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(54) MODULAR FIBER REINFORCED PLASTIC POLES

MODULARE FASERVERSTÄRKTE KUNSTSTOFFPFOSTEN

POTEAUX EN MATIÈRE PLASTIQUE RENFORCÉE DE FIBRES MODULAIRES

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Description

[0001] The invention relates to poles made from reinforced polymers (Fiber Reinforced Plastics - FRP), the production process of poles and the use of poles as a modular product.

[0002] Reinforced polymers belong to the class of composites, and consist of polymers and reinforcing glass fibers or other materials (aramid, carbon, etc.) in various forms (yarns, matts, felts, fabrics, meshes).

[0003] The poles are widely used for overhead power distribution lines, for the support of transmission lines in telecommunications and for various public and private uses (lighting, road signs, camera support, flag poles, etc.).

[0004] The first applications of overhead utility lines, lighting, telecommunications, etc., were made using wooden poles, because it was easier and cheaper to be produced from tree felling. They also had the advantage of insulation. For this reason, they were the dominant technology and even today they still hold the largest share of installed poles in many countries around the world.

[0005] Wooden poles, however, have considerable disadvantages due to the nature of wood (natural product), such as being attacked by insects, microorganisms and the weather conditions. Therefore, they require impregnation with dangerous pesticides, the use of which is subject to restrictions (e.g. creosote - DIRECTIVES 98/8/EC, 2011/71/EU). Wooden poles can also spread the fire, and when used in power distribution significant current leakages to the ground occur and reduce the network efficiency. Finally it is a non-industrial product with seasonal production which is not always predictable, with negative consequences on the availability (need to keep large stocks) and the price.

[0006] For these reasons, alternative pole technologies and materials have been developed such as Iron, reinforced concrete and reinforced polymer (FRP).

- Iron provides higher strength than wood. Iron poles have stable availability and are hollow, facilitating the passage (lowering) of the cables. However they rust and thus require protection. Furthermore Iron is a good conductor of electricity and its use requires additional components (e.g. insulators) and special working conditions and precautions in order to avoid accidents.

- Reinforced concrete provides sufficient strength and a certain degree of insulation, but the heavy weight of these poles is a problem for their transport and installation. Also the rigid behavior of the centrifugal concrete poles in car crashes is dangerous (causing serious traffic accidents). Furthermore, concrete cracks over time and the steel reinforcement is exposed and rusts.

- Poles made of FRP combine significant advantages such as low weight, hollow shape, resistance against micro-organisms and environmental conditions and reliable availability. However, their use is limited because of their higher cost, compared to other solutions.

[0007] Also in all the above cases (wood, iron, concrete, FRP) the currently existing poles are manufactured, sold, delivered, transported and installed in their full dimension. This means that the user doesn't have the potential to purchase and have these poles delivered as individual parts (modular product) in smaller packaging, and to assemble those on-site (at the installation area), which would facilitate both their transport - by using a smaller transport mean - and their installation, making them cheaper.

[0008] Known from the state of the art is document WO00/36261 A1 (Orlandi Mauro), presenting poles capable of supporting overhead electrical or telephone lines, lighting equipment or others from reinforced plastic. The poles consist of portions with dimensions that one end of a portion can be inserted into the end of an adjacent portion. One of the major issues raised in the above mentioned case is that the hollow parts have to be of the same shape in order to fit with each other. Moreover, the poles are not constructed entirely of fiber reinforced plastic, which creates the need to maintain the poles and raises the relevant cost. Also known are documents US 8 474 221 B1 (Ceko Peter) presenting a telescoping fiberglass utility pole consisting of three sections protruding and intruding to each other and WO2005/067544 A2 (Composite Tech Corp) presenting a composite utility pole with implements for use in electrical distribution networks.

[0009] The present invention relates to poles made of FRP, which consist of individual parts of suitable shape so that:

- a. every single individual part can be produced in industrialized, automatic or semi-automatic, economical production methods of FRP and

- b. the poles can be easily assembled, in a standardized manner by unqualified personnel by using simple and light tools, according to the manual.

[0010] The result of the above design is that the poles of the invention :

- a. firstly, have stable and repeatable (industrial) quality, short production cycle and easy availability, combined with low production costs, directly competitive against the poles from other materials, and even lower life cycle cost,

- b. and secondly, can be provided to customers (utility companies, contractors or other users) either as a

finished product, i.e. assembled as a single item, or as a modular product, i.e. their separate Individual parts before their assembly, along with the necessary tools and complete manual for their Installation and assembly on site.

[0011] Specifically:

The poles of the invention consist of two or more (depending on the total height and the desired strength) hollow (hollow) parts (tubes) of constant cross-section (cylindrical, polygonal, oval, etc.) which are connected by respective annular joints (connectors) with circumferential grooves on each side.

[0012] The hollow parts of constant cross sections (tubes) are shaped to serve the operational needs of customers in an optimal way (e.g. cross section with grooves for the easy Installation of the cable support fittings, cross section with stiffening ribs, cross section with a channel for cables crossing etc.). They also have appropriate wall thickness to meet customer requirements in terms of the mechanical strength and rigidity of the poles.

[0013] Each annular joint connects two successive hollow cross sections (tubes) and is shaped so that the one side fits to the upper section and the other side fits to the lower section. The upper side of the joint has a circumferential groove into which the upper section is inserted snugly and ends. Similarly the lower side of the joint has a circumferential groove into which the lower section is inserted snugly and ends. The above design of the joints allows the easy and precise assembly of the poles with simple means.

[0014] Adhesive is applied for the welding of the joints with the hollow sections, which may be combined with mechanical restraint (e.g. screws, pins, cotter pins, rivets etc.), which is either permanent or temporary (until the adhesive is polymerized) and removable.

[0015] The application of the adhesive can be performed by simply spreading into each groove of the joint before placing the respective tube (hollow part) in it. It can also be performed by Injecting through a special applicator, either in the groove of the joint before placing the respective hollow part (as mentioned above), or after the placement of the respective hollow part (tube) in the groove of the joint through an appropriately shaped hole, which leads the adhesive into the gap, in order to achieve the welding.

[0016] The poles of the invention also have a cap, which fits on the last upper section and is placed on top of the poles ensuring water tightness, The cap has a circumferential groove at its lower side into which the last upper section of the pole is inserted snugly and ends.

[0017] Furthermore, the poles of the invention may include additional components (rings, inserts, etc.) and configurations (holes, channels, etc.) according to the user's needs. We indicatively mention, without limitations, the opening of transverse through-holes to the poles, in which internal (reinforcing and guiding) tubes are applied and adhered. These holes are used for pass-

ing components, screws and cables (for example, near the top of the pole) or/and for mounting removable steps at regular intervals, allowing technicians to climb and stand in order to perform tasks.

[0018] The production method of the poles of the invention has two production steps of the aforementioned individual parts, and an assembly step. The first two steps, which are independent of each other and can be executed in parallel, require specialized industrial equipment, personnel and facilities. In contrast, the assembly step is designed so that it doesn't require specialized personnel or facilities.

[0019] Specifically:

The constant cross section hollow parts (tubes) of the poles of the invention can be produced by various reinforced polymer production methods (resin transfer molding, contact molding, filament winding, etc.), but are preferably produced by the pultrusion method, which is an industrial, automated, large capacity and competitive method and gives products of reproducible quality and dimensional accuracy.

[0020] The annular joints and the cap can also be produced by various reinforced polymer production methods (casting, resin transfer molding, etc.), but are preferably produced by the compression molding method, which also has the same - as abovementioned - characteristics, i.e. Industrial, automated, large capacity, competitive, reproducible and accurate. In terms of the dimensions of the produced products.

[0021] These individual parts of the poles (hollow sections, joints and cap), which are produced as abovementioned (by the pultrusion and compression molding methods respectively) are then assembled on a single pole, by using an adhesive and conventional (temporary or permanent) mechanical restraint means (screws, pins, etc.).

[0022] The use of the poles of the invention as a modular product is feasible, because the step of the poles assembly provided by their production method is not demanding in terms of expertise, equipment, facilities, utilities, etc., and can therefore be performed by the end user of the poles, with manuals and materials which are delivered together with the poles, even at the site of the final installation of the poles.

[0023] Specifically:

The poles of the invention are delivered either fully assembled and ready for installation, i.e. as the existing common poles are delivered, or as a modular product, i.e. divided in its individual parts.

[0024] In the second abovementioned case (modular product), the necessary tools, materials and manuals of the on-site assembly are also supplied to the user, along with the parts of the poles to be assembled.

[0025] Additionally, the design of the poles of the invention allows their packaging to be used as a modular product in such a way so that the volume required during their transport is submultiple of the volume of the assembled pole. This is done by placing the pieces of smaller

cross section (with the corresponding joints) in the pieces of the next larger cross section etc..

[0026] In this way the transport of the poles is facilitated and the corresponding cost is reduced, particularly in cases where the poles must be installed in inaccessible locations and in cases where the poles have to be transported over long distances (e.g. exports).

[0027] The poles of the invention are suitable for each and every use (power distribution, telecommunications, lighting, etc.).

[0028] With the invention the existing cumulative advantages of the poles from FRP are enhanced and expanded compared e.g. with wooden :

- availability, non-seasonal production
- excellent mechanical strength and elastic, predictable mechanical behavior
- long lifetime without requiring maintenance
- resistance against moisture, environmental attacks and the visible spectrum and UV radiation
- wide temperature operating range
- exemption from the need for impregnation with pesticides to protect against organisms
- repeatability of properties, dimensional stability and alignment
- ability to integrate inserted nuts and mounting parts of the pole equipment
- low weight, easy transportation and installation
- electrical insulation
- better behavior in car crashes, more safety and less damage to the vehicle and the network
- poles that do not sustain combustion (flame retardant)
- fine appearance (more aesthetics options)
- recycling

while the most important advantage of a competitive cost is also added compared to the alternative options, since the poles of the invention have :

1. low production cost due to the industrial production methods used, and
2. even lower life cycle cost (total cost of use), which is the sum of the production cost plus the costs of keeping a stock, transporting, handling, installation, inspection, maintenance, etc.) due to their light and modular structure which allows easier transport, since the bulkier individual parts can be placed one within the other requiring a much smaller space, and faster installation with less means, especially when it must be done in inaccessible places.

[0029] These enable the successful industrial application of the invention.

[0030] The full development and detailed description of the characteristics and the operation of the invention, the production method and the use as a modular product is made by designs (figures), which show poles of the

invention consisting of three cylindrical tube parts, with the corresponding joints and cap.

[0031] However the use of poles of other cross sections is not excluded (e.g. polygonal, oval, with functional recesses and channels, with stiffening ribs, etc.), representative designs (figures) of which have also been added.

[0032] The selection of a smaller or a larger number of pole parts also is not excluded, depending on its height, use and strength required.

[0033] According to the invention the poles consist of successive parts of constant cross-section of different shape (e.g. cylindrical parts at the base for the even distribution of mechanical stresses and polygonal at the top for the easier mounting of the arms and the support parts of the cables). This is achieved by appropriately adjusting the shape of the respective joints, in order to fit to the different (upper and lower) sections.

