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(54) **An internal combustion engine with controlled ignition and a connector for connecting an ignition coil and a spark plug for the engine.**

(57) The connector (10) includes a tubular insulating element (11) with a first end (11a) which is intended to be inserted in a recess in the engine (8) and fitted onto a plug (SP), and a further or second end (11b) which is intended to project from the recess (8) for connection to an output terminal (7) of the coil (3). A conductor member (12) is disposed in the tubular element (11) for establishing a conductive path between the coil and the plug (SP). The surface of the engine (1, 2) surrounding the mouth of each recess (8) has an annular, collar-like raised portion (13) and the second end (11b) of the tubular element (11) of the connector (10) has an integral, bell-like external skirt (14) whose edge portion bears against the surface of the engine (1, 2) surrounding the collar (13) in the mounted condition.

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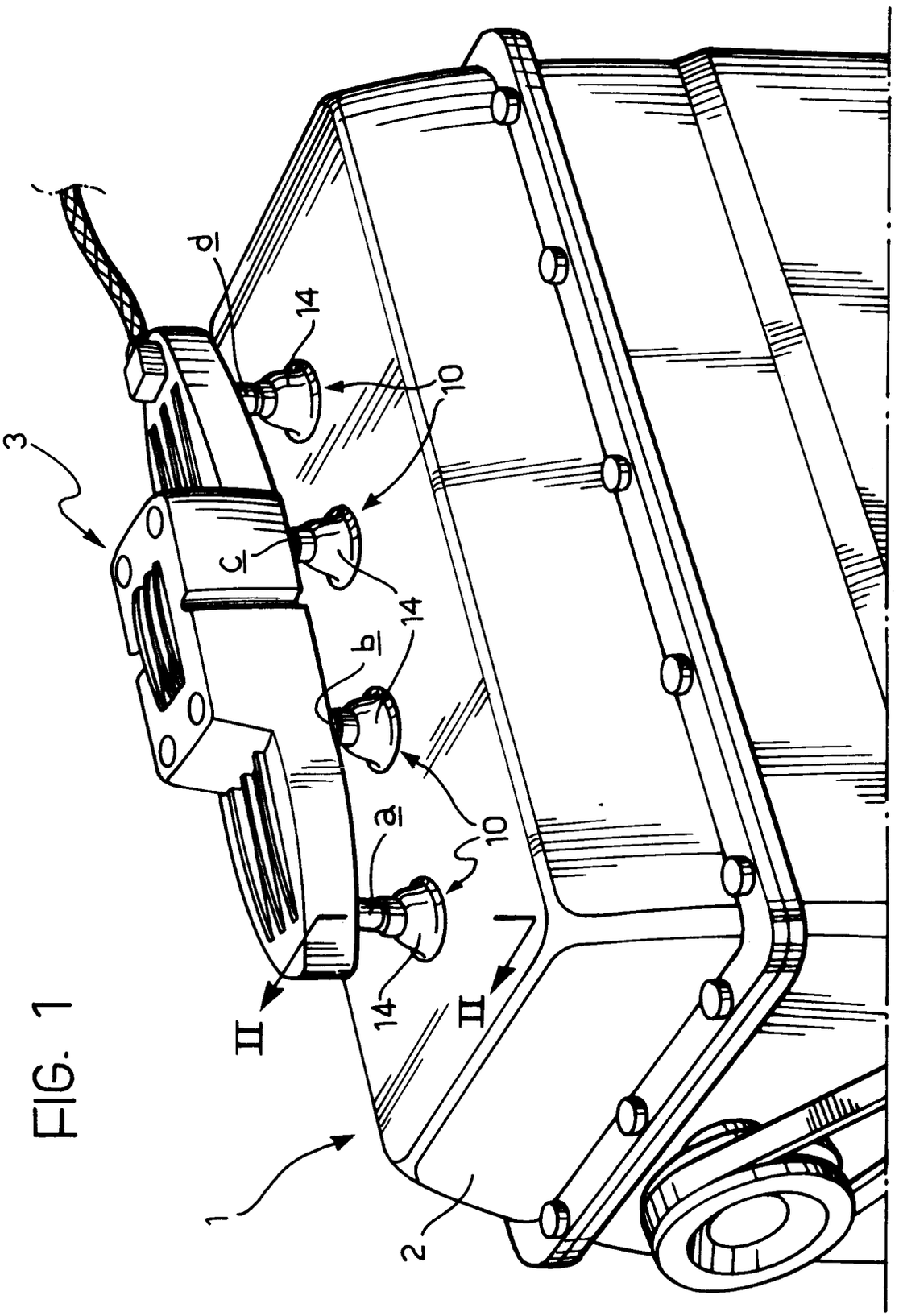


