned with respect to their drive velocities.

Further in fig. 2 an automatic welding device 26 is illustrated schematically, said welding device interconnecting the upper edge of the supplied metal band and the lower edge of the already constructed building construction section. Of course every other connecting method can be applied, for example the application of bolts or rivets. However, if materials such as steel, stainless steel, aluminum and the like are used, welding constitutes a very simple but however safe connecting method.

At both sides of the welding device 26 guiding rolls 27 are shown for guiding and leading the metal band 17 as well as the already constructed building construction section at the welding device 26. These guiding rolls too can be settable for an adjustment to several material gauges.

If a thin material is used, it is possible that the welding device comprises a device for single sided welding, in which at the side of the building construction wall facing away from the welding device a cooling unit is applied for cooling this side. This cooling unit can be pushed resiliently against the welding seam for obtaining a smooth wall. Further than a change of the structure of the material and a possible reduction of the resistence against corrosion can be avoided as much as possible. Too the mechanical characteristics of the material, such as the tensile strength and the tensile limit are maintained better.

By a number of materials to be used such a cooling unit is desirable if a double sided welding is applied. These cooling units are not shown in fig. 1 or 2.

Further it is possible that ahead of the welding device 26 an apparatus (not shown) is positioned for treating the edges to be welded, whereas behind the welding device 26 an apparatus for treating the welding seams can be applied.

Instead of the shown automatic welding device 26 it is possible however that the welding process is carried out manually.

As appears clearly from fig. 2 the rolling machine 20 is positioned outside of the circumference of a constructed ring 4. As a result the separate rolling rolls of this rolling machine can be interconnected at their upper and lower sides in a way not shown in detail. As a result this rolling machine 20 too can roll very thick metal band 17 without moving apart the separate rolling rolls of this rolling machine 20.

If a ring is completed it can be rotated along the guidings 13 before lifting the constructed building construction section. By a profile apparatus not shown reinforcement ridges can be pressed into the metal band thus offering the complete building construction a greater stiffness.

After obtaining a building construction section with the desired height, thus a building construction section having enough rings positioned one on top of the other, this building construction has to be placed onto the ground. This can be achieved as represented schematically in the fig. 3 - 6.

Fig. 3 shows that it is not directly possible to place the lower ring 4 onto the ground by means of the guidings 13. Therefore, after the entire complete building construction is sligthly lifted, between the guidings 13 support blocks 28 are positioned (fig. 4), said support blocks 28 having such a height that the guidings 13, after lowering the complete building construction onto the support blocks 28, disengage the lower edge of the lower ring 4 if this lower egde rests on the support blocks 28. Next the guidings 13 are disassembled from the lifting units 5 - 12 and are removed from underneath the lower edge of the lower ring 4.

Fig. 5 shows the next phase, in which the guidings 13 are removed by auxiliary means 29, for example an angle plate with a locking lip. These auxiliary means 29 engage the lower edge of the ring 4 and lift the entire building construction by a synchronous activation of all lifting units 5 - 12. The support blocks 28 are removed, whereafter the auxiliary means 29 are synchronously lowered until one or a number of said auxiliarly means nearly contacts the highest point of the ground, that mostly comprises concrete. After this, divided along the circumference, a number of filling plates are positioned underneath the building construction for filling up the space between the ground and the lower side of the constructed construction, and for leveling and unevennesses of the ground. The auxiliary means 29 now can be lowered synchronously until the entire construction rests on the filling plates (fig. 6), whereafter the auxiliary means 29 and the lifting units 5 - 12 can be disassembled. Next the complete construction can be anchored in the usual way and be sealed.

If the completed building construction has to be mounted onto a prefabricated steel bottom it will be necessary to mount auxiliary means to the inner side and to the lower side of the ring 4 so that by means of specially designed auxiliary means the complete construction can be positioned directly onto the steel bottom.

The invention is not limited to the embodiment described before but can be varied widely within the scope of the invention.

Claims

1. Method for constructing a cylindric metal building construction by positioning successive rings one on top of the other and interconnecting said rings, said method comprising the steps of:
- in a vertical position supplying the material for constructing the rings, such as metal band or metal plates to be assembled to a metal band, and shaping the material into the desired shape with a shaping device,
- shaping the supplied material into a ring by means of appropriate guidings,
- cutting the metal band or the metal plates assembled to a metal band to a length corresponding to the circumference of the corresponding ring to be shaped,
- connecting the upper edge of the metal band to the lower edge of an already constructed building construction section and interconnecting the beginning and the end of the cut-off metal band section,
- entirely lifting the building construction section constructed like this and supplying further rings underneath until the building construction has reached the desired height, and
- finally placing the building construction onto the ground **characterized** in that lifting the building construction already constructed is carried out by synchronously moving the guidings upwards, said guidings comprising supports engaging the lower edge of this building construction section, whereas always that guiding that in the circumferential direction of the building construction section is positioned ahead of the supplied metal band is moved downwards so far shortly before the beginning of the metal band reaches said guiding, that the metal band is moved over said guiding and that the lower edge of the metal band is supported by said guiding.