[0034] Figure 1 shows (in perspective view and in side view) an example of a pole which does not fall under the scope of the appended claims, which consists of three successive cylindrical parts, which are connected with joints. The upper cylinder has a cap.

[0035] In figure 2, the abovementioned pole is analyzed in its individual parts, which are illustrated in side view and sectional view (B-B).

[0036] Figures 3, 4 and 5 show in greater detail (in perspective view, top view, side view and sectional view) three individual parts of the pole with constant cylindrical section. The size of the cross section of the lower part is larger, of the middle part intermediate and of the upper part smaller. All the parts with constant cross section may be produced by the pultrusion method,

[0037] Figures 6 and 7 show in greater detail (similarly) the joints that connect the successive cylindrical sections in pairs. This means that the lower joint, which is larger one, connects the lower cylindrical part of the pole with the intermediate, and the upper joint, which is smaller one, connects the intermediate cylindrical part of the pole with the upper.

[0038] Each joint is designed so as to "receive" at appropriately shaped circumferential grooves (recesses) the two cylindrical sections (upper and lower) which it connects, in order firstly to achieve the strong adhesion between the joint and the sections with adhesive, and secondly the assembling of the section to be performed accurately (the sections "end" in the grooves (recesses) of the joint, without the need for measuring, leveling, etc.). All the joints can be produced by the compression molding method. The design of the joints ensures that the successive sections overlap at a small part of their length, so that the connection is resistant against bending.

[0039] Figure 8 shows in greater detail (similarly) the cap, which fits with the upper cylindrical part and is placed on top of the pole of the invention. Regarding the connection of the cap to the cylindrical part, the welding, its assembly and production (compression molding), exact-

ly the same apply as mentioned above for the joints. The design of the cap ensures tightness, regardless of good or bad application of the adhesive. The top of the cap is slightly curved; however caps with flat, conical or of any other shape surface are not excluded, depending on the requirements of the use.

[0040] Figure 9 shows (in perspective view and sectional view) a pole which does not fall under the scope of the appended claims, which has two transverse through holes at a short distance from its top for passing components, screws and cables and at a lower height five transverse through holes (in vertical direction comparing to the previous) for placing removable steps (stiles). Fitted, strong, inner tubes are welded at all the holes, which : a. strengthen the pole and prevent its shattering in case threaded fittings, through-bolts, etc., must be tightened, b. direct the passing of rods, cables, ropes etc., and c. prevent the communication of the holes with the inside of the pole, the entry of water, insects, etc.,

[0041] Figure 10 shows the assembly process of the pole in successive steps. All the steps of the assembly can take place either at the factory (before the delivery of the pole as a finished product) or on-site at the installation location (after the delivery of the pole as a modular product).

[0042] At the first step of the assembly (A) the joints and the cap are welded to the corresponding lower cylindrical sections, by applying an adhesive (K). The application of the adhesive can be made in all possible ways (spreading, infusion, injection, etc.), depending on the viscosity of the adhesive and the specific design of the joints and the sections. Similarly the type of adhesive application equipment vary (spatula, pressing machine with static mixer, etc.). The welding can also be combined with mechanical restraint, either permanent or temporary, until the completion of the polymerization (hardening) of the adhesive.

[0043] The first step of the assembly (A) preferably takes place at the factory (before delivery) even when the pole is delivered as a modular product. This is partly because, after the first step, the individual parts of the pole may still be placed inside one another (in order to be transported easily and inexpensively), and also because by performing the first step at the factory the labor that must be done on-site and the corresponding installation time of the pole are reduced.

[0044] At the second step of the assembly (B) the Joints are welded to the corresponding upper cylindrical sections, by applying an adhesive (K). In this way the Individual assemblies resulted from the first step are joined to form the final pole (C). Regarding the application of the adhesive and mechanical restraint exactly the same are applied as mentioned for the first step. When the pole is delivered as a modular product, the second step is always performed on-site.

[0045] Figure 11 is a schematic representation of of adhesive application by injection in the gaps between the joints and the cylindrical sections, by using the pressing

device. In this case, the assembly process consists of: a the mounting of the cylindrical parts at their place, which may be combined with a permanent or temporary mechanical fixing (e.g. with pins), and b. the application of the adhesive by the applicator through holes that lead the material to fill the gaps in order to achieve the welding. If the adhesive has two components, the mixing occurs in a static mixer of the applicator, to avoid mistakes.

[0046] Figures 12, 13 and 14 show the individual parts of another version of the pole which does not fall under the scope of the appended claims, which pole is of octagonal cross-section. The pole of this version consists of successive sections of constant octagonal cross-section, the corresponding joints that fit to the octagons and the cap similarly. More specifically, Figure 12 shows (in perspective view, top view, side view and sectional view) a part with an octagonal shaped constant cross-section, Figure 13 shows (similarly) an octagonal shaped joint and Figure 14 shows (similarly) the corresponding cap.

[0047] Also Figure 15 shows the corresponding assembly steps of the octagonal pole which are not substantially different from those of the corresponding cylindrical described above.

[0048] Figure 16 shows (in perspective view) a pole which does not fall under the scope of the appended claims, with an oval cross section. The joints are designed to fit to the oval cross-sections, to ensure the required overlap and to connect strongly. The image 16a shows two successive oval cross sections connected to a joint and image 16b shows an oval cross-section.

[0049] Figure 17 shows (in perspective view) a pole which does not fall under the scope of the appended claims, with a composite cross section, which is cylindrical, but also forms an internal channel which facilitates the passing and protection of the cables. Regarding the joints exactly the same are applied as mentioned above, with the addition that also allow the contact/continuity of the internal channel throughout the height of the pole (see Image 17d). Also, image 17a shows two successive sections with a channel connected to the joint and image 17c shows the same components (two cross sections and a joint) before the assembly. Finally, image. 17b shows a cross section with a channel separately and Image 17e shows a joint separately.

[0050] Figure 18 shows (in perspective view) a pole which does not fall under the scope of the appended claims, with a composite cross section, which is cylindrical, but also forms grooves for fixing channels, fittings, branch boxes, cables, etc.. Regarding the joints exactly the same are applied as mentioned above. Images 18a and 18e show two successive sections with grooves, connected with a joint. Image 18b shows a cross-section separately and images 18c and 18d show each joint separately.

[0051] Figure 19 shows (in perspective view) a pole of the invention which consists of successive sections of constant cross-section of different shape. Specifically, the bottom section is cylindrical, while the upper section

is octagonal. Images 19a and 19b show two successive sections (cylindrical at the bottom and octagonal at the top) connected to the joint, and image 19c shows the same components (two cross sections and a joint) before the assembly. The joint (image 19d, separately) that connects the two different sections, is designed so as to fit to both sections, having a circular groove at its bottom side and an octagonal groove at its top.

[0052] All of the figures and Images 20-21 and 22-26 describe all the steps of the assembly, packaging for transportation and installation of a modular pole of three stages, from the production of its individual pieces until the completion of its installation on-site. Figures 20-21 relate to the steps that take place in the factory, while figures 22-26 relate to the steps that take place at the installation location of the pole (on-site).

[0053] Figure 20 shows the individual parts of the pole, i.e. the cylindrical parts that have been produced by the pultrusion method and the joints and the cap that have been produced by the compression molding method, and the first assembly step of these pieces is described in pairs (see explanation of figure 10 - step A, as mentioned above), which takes place at the factory. Images 20a and 20b show the pieces (three sections, two joints and cap) separately from one another. Images 20c and 20d show the pieces glued in pairs (lower cylinder + lower joint, intermediate cylinder + upper joint, upper cylinder + cap) as obtained after the step A of the assembly at the factory. Images 20e and 20f show the same abovementioned pairs but in reverse order (with no other change), that can be placed one inside the other.

[0054] Figure 21 shows the placing of partially assembled pieces (pairs) telescopically one inside the other. In this way the packaging is done in the factory before shipment, so as to reduce the length and the volume occupied by the modular pole, to facilitate its transportation and to be possible even by a smaller vehicle. Images 21a, 21c and 21e show (in side and perspective view) the pairs as they are inserted into each other and images 21b, 21d and 21f (similarly) show the pairs completely packaged in the smallest possible dimension.

[0055] Figure 22 shows (in side and perspective view) the first step of installation of the modular pole, after its transportation on-site. The lower cylindrical section, which has the first joint already welded at its top, is placed, leveled and anchored to the hole where the pole will be placed.

[0056] Figure 23 shows (in side and perspective view) the application of the adhesive (K) to the joint of the first compacted part of the pole, which will be used for the welding of the next cylindrical section.

[0057] Figure 24 shows (in side and perspective view) the placing of the second cylindrical part of the pole at the corresponding socket of the first joint, wherein the adhesive (K) has already been applied. Because the compression molding and pultrusion production methods by which the joint and the cylindrical part have been produced, respectively, are very precise regarding the di-

mensions and the tolerances between the joint and the cylindrical part are very small, the placing of the second part is simple, accurate and does not require new measurements and leveling.

[0058] Figure 25 shows (in side and perspective view) the application of the adhesive (K) at the joint of the second, already placed, part of the pole, which will be used for the welding of the last, upper, cylindrical part that also bears the cap.

[0059] In figure 26 (in side and perspective view) the installation of the pole is completed by placing the third and last cylindrical part at the corresponding socket of the second joint, wherein the adhesive (K) has already been applied. Regarding the dimensional accuracy, the tolerances and the leveling exactly the same are applied as abovementioned (for the figure 24).

[0060] If the adhesive is applied by Injection by an applicator into appropriate for this purpose sockets (holes) of the parts and the joints, then all the steps of the assembly/installation can be preceded (figures 22, 24 and 26), the intermediate steps of the application of the adhesive are skipped (Figures 23 and 25), and the application of the adhesive is done at the end of all the joints (according to figure 11).

[0061] Figure 27 is a schematic representation of the production method of the poles of the invention as a flow chart, which includes the production of the individual pole parts by the compression molding (C) and pultrusion (P) methods, which can take place in parallel and independently from one another, and then the assembly of the individual parts of the pole with adhesive (K) or/and mechanical means, which may be done either at the factory or later by the user (in case the poles are used as a modular product).

Example 1

[0062] In figure 28, an example of a pole ready to be produced industrially is shown with all its dimensions.

[0063] The determination of the individual dimensions of the pieces that form the pole of the example was made by using a finite element software package, taking into account firstly the mechanical stresses and strains that the pole must resist and secondly the resistances of the reinforced polymers from which the pieces are manufactured and the direction of these resistances (compression molding isotropic material for the joints and the cap and pultrusion orthotropic material for the cylindrical parts),

[0064] The pole of the example is 7m long and meets the requirements of the specifications relating to poles of respective size suitable for installation in networks. It also meets the requirements of relevant international standards (EN 50341, EN 50423).

