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(72) Inventor: **Igot, Alain**
6740 Etalle (BE)

(74) Representative: **Beissel, Jean et al**
Office Ernest T. Freylinger S.A.
234, route d'Arlon
B.P. 48
8001 Strassen (LU)

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(71) Applicant: **Delphi Technologies, Inc.**
Troy, MI 48007 (US)

(54) Method of assembly of ignition pencil coils

(57) A method of assembly of ignition pencil coils comprises the steps of:

- providing a leadframe (14) comprising tracks (16) for the electrical connection of said ignition pencil coils (12);
- overmolding said leadframe (14) with a polymer so

as to form a casing (20) for said tracks (16), while leaving accessible track terminals (22) for connecting coil terminals (26) of said ignition pencil coils (12); and

- fastening said ignition pencil coils (12) to said casing (20) and connecting electrically said coil terminals (26) to said accessible track terminals (22).

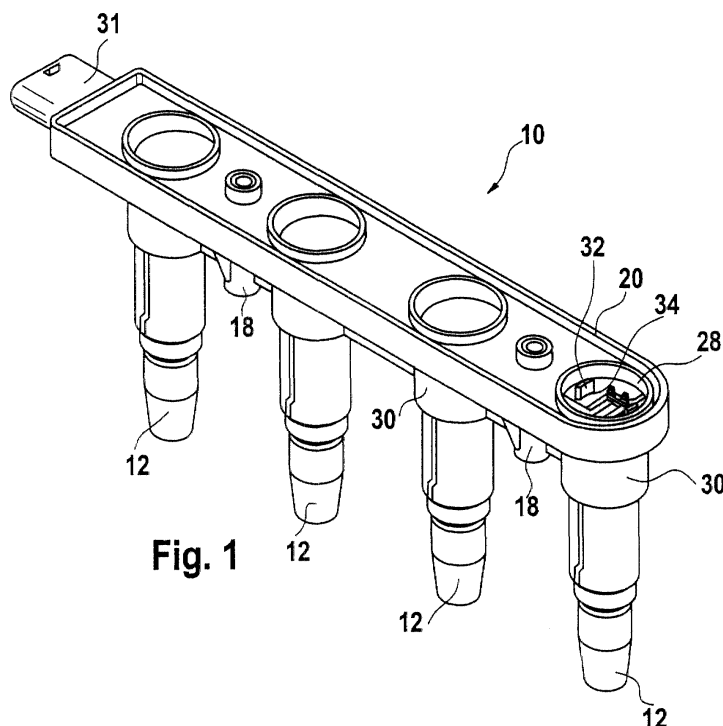


Fig. 1

EP 1 146 227 A1

Description

Field of the invention

[0001] The present invention generally relates to a method of assembly of ignition pencil coils.

Background of the invention

[0002] Recent developments in ignition systems have led to the introduction of ignition pencil coils. The actual practice is to assemble each pencil coil individually on a cylinder head. However, it would be profitable to find a simple method for assembling those ignition pencil coils into a unit of ignition pencil coils, to simplify their mounting on cylinder heads.

[0003] In today's prototypes, a unit of ignition pencil coils comprises one steel bracket acting as rigid support, on which the four pencil coils (one per cylinder) are fastened by means of screws, with one large seal between the coils and the bracket. A printed circuit board connects the four pencil coils to a primary connector mounted at one end of the printed circuit board. For protection, this assembly is generally placed into a plastic housing, which is mounted on the bracket by means of two screws. Such a unit of pencil coils requires a complicated assembly process, thus resulting in high manufacturing costs and risks of manufacturing faults. Hence, there is a strong need for a simpler method of assembly of ignition pencil coils.

Object of the invention

[0004] The object of the present invention is to provide a simple and efficient method of assembly of ignition pencil coils. This object is achieved by a method as claimed in claim 1.