2. Method according to claim 1, **characterized** in that after completing the last, lowermost ring and connecting it to the already constructed building construction section, the building construction is lowered by synchronously lowering all guidings and is positioned onto support blocks whereafter the guidings are removed from under the lower edge of the lowermosts ring and wherein the building construction is slightly lifted by means of auxiliary means for removing the support blocks and wherein finally the building construction is lowered onto the ground.

3. Apparatus for carrying out the method according to claim 1 or 2, **characterized** in that it comprises a number of lifting units each having a guiding that can be moved upwards and downwards and wherein the lifting units are positioned such that the location of their guidings corresponds with the diameter of the building construction to be constructed.

4. Apparatus according to claim 3, **characterized** in that each guiding is connected to a carriage that can be moved upwards and downwards along a guide track.

5. Apparatus according to claim 4, **characterized** in that each guiding comprises a support roll with flange edges.

6. Apparatus according to claim 5 and 2, **characterized** in that each support roll can be released from its carriage and can be replaced by an auxiliary means that is constructed as an angle plate engaging the lower edge of the building construction.

7. Apparatus according to one of the claims 3 - 6, with a rolling machine as shaping device, **characterized** in that the rolling machine is positioned outside of the circumferential track of the rolled metal band as defined by the guidings.

8. Apparatus according to one of the claims 3 - 7, **characterized** in that it comprises a drive unit for supplying the metal band or the metal plates assembled to a metal band, said drive unit being positioned ahead of the shaping device as seen in the direction of motion of the metal band.

9. Apparatus according to one of the claims 3 - 8, **characterized** in that it comprises at least a drive unit for circumferentially moving the already constructed building construction section wherein said drive unit, as seen in the direction of motion, is positioned shortly ahead of the location where the upper edge of the metal band is connected to the lower edge of the already constructed building construction section.

10. Apparatus according to claim 9, **characterized** in that the drive unit for circumferentially moving the already constructed building construction section comprises two pairs of drive rolls positioned one on top of the other, wherein the drive rolls of the upper pair of drive rolls engage both sides of the lower edge of the already constructed building construction section whereas the drive rolls of the lower pair of drive rolls engage both sides of the upper edge of the metal band.

11. Apparatus according to claim 10 , **characterized** in that at least one roll of each pair of drive rolls is settable spring-loaded.

12. Apparatus according to one of the claims 3 - 11, which is provided with a welding device for interconnecting the metal band and the already constructed building construction section, **charac-**

terized in that near to the welding device at least one pair of guide rolls are provided for guiding the metal band and the building construction section.

13. Apparatus according to claim 12, **characterized** in that the welding device comprises a device for single-sided or double-sided welding wherein at that side of the building construction wall facing away from the welding device a cooling unit is provided for cooling said side of the wall.

14. Apparatus according to one of the claims 3 - 13, **characterized** in that it is provided with pressing rolls for pressing reinforcement ridges into the metal band and/or the building construction section.