FIG. 1

The present invention relates to an internal combustion engine with an ignition system including at least one "plug-top" ignition coil which is connected by a connector to an associated spark plug mounted in a recess or seat in the engine, the connector comprising:

a tubular element of electrically-insulating material with a first end which is adapted to be inserted in the recess and fitted onto the plug, and a further or second end which is intended to project from the recess for connection to an output terminal of the coil, and

at least one conductor member disposed in the tubular element for establishing a conductive path between the output terminal of the coil and the plug.

Recently, the use of ignition systems which have static electronic distribution with ignition coils or transformers mounted directly on the engine near the associated spark plugs has become increasingly widespread. Solutions in which a single ignition coil is connected to one spark plug or to a pair of spark plugs have been proposed for this purpose. A solution of this type is described, for example, in Italian application No. 53206-B/89.

According to another solution, such as, for example, the solution described in U.S. patent No. 4,767,639, an integrated coil ignition unit associated with the engine includes a plurality of ignition coils or transformers in a single support casing. This integrated unit has a plurality of outputs, each of which is connected to an associated spark plug by means of a respective connector.

The use of a connector including a tubular element of insulating material, one end of which has an integral tubular skirt with external peripheral projections which are intended to be force-fitted, that is, fitted with interference, in the mouth of the recess in which the plug is housed, has recently been proposed for interconnecting the output of the "plug-top" ignition coil and the associated spark plug.

This solution has the disadvantage that a certain amount of force is needed to insert the connector into the recess and to remove it therefrom, for example, when a plug has to be replaced.

This disadvantage is particularly noticeable in internal combustion engines with integrated coil ignition units of the type described, for example, in the aforementioned United States patent, in which a plurality of connectors have to be inserted in or removed from the corresponding recesses in the engine at the same time.

A further disadvantage of the prior art described above lies in the fact that the dimensional tolerances of the recesses in the engine in which the plugs are housed are quite critical.

These disadvantages are all the more significant when the ignition system is to be fitted and, in particular, when the connectors are to be inserted in the recesses in the engine by automatic assembly systems.

The object of the present invention is to identify solutions which solve the problems of the prior art described above.

According to the invention, this object is achieved by an internal combustion engine and a connector for connecting a coil and a spark plug having the characteristics defined in the appended claims.

Further characteristics and advantages of the invention will become clear from the detailed description which follows, with reference to the appended drawings provided purely by way of non-limiting example, in which:

Figure 1 is a partial perspective view of an internal combustion engine according to the invention,

Figure 2 is a partially sectioned view taken on the line II-II of Figure 1, and

Figures 3 and 4 are partially sectioned views showing details of two variants of the connector for connecting coils and plugs, on an enlarged scale.

In Figure 1, an internal combustion engine, for example, a four-cylinder, four-stroke engine, is generally indicated 1. An integrated coil ignition unit, generally indicated 3, is mounted on the head 2 of the engine. This unit is, for example, of the type described in European patent application No. 91830163.1 and comprises a support casing which houses two ignition transformers, each for connection to a pair of spark plugs of the engine. For this purpose, the integrated unit 3 has four high-tension output terminals, indicated a, b, c and d, each of which is connected electrically to a respective spark plug in the manner which will be described below.