Summary of the invention

[0005] A method of assembly of ignition pencil coils in accordance with the invention comprises the following steps:

- (a) providing a leadframe comprising tracks for the electrical connection of said ignition pencil coils;
- (b) overmolding said leadframe with a polymer so as to form a casing for said tracks while leaving accessible track terminals for connecting coil terminals of said ignition pencil coils ; and
- (c) fastening said ignition pencil coils to said casing and connecting electrically said coil terminals to said accessible track terminals.

[0006] The great advantage of the method of the invention is its simplicity. Within a few steps, the ignition

pencil coils are assembled into a unit of ignition pencil coils. In conventional units of pencil coils, the support for the coils is supplied by a bracket and the electrical connection by a printed circuit board. In the present method, the use of an overmolded leadframe provides the electrical circuit for connecting the ignition pencil coils as well as a support for the latter. Moreover, the casing protects and insulates the tracks. The pencil coils may be fastened to the casing by thermal or ultrasonic welding. A plastic portion of the body of the pencil coils can e.g. be soldered to the casing. The electrical connection between the coil terminals and the accessible track terminals may be carried out by welding or soldering. However, this electrical connection does not necessarily require soldering as the coils are fixed to the casing. Indeed, the coil terminals may be formed as female terminals for receiving the male-shaped accessible track terminals.

[0007] The casing may comprise first fastening means and each ignition pencil coil may comprises second fastening means, which are capable of cooperating with the first fastening means for fastening said ignition pencil coils to said casing. The first and second means may be e.g. at least partially soldered or welded together. It is also possible to deform one of the fastening means. However, the first and second means may be advantageously designed so as to provide a snap-fit connection, thereby enabling a very simple and rapid fastening of the coils to the casing.

[0008] In a preferred embodiment, the first fastening means comprises at least one slot per pencil coil and the second fastening means of each pencil coil comprises at least one tab, which can be received in a respective slot of the first fastening means. As explained before, the coils may be fastened to the casing by welding the tabs to the casing, once inserted through the slots. Another possibility is to heat the tabs, once inserted through the slot, to deform them. However, the tabs and slots may alternatively be designed so as to provide a snap-fit connection. This can be achieved by providing a nose at the end of each tab. It shall further be noticed that the location of the slots in the casing can be used to define an orientation, or positioning, of the pencil coils. Thus connection errors can be avoided, as there is only one way of assembling the ignition coils to the casing.

[0009] Advantageously, openings are provided in the casing, each opening being capable of receiving an end of an ignition coil. Such openings may serve for guiding and positioning the ignition coils during assembly of the ignition coils. The coil end bearing the coil terminals shall be in particular received in such an opening. These openings are preferably arranged during step (b) and formed as sockets. Such sockets may ensure a rigid holding of the ignition coils after assembly.

[0010] Preferably, the leadframe is stamped out of a metal sheet. Therefore, after stamping out, the tracks of the leadframe are generally held together by spacers.

Those spacers are preferably cut before, during or after step (b) in order to individualize said tracks.

[0011] Track ends and spacers may be at least partially bent to form accessible track terminals. This will preferably take place after the cutting, at least for the spacers. The accessible track terminals are advantageously perpendicular to the tracks, so as to offer a large surface of contact with the coil terminals.

[0012] One end of the leadframe is preferably formed as a primary connector. In other words, the tracks at this end of the leadframe are shaped and spaced as the terminals of a conventional connector. Then, during step (b) a housing may be formed around said primary connector to ensure an easy and watertight connection of the ignition coil unit to a connector of the ignition system.

[0013] Advantageously, mounting bushings are fixed to the leadframe, preferably to the ground-tracks thereof, before step (b), and are subsequently overmolded with said leadframe. It follows that the ignition coil unit can be directly mounted on a cylinder head. Moreover, the mounting bushings ensure the grounding of the electric circuit of the ignition coil unit.

[0014] A RFI capacitor may be mounted to the leadframe before step (b) and overmolded with the leadframe.

[0015] Preferably, said coil terminals and said track terminals, as well as said connector tabs are embedded in a curable resin. Hence, the electrical connections are protected and the ignition coils are locked in their sockets.