Claims

1. Modular fiber reinforced plastic poles, consisting of

two or more successive hollow parts of constant cross section, said successive hollow parts having different sizes, said poles further consisting of annular joints of shape corresponding with the shape of the hollow parts that they connect, with circumferential grooves at both their sides suitable for fitting the hollow parts that they connect, whereby each hollow part is fitted with the other via the annular joints; **characterized in that:**

said successive hollow parts have different shapes, and
said modular fiber reinforced plastic poles further consist of a cap of shape corresponding to the shape of the upper hollow part, whereby the cap is fitted on the top of the upper hollow part of the pole,

2. Modular fiber reinforced plastic poles, according to claim 1, **characterized by** the fact that the hollow parts of constant cross section are cylindrical, polygonal or oval.
3. Modular fiber reinforced plastic poles, according to claim 1, **characterised by** the fact that inner tubes are transversely passed through holes in the hollow parts and welded, for the passing of components, screws, cables and for fixing of removable steps.
4. Method for producing modular fiber reinforced plastic poles, according to claim 1, consisting of two or more hollow successive parts of constant cross section, of annular joints of corresponding shape with circumferential grooves at both their sides suitable for fitting the sections that they connect, and of a cap of corresponding shape, **characterized by** the fact that the hollow parts of constant cross sections are produced by the pultrusion method and the annular joints and the cap are produced by the compression molding method.

Patentansprüche

1. Modulare faserverstärkte Kunststoffstangen, bestehend aus zwei oder mehr aufeinanderfolgenden Hohlteilen mit konstantem Querschnitt, wobei die aufeinanderfolgenden Hohlteile unterschiedliche Größen aufweisen, wobei die Stangen ferner aus ringförmigen Verbindungen bestehen, deren Form der Form der Hohlteile die sie verbinden entspricht, mit Umfangsnuten an beiden Seiten, die zum Anbringen der von ihnen verbundenen Hohlteile geeignet sind, wobei jedes Hohlteil über die Ringverbindungen mit dem anderen verbunden ist, **dadurch gekennzeichnet, dass:**

die aufeinanderfolgenden Hohlteile haben un-

terschiedliche Formen und
die modularen faserverstärkten Kunststoffstangen bestehen ferner aus einer Kappe mit einer Form, die der Form des oberen Hohlteils entspricht, wobei die Kappe oben auf dem oberen Hohlteil der Stange angebracht ist.

2. Modulare faserverstärkte Kunststoffstangen nach Anspruch 1, **dadurch gekennzeichnet, dass** die Hohlteile mit konstantem Querschnitt zylindrisch, polygonal oder oval sind.
3. Modulare faserverstärkte Kunststoffstangen nach Anspruch 1, **dadurch gekennzeichnet, dass** Innenrohre quer durch Löcher in den Hohlteilen geführt und geschweißt werden, um Bauteile, Schrauben, Kabel zu führen und abnehmbare Stufen zu befestigen.
4. Verfahren zur Herstellung modularer faserverstärkter Kunststoffstangen nach Anspruch 1, bestehend aus zwei oder mehr aufeinanderfolgenden Hohlteilen mit konstantem Querschnitt, Ringverbindungen entsprechender Form mit Umfangsnuten an beiden Seiten geeignet für die Montage der Abschnitte, die sie verbinden und eine Kappe mit entsprechender Form, **dadurch gekennzeichnet, dass** die Hohlteile mit konstanten Querschnitten durch das Pultrusionsverfahren hergestellt werden und die Ringverbindungen und die Kappe durch das Formpressverfahren hergestellt werden.

Revendications

1. Poteaux en plastique modulaires renforcés de fibres, constitués de deux ou plusieurs parties creuses successives de section constante, lesdites parties creuses successives ayant des tailles différentes, lesdits poteaux étant en outre constitués de joints annulaires de forme correspondant à la forme des parties creuses qu'ils relient, avec des rainures circonferentielles sur leurs deux côtés adaptées pour le montage des parties creuses qu'elles relient, au moyen desquelles chaque partie creuse est ajustée avec l'autre via les joints annulaires, **caractérisés en ce que:**

lesdites parties creuses successives ont des formes différentes, et
lesdits poteaux en plastique renforcés de fibres modulaires sont en outre constitués d'un capuchon de forme correspondant à la forme de la partie creuse supérieure, moyennant quoi le capuchon est ajusté sur le dessus de la partie creuse supérieure du poteau.

2. Poteaux plastiques modulaires renforcés de fibres,

selon la revendication 1, **caractérisés en ce que** les parties creuses de section constante sont cylindriques, polygonales ou ovales.

3. Poteaux plastiques modulaires renforcés de fibres, selon la revendication 1, **caractérisés en ce que** des tubes intérieurs sont passés transversalement à travers des trous dans les parties creuses et soudés, pour le passage de composants, vis, câbles et pour la fixation de marches amovibles.
4. Procédé de fabrication de poteaux en plastique modulaires renforcés de fibres, selon la revendication 1, constitués de deux ou plusieurs parties creuses successives de section constante, de joints annulaires de forme correspondante avec des rainures circonférentielles de part et d'autre adaptées pour le montage des sections qu'elles reliaient, et d'un capuchon de forme correspondante, **caractérisée en ce que** les parties creuses de section transversale constante sont réalisées par le procédé de pultrusion et les joints annulaires et le capuchon sont réalisés par le procédé de moulage par compression.

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Figure 1

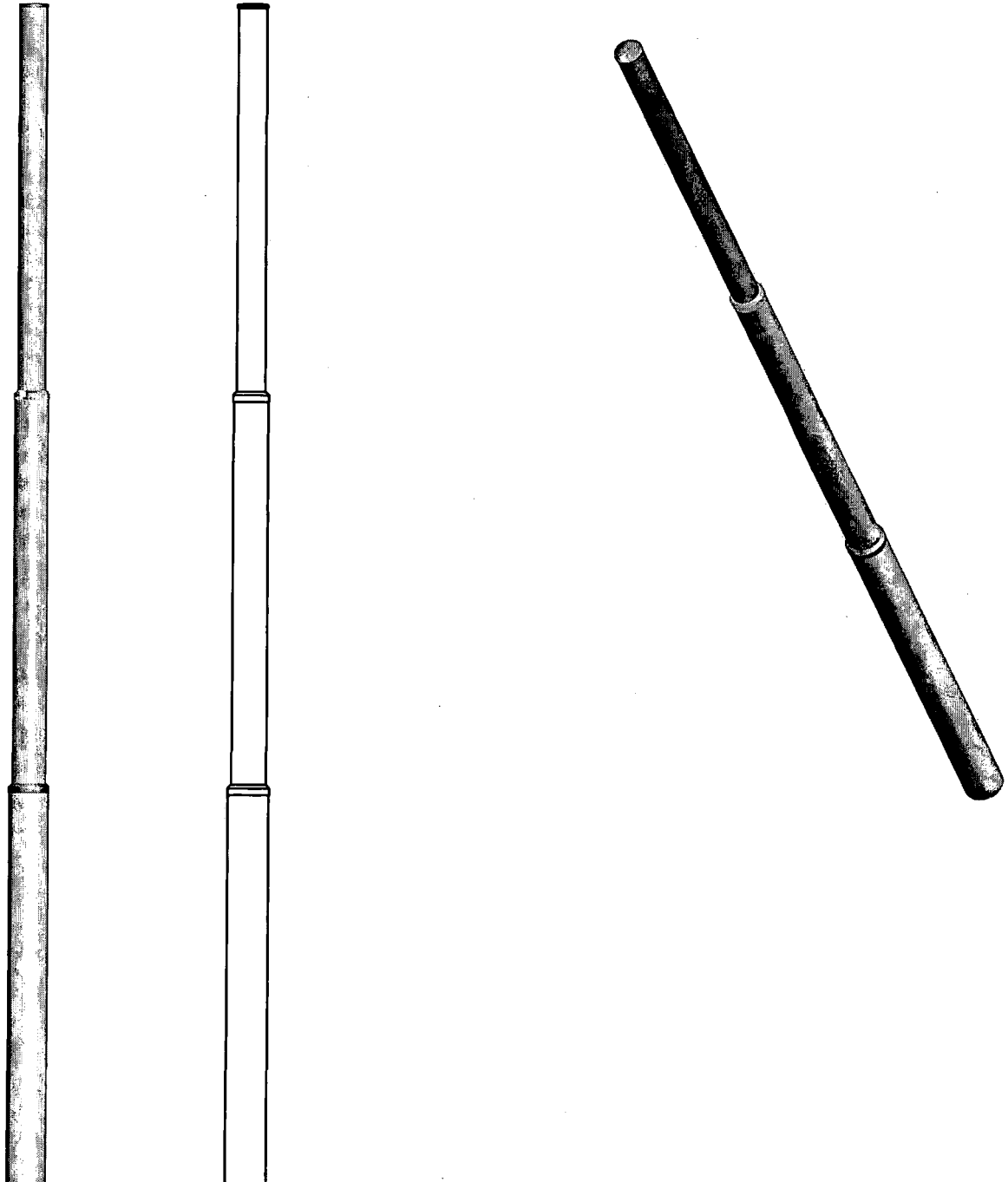


Figure 2

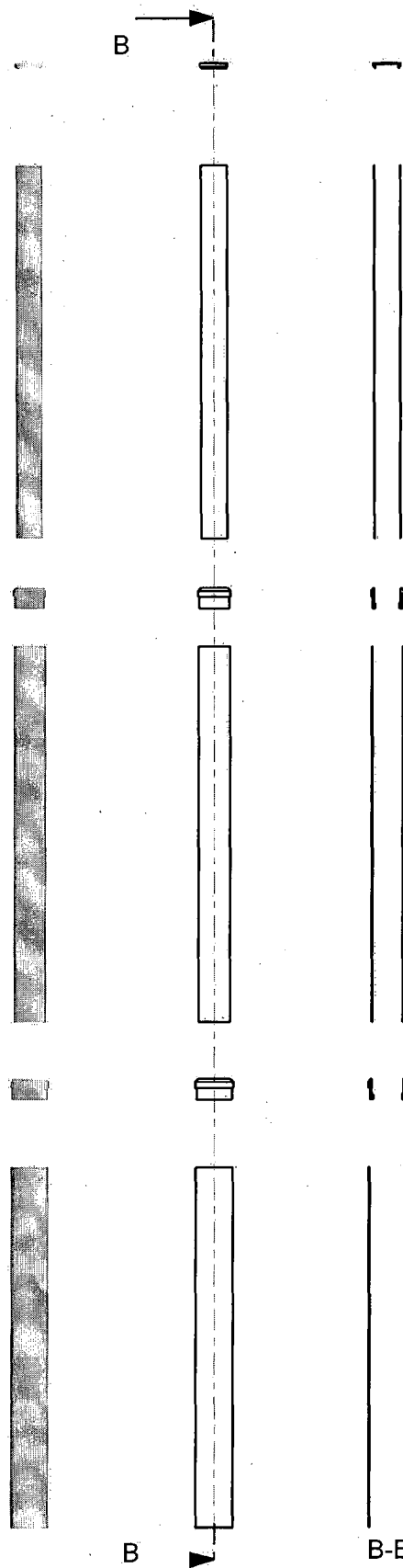


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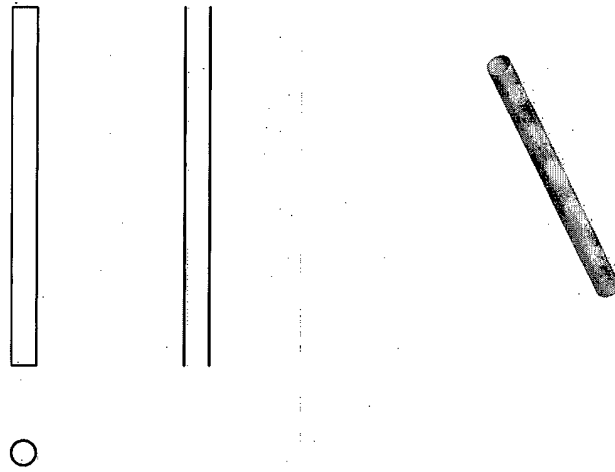