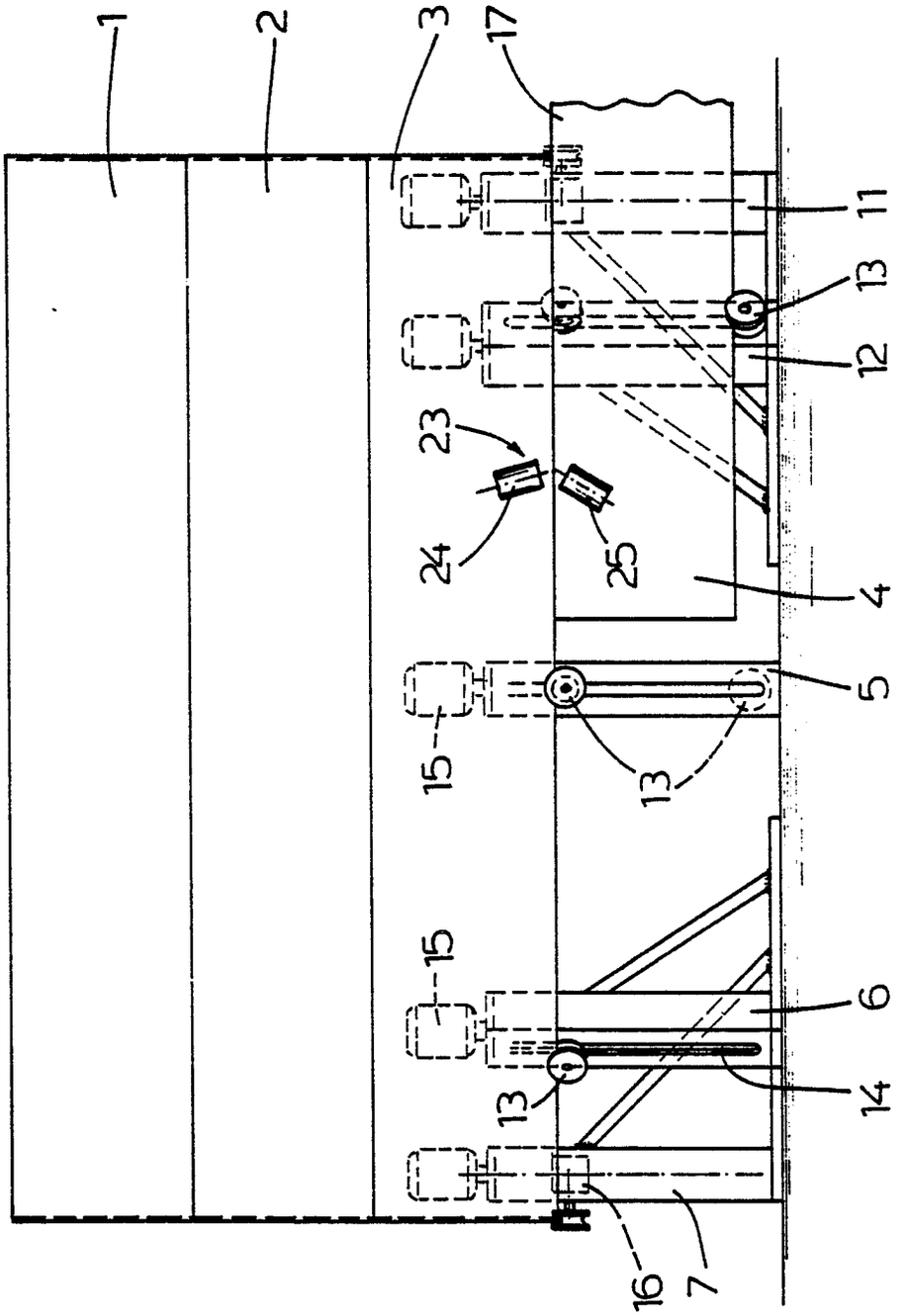

fig.1

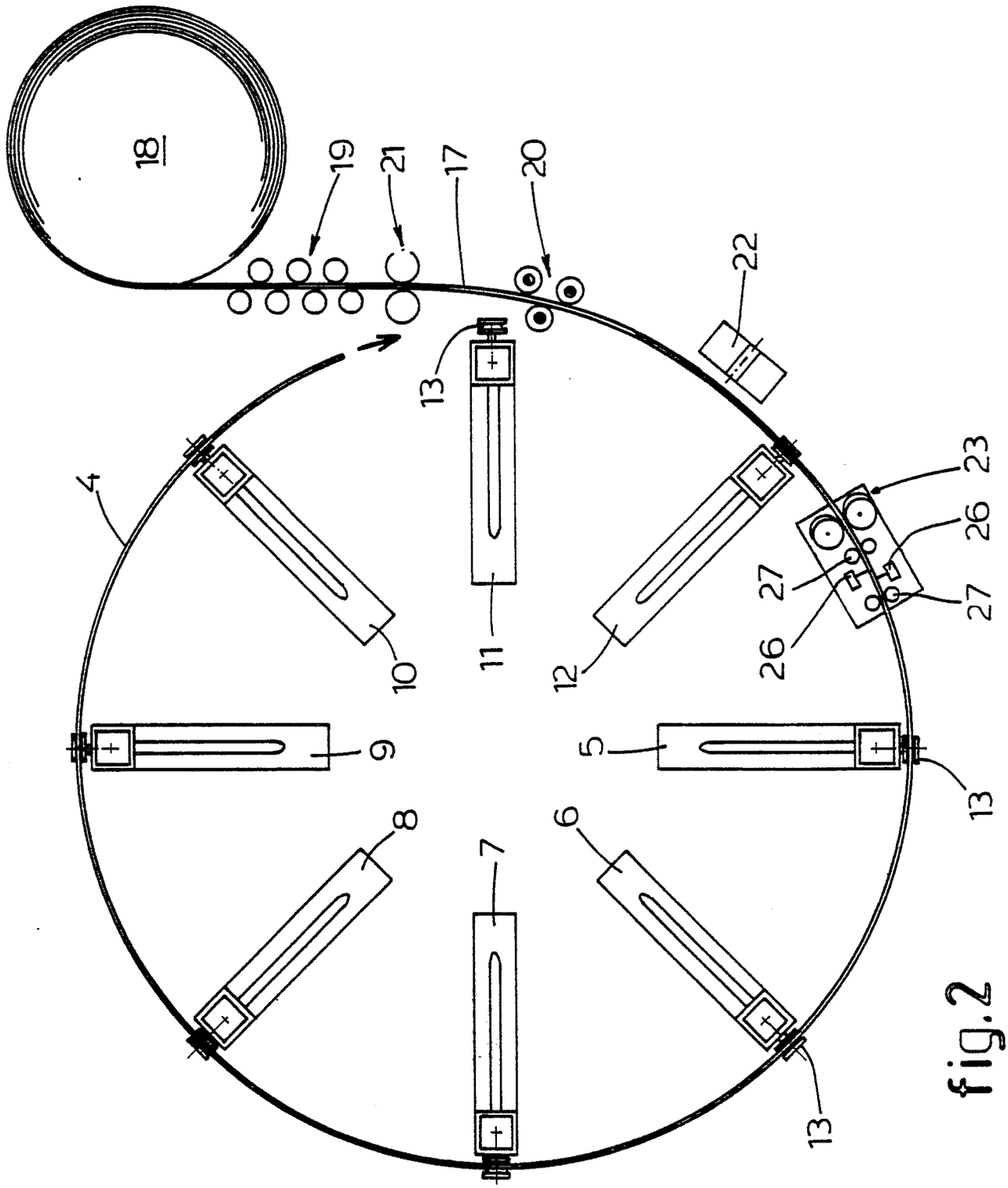

fig.2

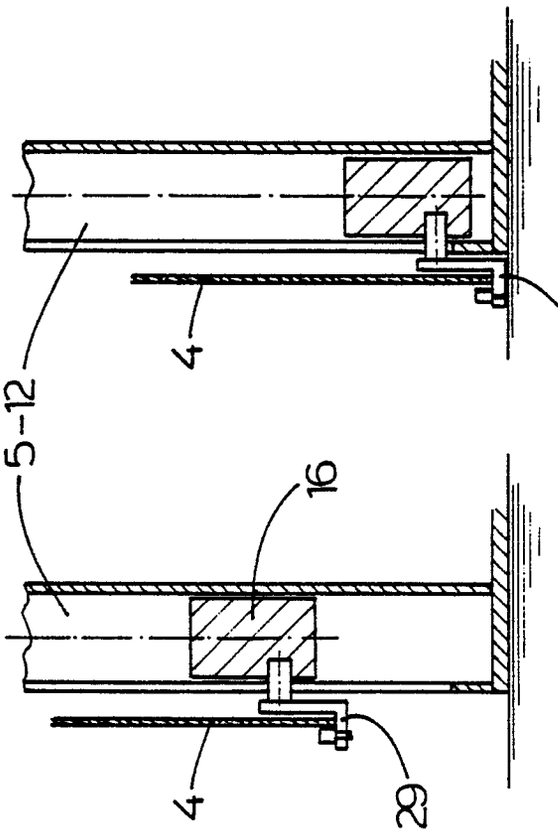