[0016] The method of the invention is particularly suited for assembling ignition pencil coils. Within a few simple steps, there is obtained an engine mountable unit of ignition pencil coils, consistent with the actual requirements of ignition systems: use of ignition pencils coils, integrated RFI capacitor, good sealing of electrical connections. Moreover, the method of assembly is very simple, namely because of a reduced number of elements. This results in a reduction in cost and weight, and in improved performance of unit ignition pencil coils.

Brief description of the drawings

[0017] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig.1: is a view of an unit of ignition pencil coils obtained according to a preferred embodiment of the method of the invention;

Fig.2: is a top view of the unit shown in Fig.1;

Fig.3: is a partial view of the unit shown in Fig.1, without the casing;

Fig.4: shows the casing before introduction of the pencil coils.

Detailed description of a preferred embodiment

[0018] In order to rapidly and easily assemble ignition coils into a unit of ignition pencil coils, the present invention proposes the use of an overmolded leadframe, i.e. a structure featuring the electrical circuit for connecting the pencil coils and capable of supporting the pencil coils. A unit 10 of ignition pencil coils, shown in Fig.1, comprises four ignition pencil coils 12. This unit 10 has been obtained in accordance with a preferred embodiment of the method of the invention, which will now be described in detail.

[0019] In a first method step (a), a leadframe 14 (partially shown in Fig.3) is stamped out of a metal sheet. At the issue of the stamping machine, the leadframe 14 consists of tracks 16 held together by spacers 17. The tracks 16 provide the electrical circuit necessary to connect the ignition pencil coils 12 to the ignition system (not shown). The spacers 17 are metal strips left from the metal sheet to hold the tracks 16. At one of its ends, the leadframe 14 is formed as a primary connector, for connection with the ignition system (this end of the leadframe 14 is not shown). This means that at this end of the leadframe 14, the tracks 16 are shaped and spaced as the terminals of a conventional connector.

[0020] Advantageously, two mounting bushings 18 are subsequently fixed to the leadframe 14. They will later permit the insertion of screws through the ignition coil unit 10 for its mounting on the cylinder head of an engine. It shall be noted that an optional RFI capacitor (not shown) may be connected to the leadframe 14 at this point of the method.

[0021] In the next step (b), the leadframe 14 is overmolded with a polymer so as to form a casing 20 for the tracks 16. The part as obtained at the issue of the injection molding machine is shown in Fig.4. It consists of a plastic casing (casing 20) with inner electric circuit (tracks 16).

[0022] In fact, step (b) preferably comprises several sub-steps. Firstly, the leadframe 14 is placed into a mold. Then, the spacers 17 are cut in order to individualize the tracks 16, thereby forming the electric circuit. As a matter of fact, the mold is designed so that the tracks 16 may be kept in position after they have been individualized, i.e. after cutting of the spacers 17, and until the polymer is injected. It shall also be noticed that the positions of the spacers 17 in the leadframe 14 may be advantageously defined in such a way that some of them may serve as track terminals 22 after cutting. Once the spacers have been cut, all the parts of the circuit that shall serve as track terminals 22 are bent to an angle of 90° with regard to the rest of the tracks 16. This may be seen in Fig.3 where the ignition coil unit 10 of Fig.1 is illustrated without its casing 20. The parts of the circuit used as track terminals are preferably track ends 24 or spacers 17. It will be noticed that the cutting and bending could also take place after overmolding. In Fig.3, the pencil coils 12 are connected to the track terminals 22,