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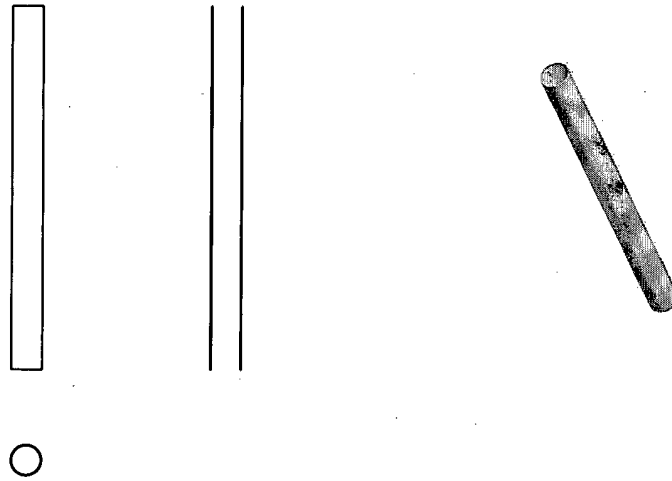


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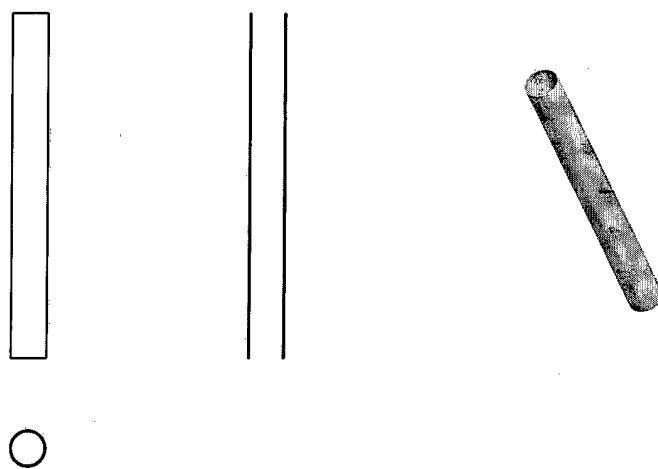


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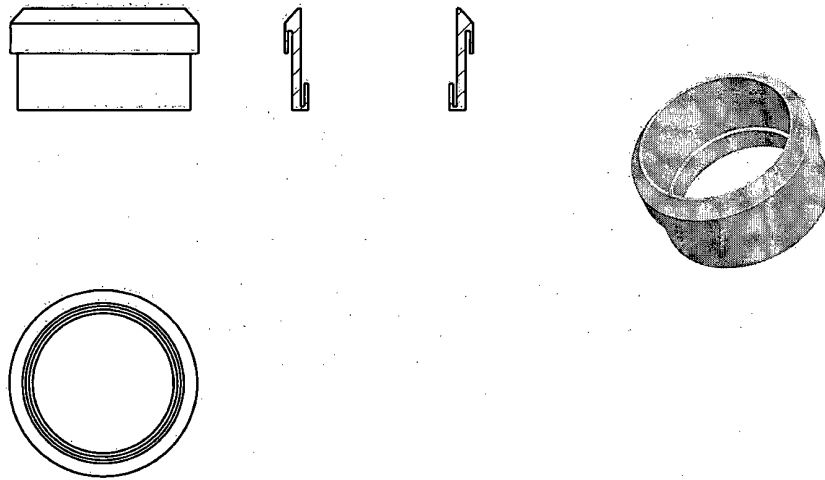


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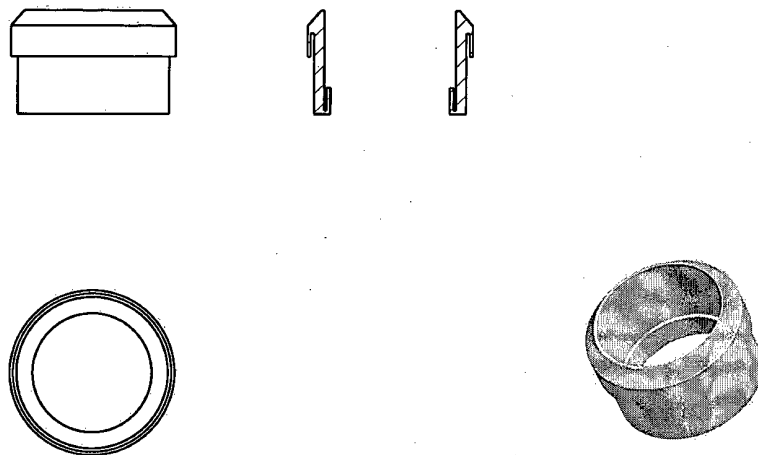


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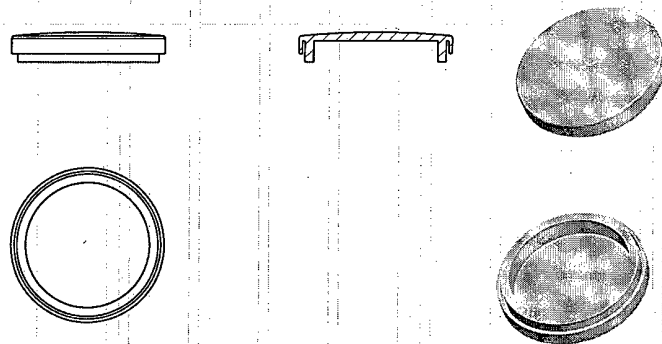


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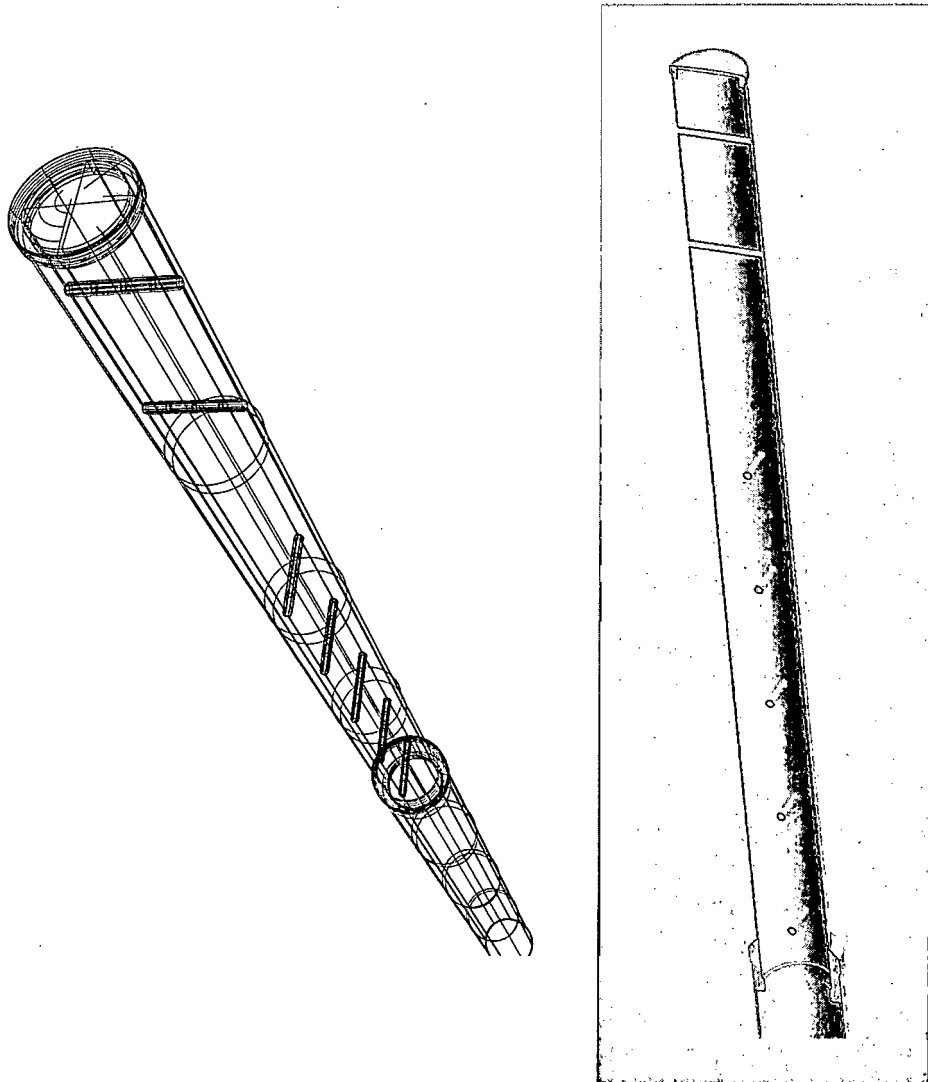