fig.6

fig.5

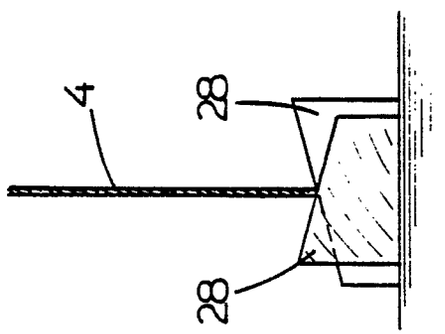

fig.4

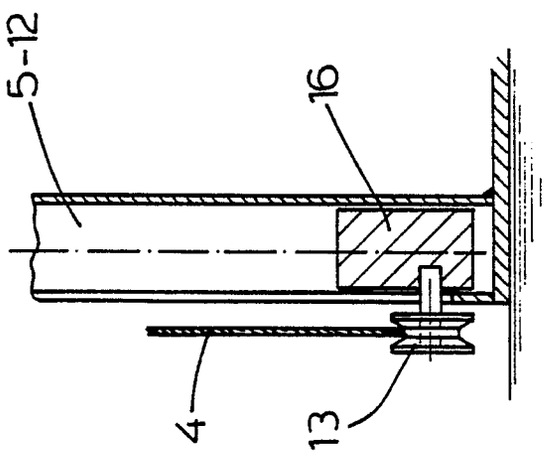

fig.3