which is not yet the case at this step of the method. However, this figure shows the advantage of bent track terminals 22: a greater area of contact between coil terminals 26 and track terminals 22. It is also shown how the mounting bushings 18 are assembled to the leadframe 14, and will permit to ground the circuit once mounted onto the engine. Finally, a polymer is injected into the mold, and the tracks 16, together with the RFI capacitor and the bushings 18 are overmolded with the polymer. It is clear that in order to connect the track terminals 22 to the coil terminals 26, the track terminals 22 have to be accessible. Therefore, the mold is preferably designed in such a way that the casing comprises openings 28, in which the track terminals 22 protrude, and are thereby accessible. Such an opening 28 is represented in Fig.2, which shows a top view of the ignition coil unit 10 of Fig.1 (only one opening 28 per casing 20 is shown in the Figures). As a matter of fact, the mold is preferably designed so that the casing 20 is provided with socket-shaped openings 28, which shall serve for positioning, guiding and connecting the pencil coils 12. The sockets are indicated by reference sign 30 and can be easily identified in Fig.4.

[0023] As mentioned earlier, one end of the leadframe 14 is formed as a primary connector. Therefore, during the overmolding at step (b) a housing 31 (see Fig.4) is formed around this primary connector to permit an easy and watertight connection of the ignition coil unit 10 to a primary connector of the ignition system.

[0024] Once the casing 20 is obtained, a pencil coil 12 is introduced into each socket 30 so as to bring the coil terminals 26 in contact with the track terminals 22. It shall be noticed that the pencil coils 12 are advantageously provided with two orientation tabs 32 (see Fig. 4 and Fig.1) that fit into two slots 34 of the casing 20. Those tabs 32 and slots 34 may differ in size, shape or position, so that there is only one way of inserting the pencil coils 12 in the sockets 30, thereby avoiding connection errors of the coils 12.

[0025] In the next step (c), the pencil coils 12 are firstly fastened to the casing 20, e.g. by welding the tabs 32 to the casing 20. Both thermal and ultrasonic welding is appropriate. Then, the coil terminals 26 are firmly attached to the track terminals 22 to ensure a good electrical connection. This connection is shown in Fig.3 and can be carried out by soldering or welding, and preferably by spot-welding.

[0026] After that, a curable resin is poured in each opening 28 in order to seal them and to embed the track terminals 22 and coil terminals 26 in the resin to insulate them. As a result, the connections are protected from the environment and the pencil coils 12 are securely locked in their sockets 30.

[0027] It shall be appreciated that the ignition coil unit 10 obtained with the present method, as shown in Fig. 1, is ready for use. It can easily be mounted on a cylinder head by inserting two screws through the bushings 18 and screwing in the cylinder head. The ignition coil unit

10 is sealed, features an integrated RFI capacitor, mounting bushings, ignition pencil coils, and a primary connector.

Claims

1. A method of assembly of ignition pencil coils comprising the steps of:

(a) providing a leadframe (14) comprising tracks (16) for the electrical connection of said ignition pencil coils (12);

(b) overmolding said leadframe (14) with a polymer so as to form a casing (20) for said tracks (16), while leaving accessible track terminals (22) for connecting coil terminals (26) of said ignition pencil coils (12); and

(c) fastening said ignition pencil coils (12) to said casing (20) and connecting electrically said coil terminals (26) to said accessible track terminals (22).

2. The method according to claim 1, **characterized in that** said coil terminals (26) and said accessible track terminals (22) are connected by welding or soldering.

3. The method according to claim 1 or 2, **characterized in that** said ignition pencil coils (12) are fastened to said casing (20) by thermal or ultrasonic welding.

4. The method according to anyone of the preceding claims, **characterized by** the step of providing openings (28) in said casing (20), each opening (28) being capable of receiving an end of an ignition pencil coil (12).

5. The method according to claim 4, **characterized in that** said openings (28) are arranged during step (b) and are formed as sockets (30).

6. The method according to anyone of the preceding claims, **characterized in that** said casing (20) comprises first fastening means and each ignition pencil coil (12) comprises second fastening means, which are capable of cooperating with said first fastening means for fastening said ignition pencil coils (12) to said casing (20).

7. The method according to claim 6, **characterized in that** said first fastening means comprises at least one slot (34) per pencil coil (12) and **in that** said second fastening means of each pencil coil (12) comprises at least one tab (32), which can be re-

ceived in said at least one slot (34).