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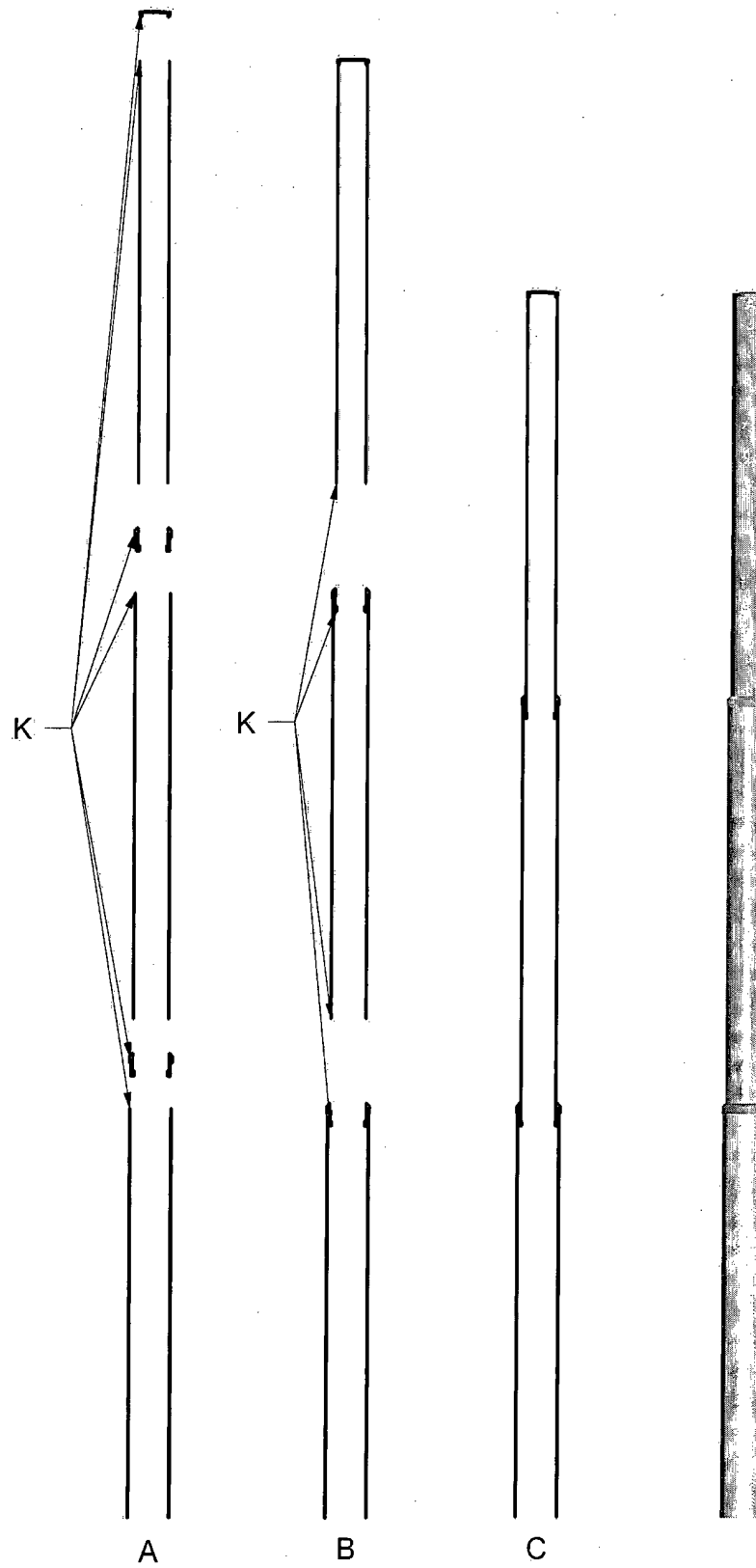


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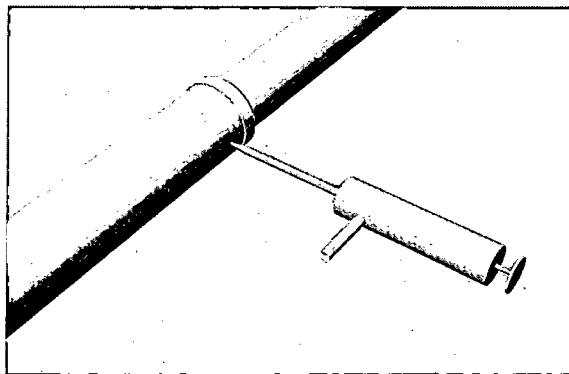
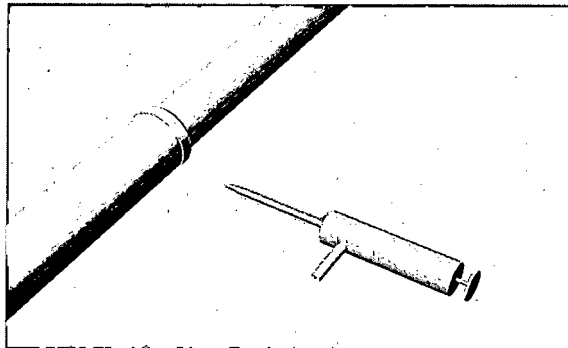
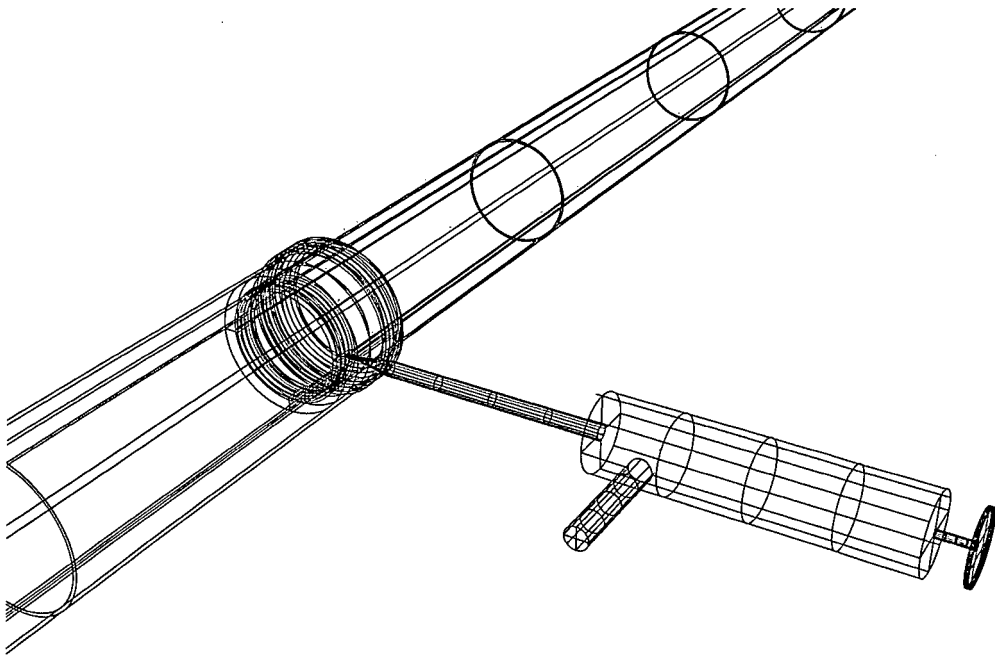


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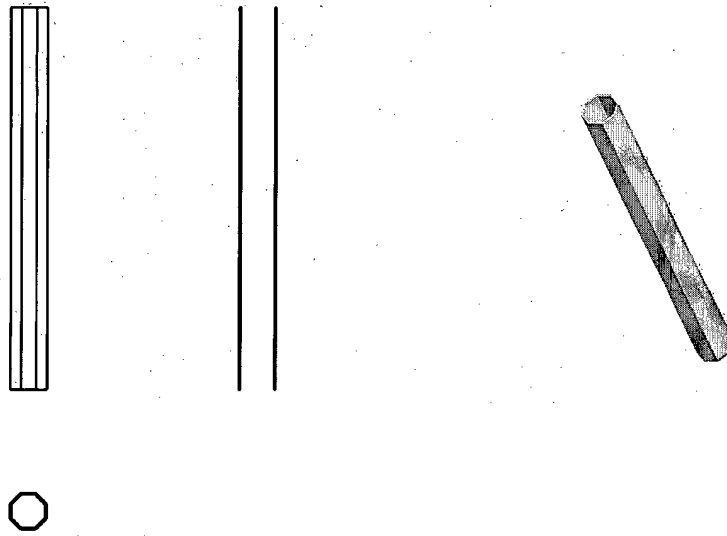


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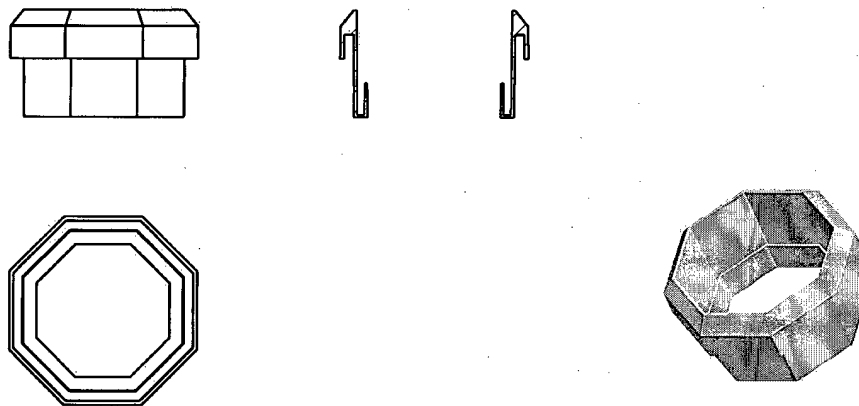


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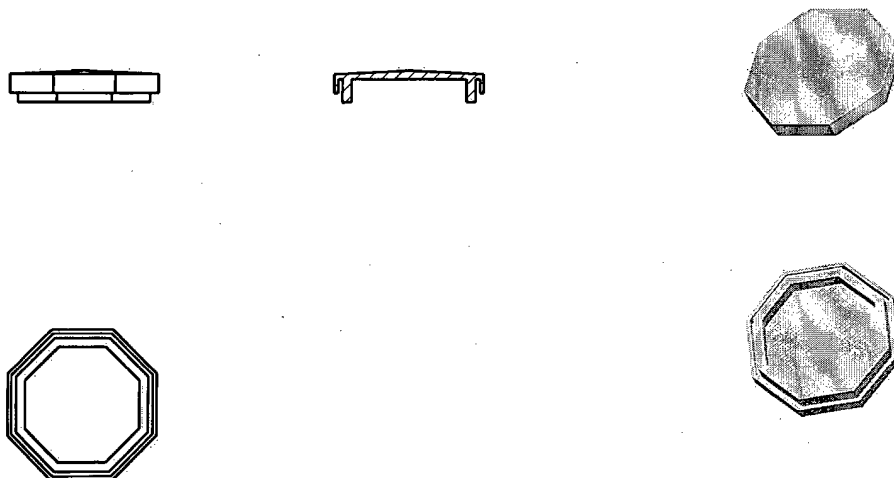