Figure 2 shows the high-tension output a of the integrated unit 3: this output includes an insulating element 5, the end of which has a recess 6 with an output terminal 7 of electrically-conductive material fixed to its inner end.

Recesses or seats 8 are formed in the engine 1 in known manner (Figures 2 to 4) and a respective spark plug SP is mounted in the bottom of each.

With reference to Figure 2, the non-earthed terminal 9 of each plug SP is connected electrically to the terminal 7 of a respective output of the integrated unit 3 by means of a connector, generally indicated 10. This connector comprises a tubular element 11 of electrically-insulating material, for example, elastomeric material, having a first end 11a inserted in the recess 8 in which the plug SP is mounted and fitted onto the end of the plug. The tubular element 11 has a second end, indicated 11b, which projects from the recess 8 and is connected to an output terminal 5 of the integrated unit 3.

A conductor member 12 is disposed in the tubular insulating element 11 and, in the embodiment illustrated, is constituted by a helical metal spring. This

member forms an electrically-conductive path between an output terminal 7 of the integrated unit 3 and the associated plug SP.

As can be seen in Figure 2, the surface of the engine surrounding the mouth of each recess 8 has an annular, collar-like raised portion 13.

The end 11a of each tubular element 11 has a flexible, integral, bell-like external skirt 14 facing its other end 11a. In the mounted condition, the edge portion of the skirt 14 bears against the surface of the engine surrounding the collar 13 and is resiliently deformed, as can be seen in Figure 2.

The transverse dimensions of the tubular element 11 of each connector are such that it extends in the respective recess 8 in the engine with radial clearance.

The opening in the end 11a of each tubular element 11 has a substantially conical, outwardly-divergent surface for facilitating the fitting of the tubular element 11 onto the end of the associated plug SP.

Conveniently, the end 11a of each tubular element 11 has a tapered, preferably conical, external end surface for facilitating the insertion and centering of the tubular element 11 in a corresponding recess 8 in the engine.

These characteristics of the shape of its end 11a enable each tubular element 11 to be inserted easily in the recess 8, even by automatic assembly systems, without difficulty and without sticking.

In the mounted condition, the skirts 14 of the connectors and the associated raised collars 13 surrounding the mouths of the recesses 8 in the engine prevent the ingress of water, dust or dirt to the recesses.

Since the tubular elements 11 of the connectors extend into the recesses 8 in the engine with radial clearance, extremely small forces are needed to insert them in or remove them from the recesses. This is particularly valuable when the ignition coils or transformers are incorporated in a single integrated unit such as that shown in Figure 3. Moreover, the dimensional tolerances of the recesses 8 are no longer critical.

Small breather holes may be formed in the skirt 14 to allow the passage of air between the interiors of the recesses 8 and the atmosphere surrounding the engine.

Alternatively, at least one small breather channel or groove, such as that indicated 20 in Figure 3, may be formed for the same purpose in the internal surface of the skirt 14, starting from its edge.

In the variant shown in Figure 4, at least one breather passage 21 for each recess 8 is formed in the engine head 2, also for the same purpose, and extends between the recess 8 and a portion of the surface of the engine outside the region against which the skirt 14 of the associated connector 10 bears in the mounted condition. The breather passage 21 may be formed, for example, simply by milling.

Naturally, the principle of the invention remaining the same, the forms of embodiment and details of construction may be varied widely with respect to those described and illustrated purely by way of non-limiting example, without thereby departing from the scope of the present invention.