8. The method according to claim 6 or 7, **characterized in that** said first and second fastening means are designed so as to provide a snap-fit connection. 5
9. The method according to anyone of the preceding claims, **characterized in that** said leadframe (14) is stamped out of a metal sheet. 10
10. The method according to claim 9, wherein after stamping out, said tracks (16) are held together by spacers (17), **characterized in that** said spacers (17) are cut in order to individualize said tracks (16) before, during or after step (b). 15
11. The method according to claim 10, **characterized in that** at least one of said tracks (16) is partially bent so as to form an accessible track terminal (26). 20
12. The method according to claim 10 or 11, **characterized in that** after cutting, at least one of said spacers (17) is partially bent to form an accessible track terminal (22). 25
13. The method according to anyone of the preceding claims, **characterized in that** one end of said leadframe (14) is formed as a primary connector; and **in that** during step (b) a housing (31) is formed around said primary connector. 30
14. The method according to anyone of the preceding claims, **characterized in that** mounting bushings (18) are fixed to the leadframe (14) before step (b); and **in that** said mounting bushings (18) are overmolded with said leadframe (14). 35
15. The method according to anyone of the preceding claims, **characterized in that** a RFI capacitor is mounted on said leadframe (14) before step (b); and **in that** said RFI capacitor is overmolded with said leadframe (14). 40
16. The method according to anyone of the preceding claims, **characterized by** the step of embedding said coil terminals (26) and said track terminals (22) in a curable resin. 45