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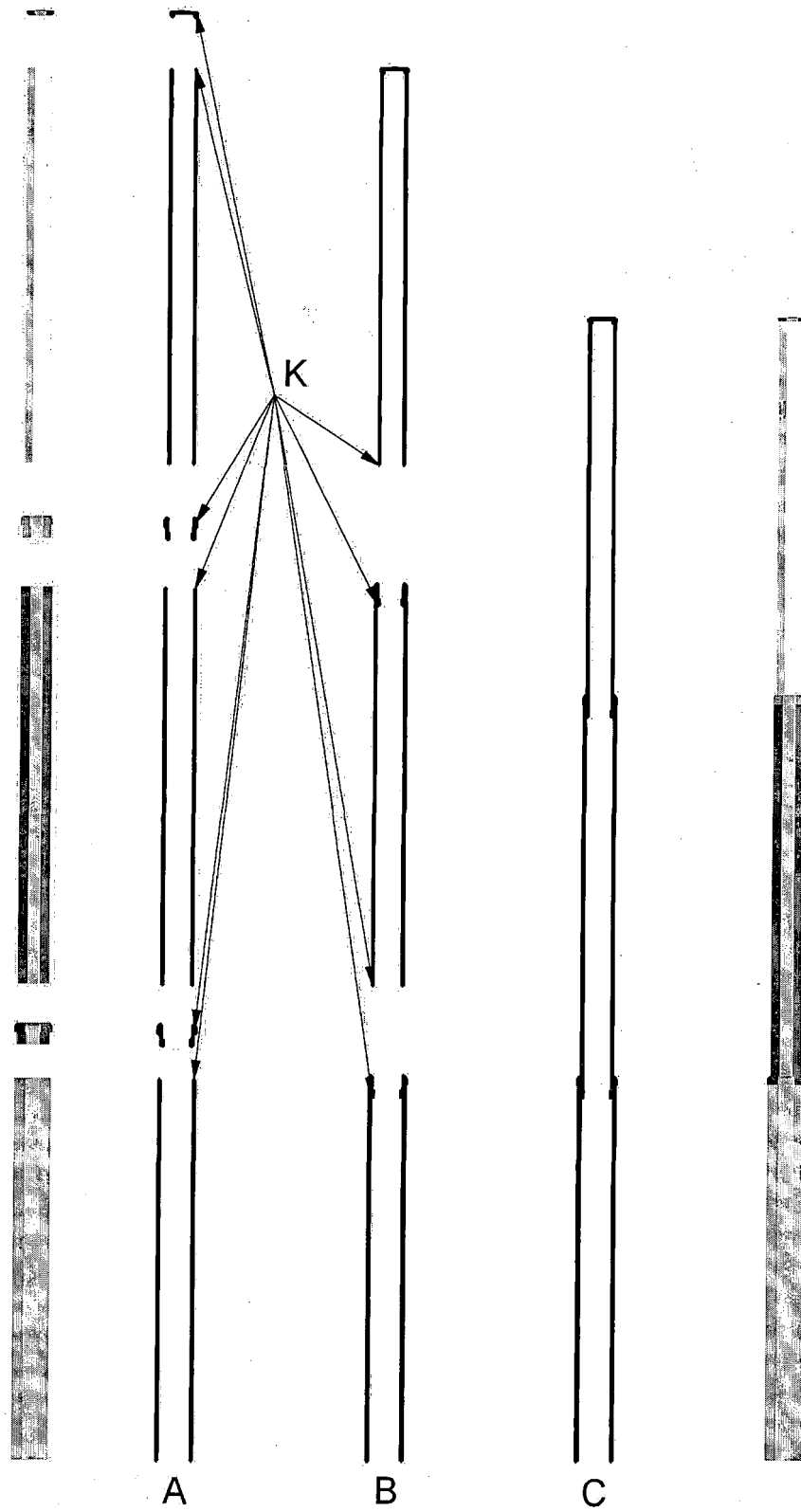
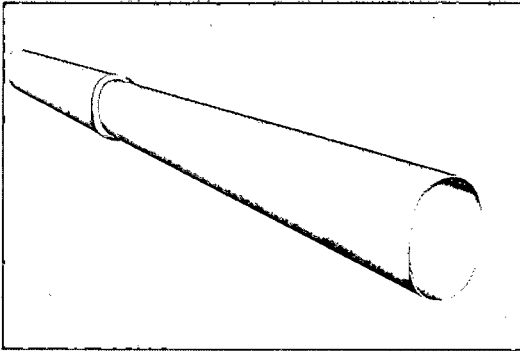


Figure 16

16a



16b

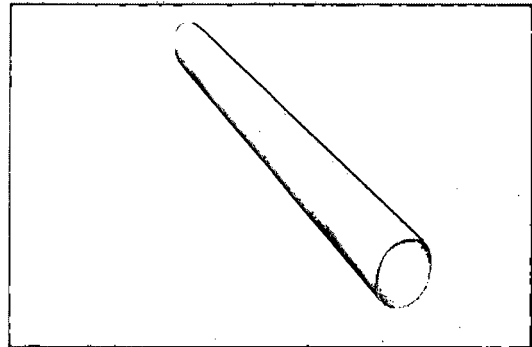
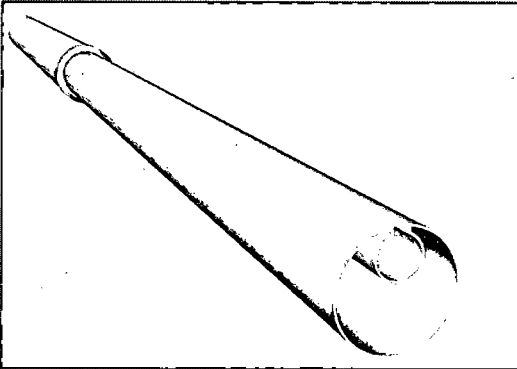
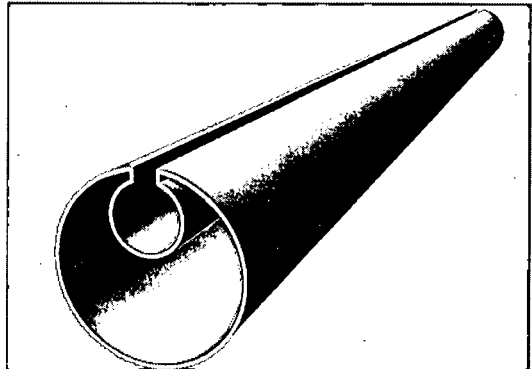


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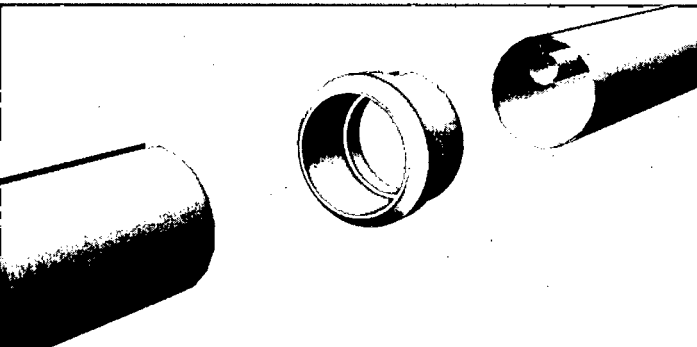
17a



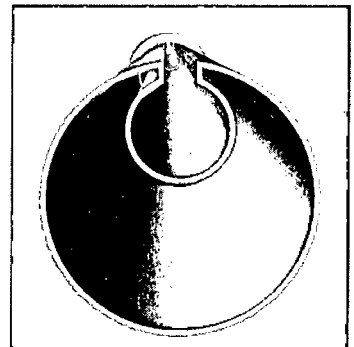
17b



17c



17d



17e

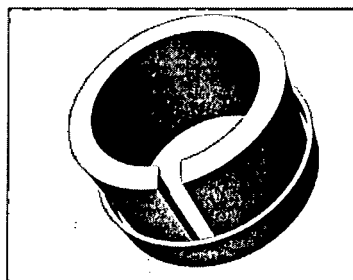


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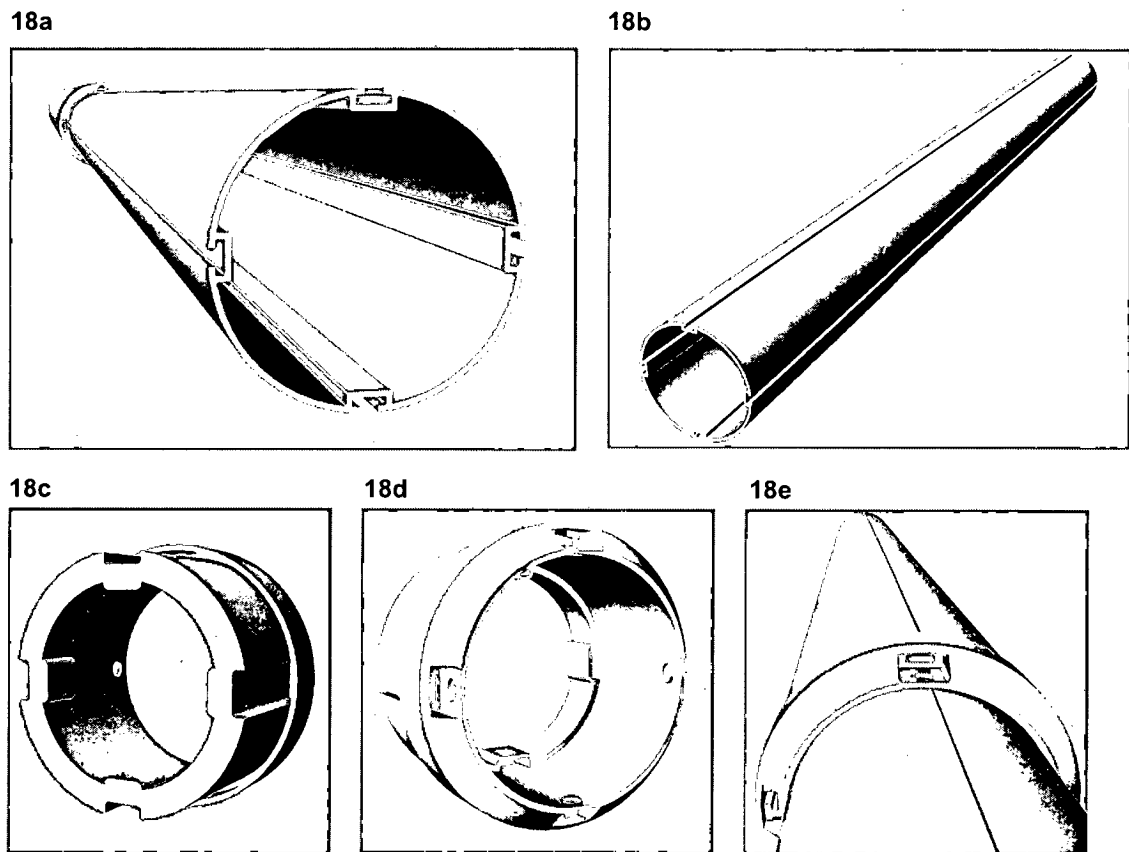