Claims

1. An internal combustion engine with an ignition system including at least one "plug-top" ignition coil (3) connected by a connector 10 to an associated spark plug (SP) mounted in a recess or seat (8) in the engine (1, 2); the connector (10) comprising:
a tubular element (11) of electrically-insulating material with a first end (11a) which is adapted to be inserted in the recess (8) and fitted onto the plug (SP) and a further or second end (11b) which is intended to project from the recess (8) for connection to an output terminal (7) of the coil (3), and at least one conductor member (12) disposed in the tubular element (11) for establishing a conductive path be tween the output terminal (7) of the coil and the plug (SP),
characterised in that:
the surface of the engine (1, 2) surrounding the mouth of the at least one recess (8) has an annular, collar-like raised portion (13), and in that
the second end (11b) of the tubular element (11) of the connecting device (10) has an integral, bell-like external skirt which faces the other end (11a) of the tubular element (11) and the edge portion of which bears against the surface of the engine (1, 2) surrounding the collar (13) in the mounted condition.

2. An engine according to Claim 1, characterised in that the skirt (14) of the tubular element (11) is flexible and its length is such that, when it bears against the surface of the engine (1, 2) surrounding the collar (13) in the mounted condition, its edge portion is deformed resiliently.

3. An engine according to Claim 1 or Claim 2, characterised in that, in the mounted condition, the tubular element (11) extends in the recess (8) of the engine (1, 2) with radial clearance.

4. An engine according to any one of the preceding claims, characterised in that the internal surface of the skirt (14) has at least one breather channel or groove(20)which extends from the edge of the skirt (14) and affords communication between the interior of the recess (8) and the atmosphere outside the skirt (14) when the connector (10) is in

the mounted condition.

5. An engine according to any one of Claims 1 to 3, characterised in that at least one breather passage (21) is formed therein (1,2) and extends between the recess (8) and a portion of the surface of the engine (1, 2) outside the region against which the skirt (14) of the connector (10) bears in the mounted condition.

6. An engine according to any one of the preceding claims, characterised in that the first end (11a) of the tubular element (11) has a substantially conical, outwardly-divergent opening (16) for facilitating the fitting of the tubular element (11) onto the associated plug (SP) .

7. An engine according to any one of the preceding claims, characterised in that the first end (11a) of the tubular element (11) has a tapered, preferably conical, external end surface (17) for facilitating the insertion and centering of the tubular element (11) in the recess (8) in the engine (1, 2).

8. A connector for connecting a "plug-top" ignition coil (3) and an associated spark plug (SP) mounted in a recess (8) in an internal combustion engine (1, 2), comprising:
a tubular element (11) of electrically-insulating material with a first end (11a) which is adapted to be inserted in the recess (8) and fitted onto the plug (SP) and a further or second end (11b) which is intended to project from the recess (8) for connection to an output terminal (7) of the coil (3), and at least one conductor member (12) disposed in the tubular element (11) for establishing a conductive path between the output terminal (7) of the coil and the plug (SP),
characterised in that the second end (11b) of the tubular element (11) has an integral, bell-like external skirt (14) which faces the other end (11a) of the tubular element (11) and the edge portion of which bears against the surface of the engine (1, 2) in the mounted condition.

9. A connector according to Claim 8, characterised in that the skirt (14) is flexible and its length is such that its edge portion is resiliently deformed when it bears against the surface of the engine (1, 2) surrounding the recess (8) in the mounted condition.

10. A connector according to Claim 9, characterised in that the transverse dimensions of the tubular element (11) are such that it extends in the recess (8) of the engine (1, 2) with radial clearance.

11. A connector according to Claim 8 or Claim 9, characterised in that the internal face of the skirt (14) has at least one breather channel or groove (20) which extends from the edge of the skirt (14) and affords communication between the interior of the recess (8) and the atmosphere outside the skirt (14) when the connector is in the mounted condition.

12. A connector according to any one of Claims 8 to 11, characterised in that the first end (11a) of the tubular element (11) has a substantially conical, outwardly-divergent opening (16) for facilitating the fitting of the tubular element (11) onto the associated plug (SP).

13. A connector according to one of Claims 8 to 12, characterised in that the first end (11a) of the tubular element (11) has a tapered, preferably conical, external end surface (17) for facilitating the insertion and centering of the tubular element (11) in the recess (8) in the engine (1, 2).