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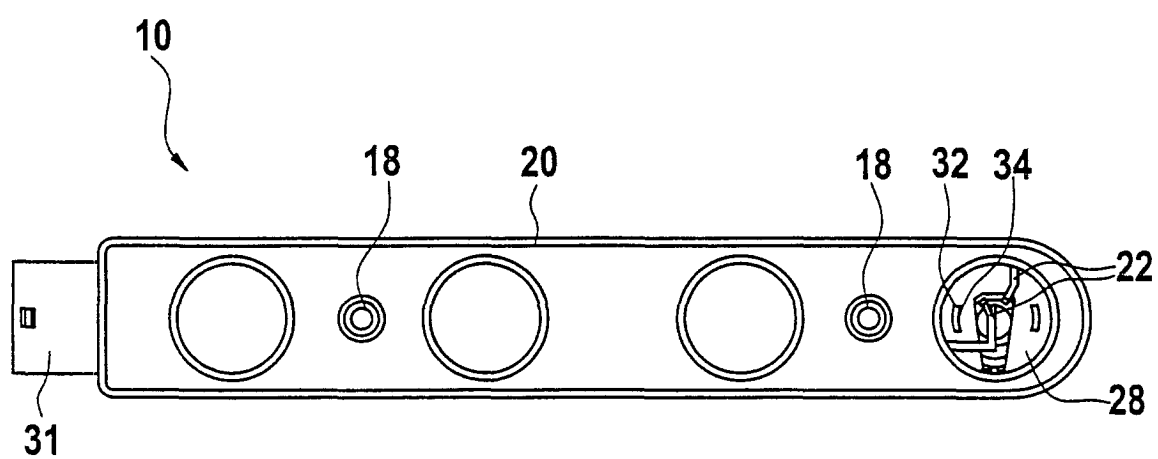
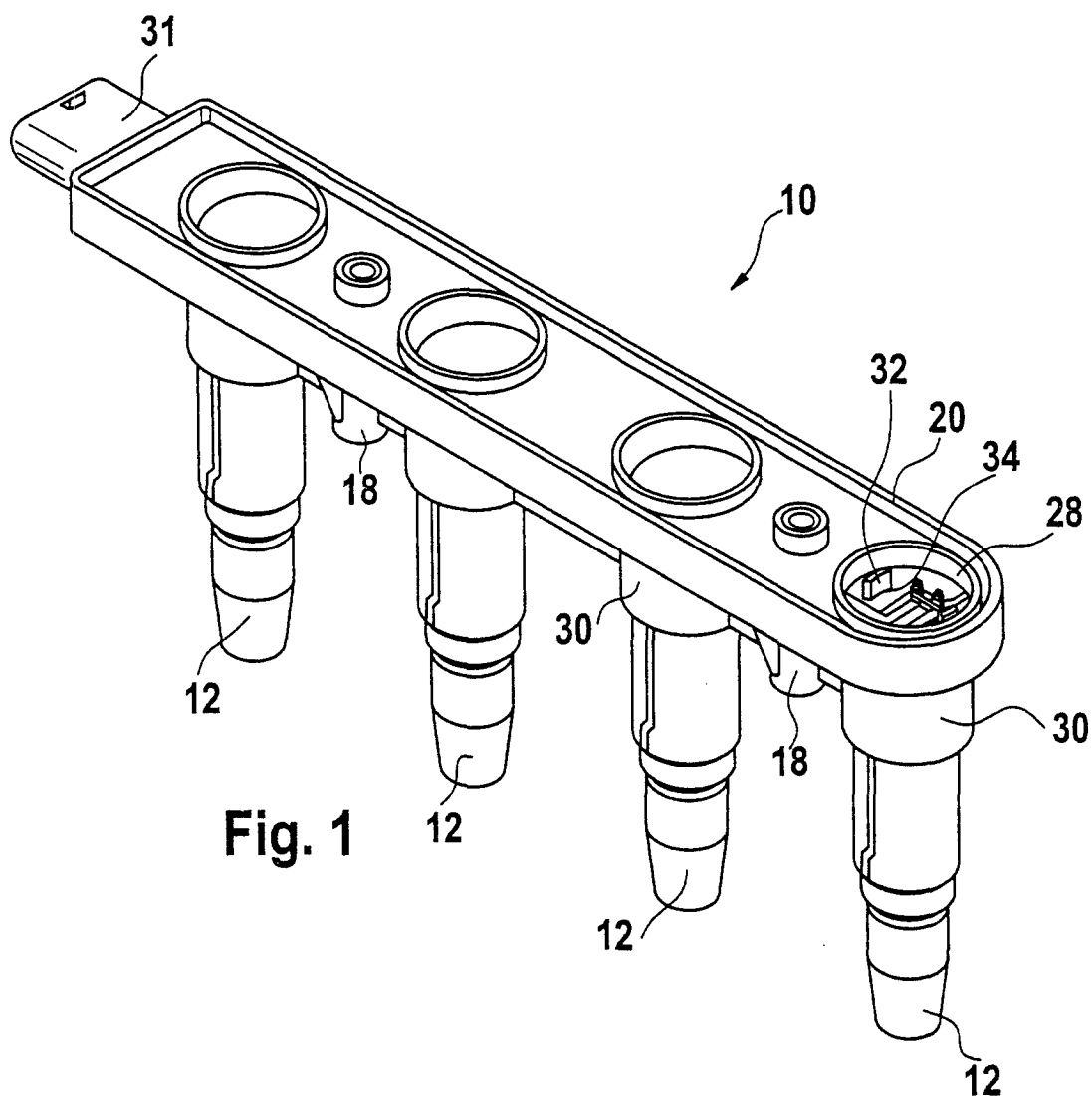