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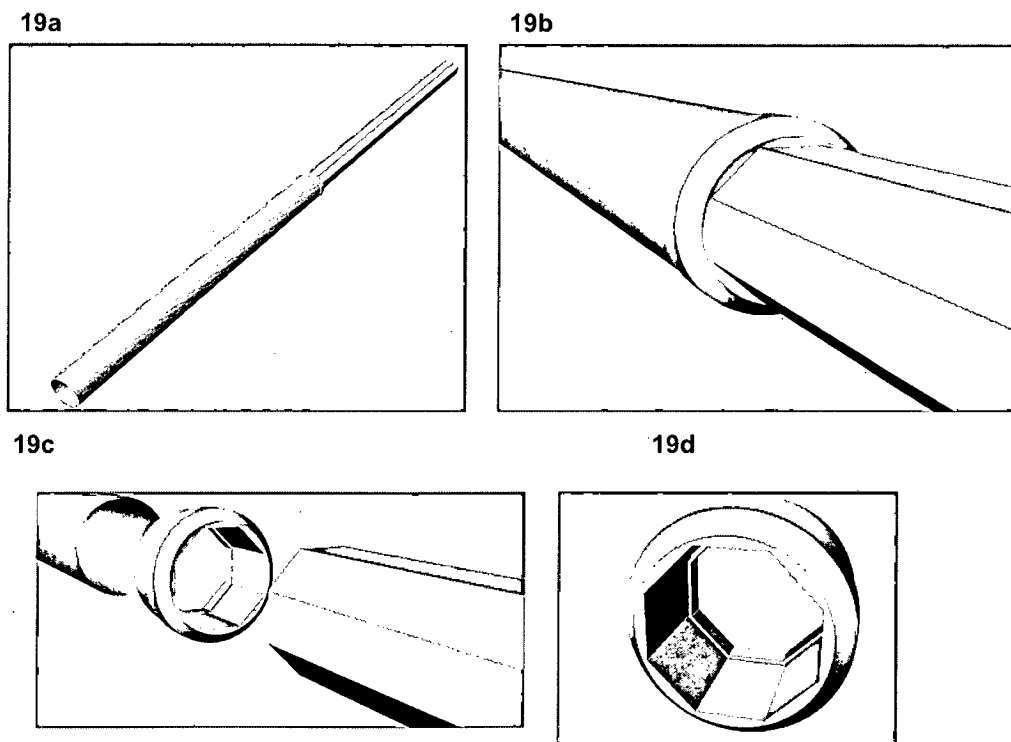


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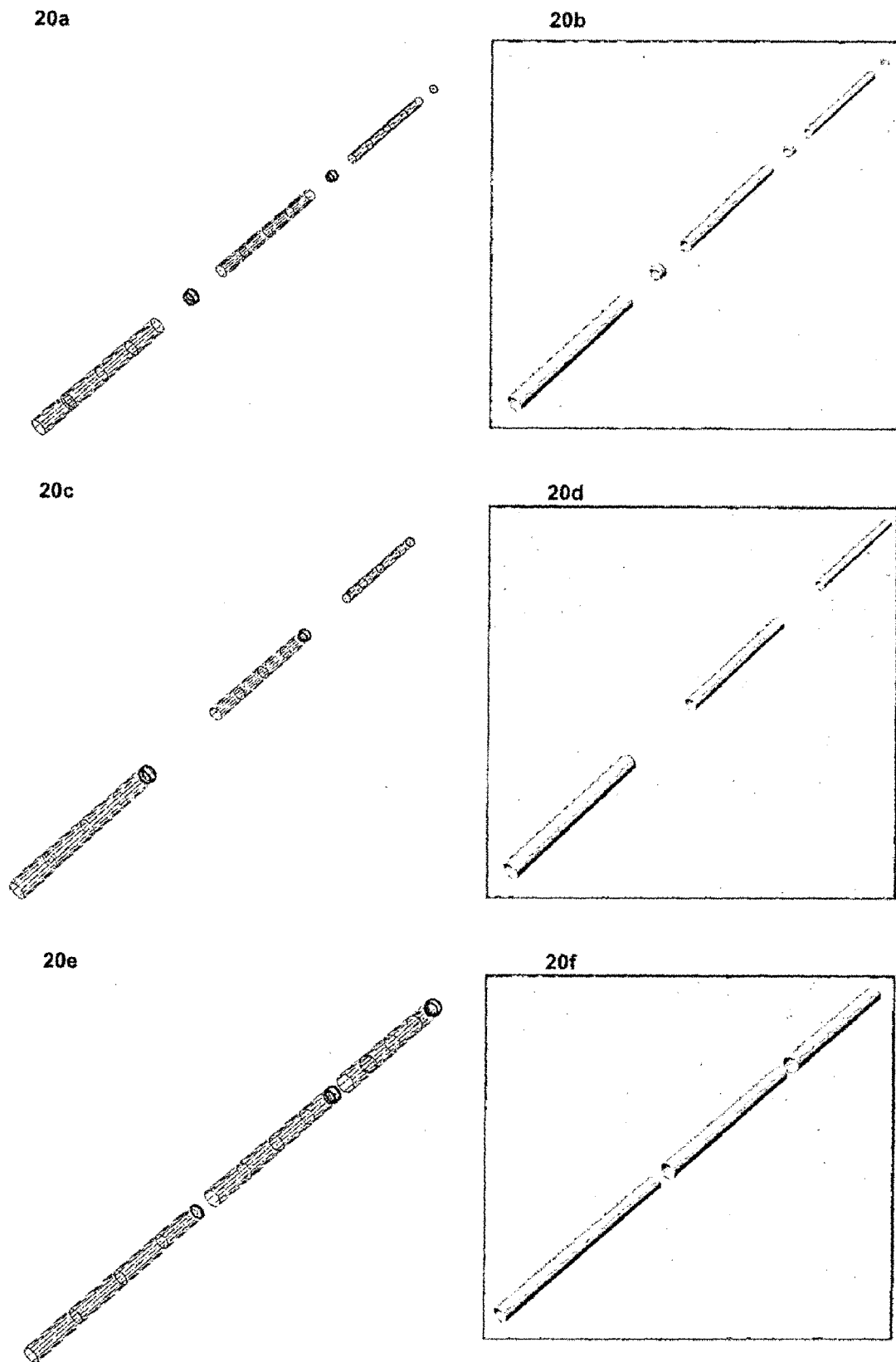
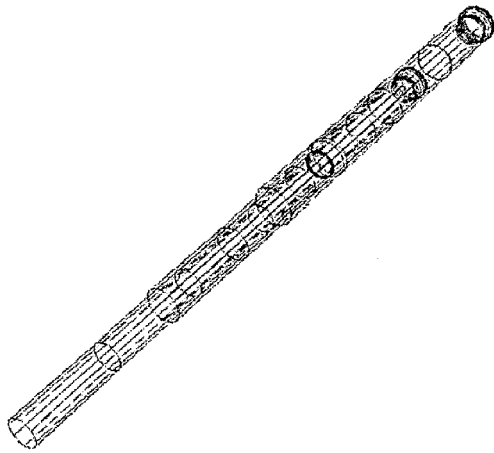
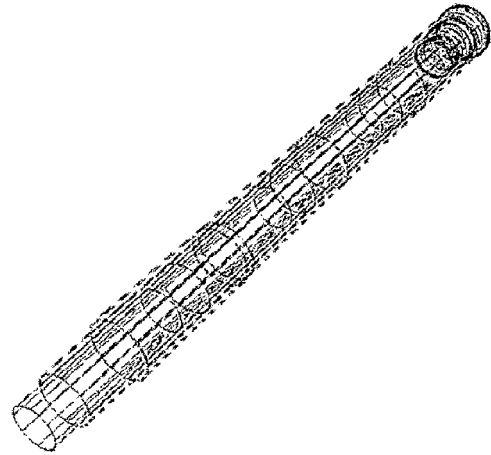


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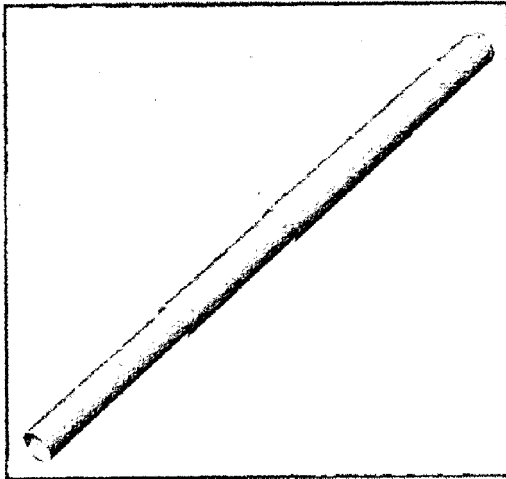
21a



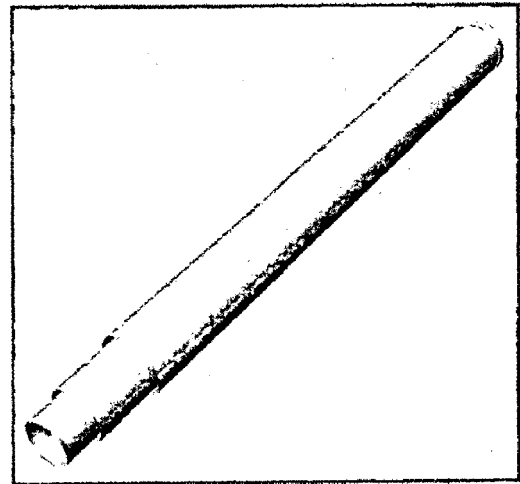
21b



21c



21d



21e



21f

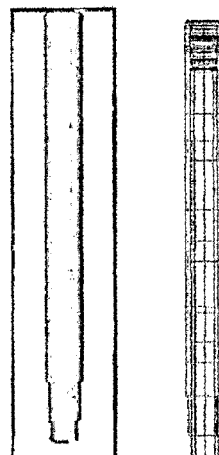


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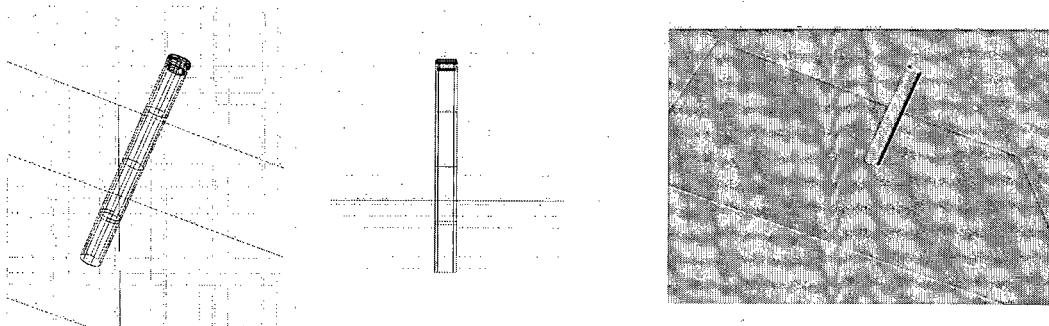


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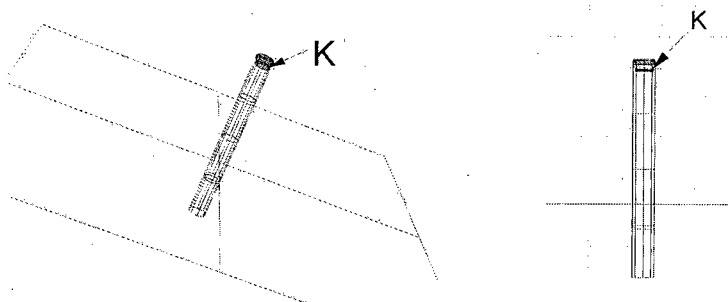


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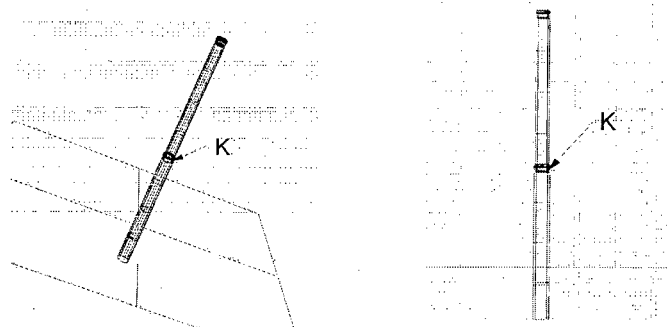


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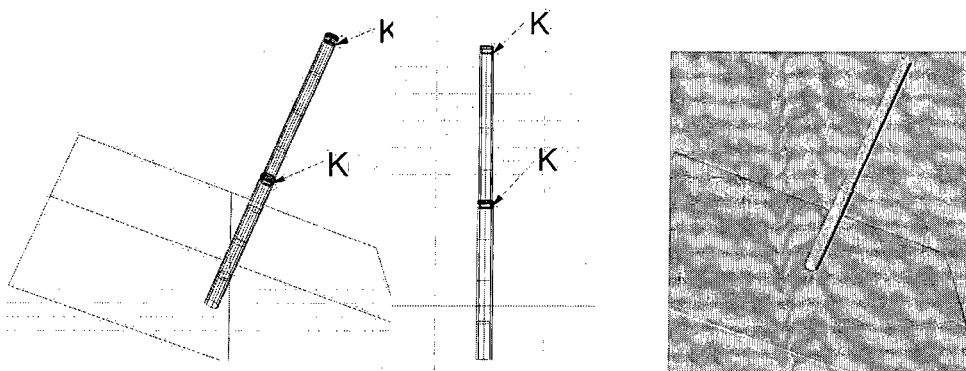


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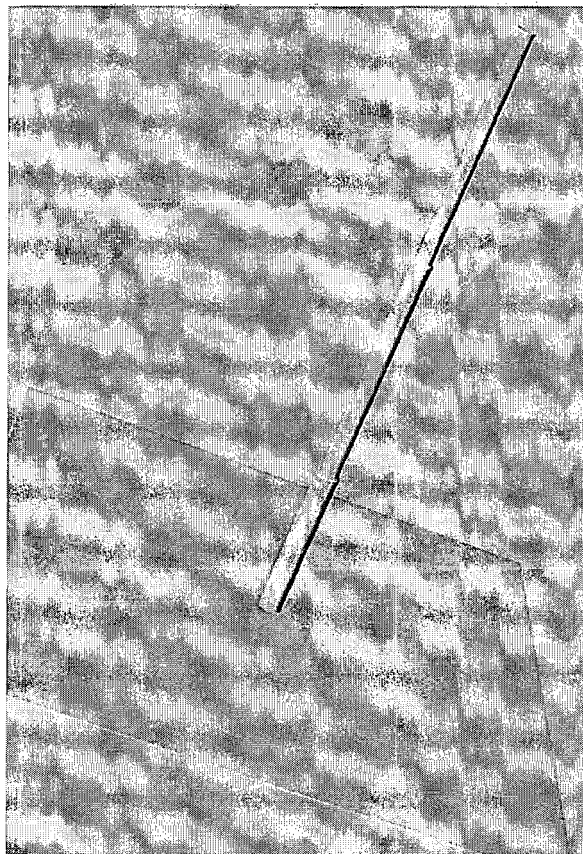
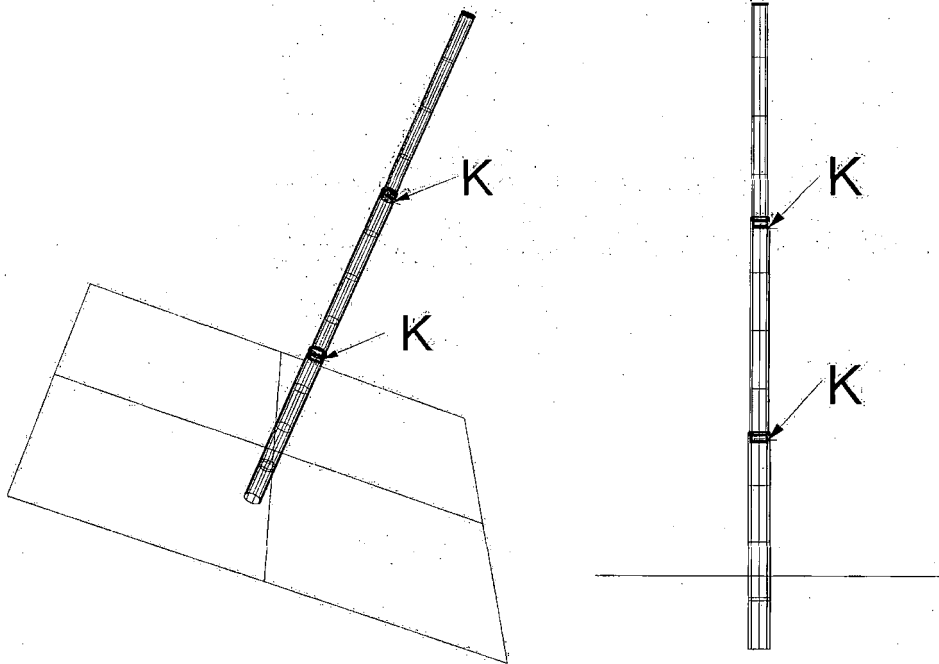


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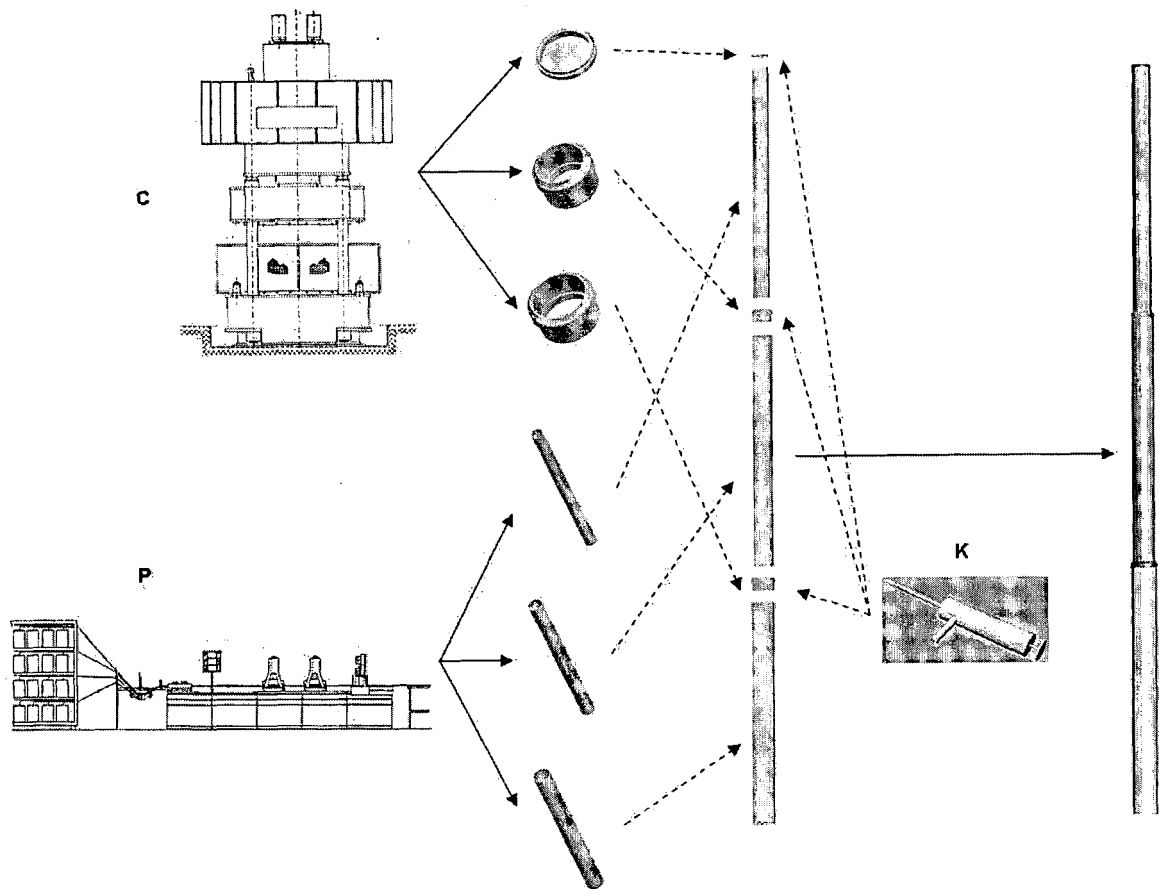
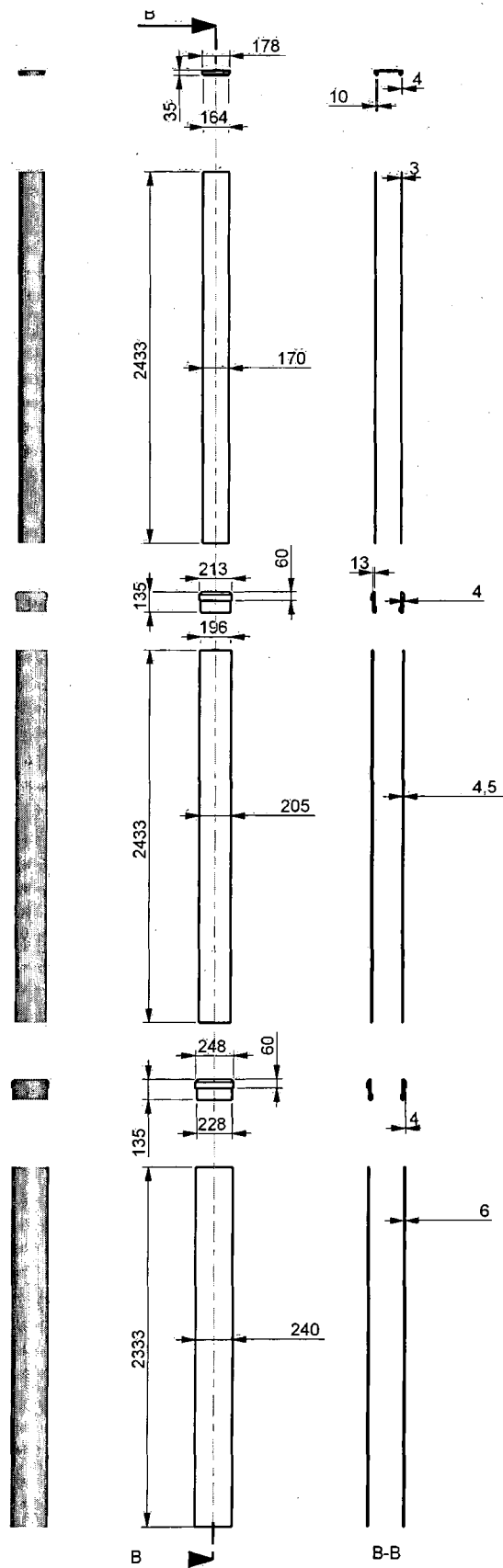


Figure 28



REFERENCES CITED IN THE DESCRIPTION

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- WO 2005067544 A2 [0008]