Fig. 3

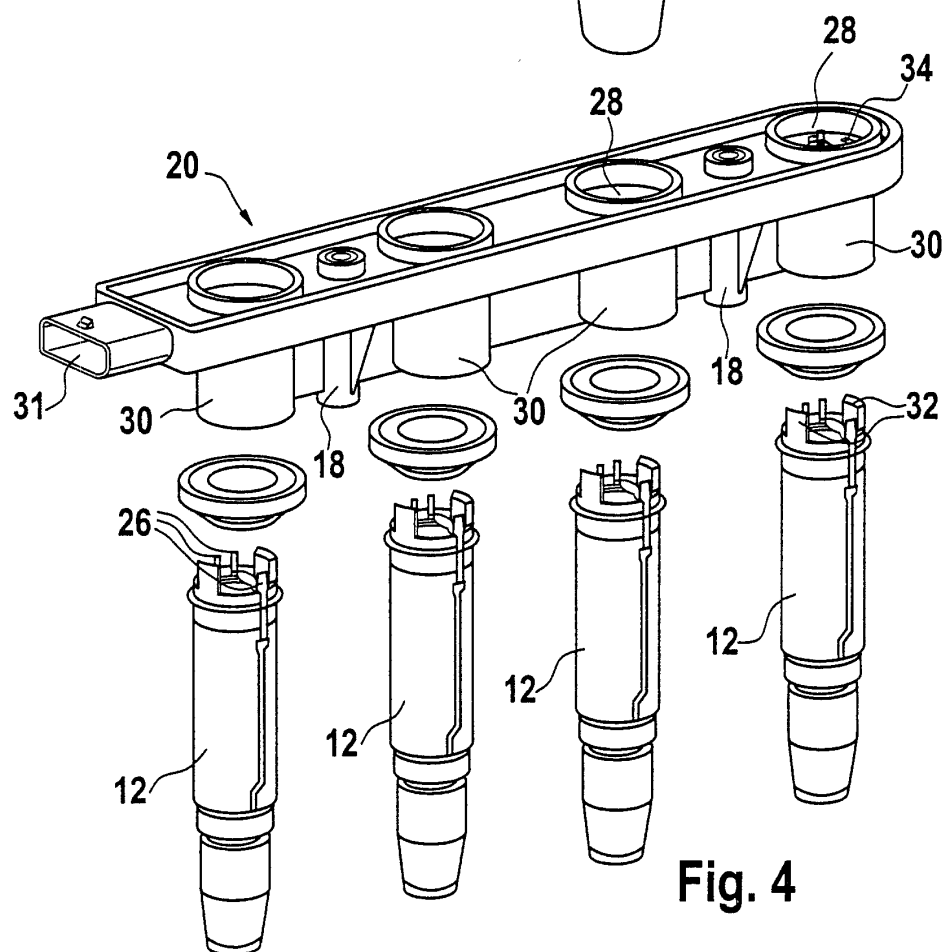
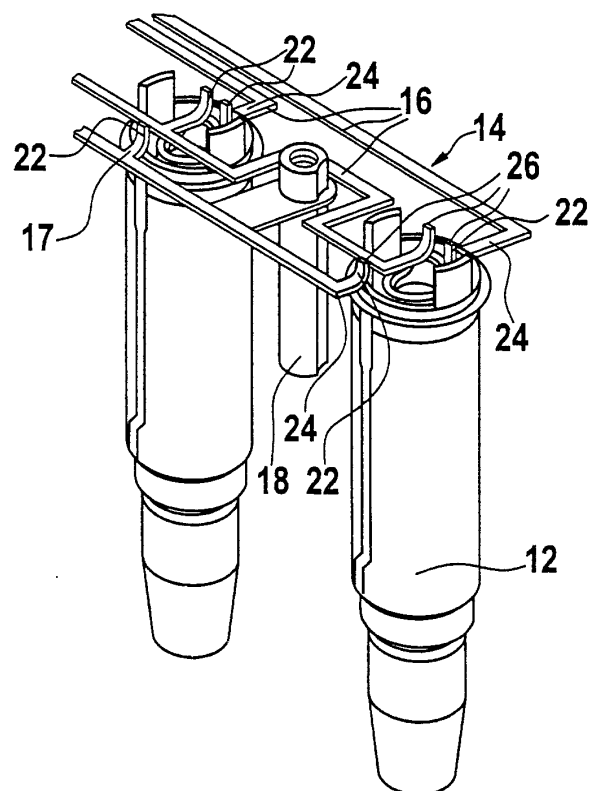


Fig. 4



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 01 10 4686

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19 July 2001	Examiner Trotureau, D
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 01 10 4686

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
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