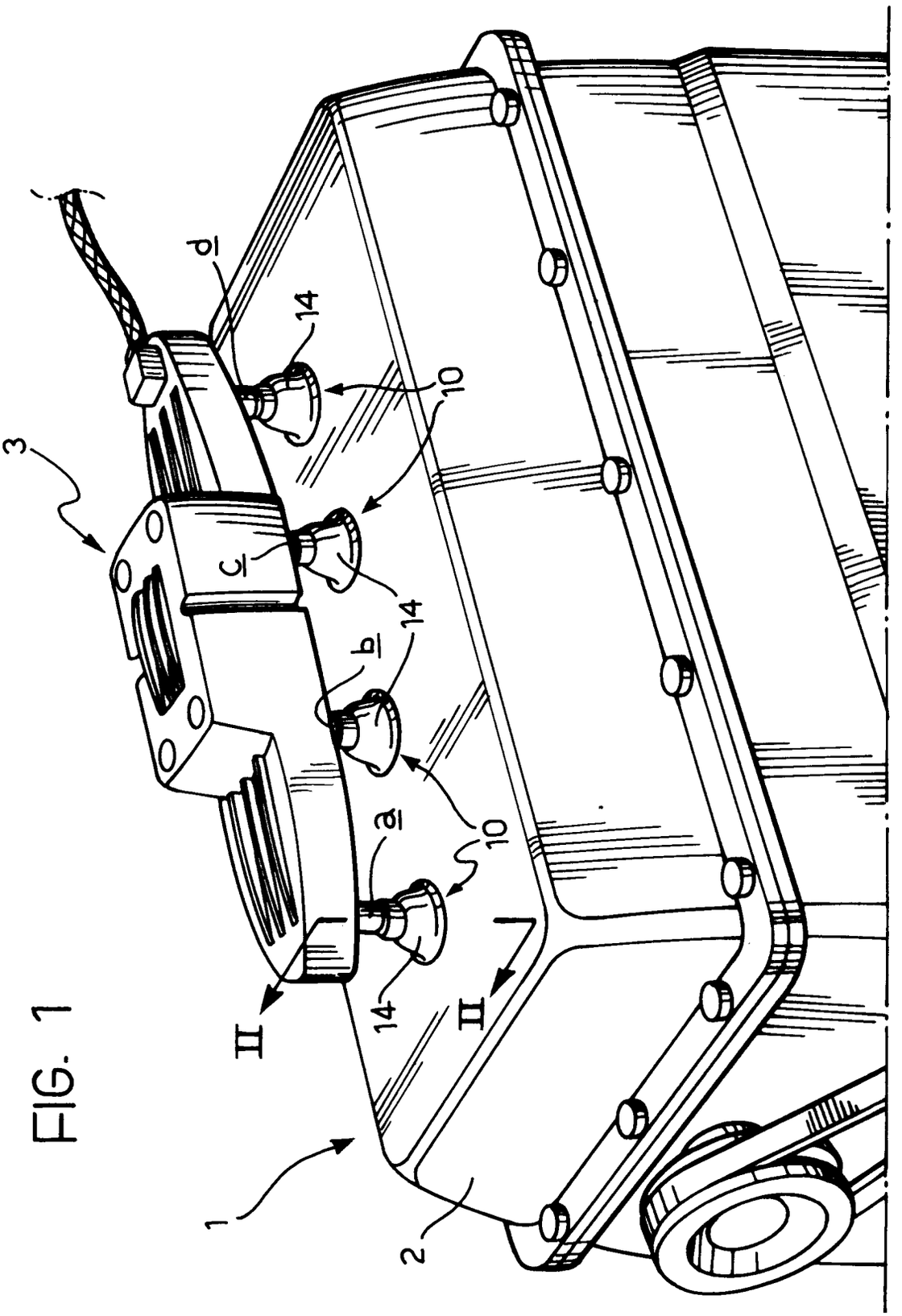


FIG. 1

FIG. 3

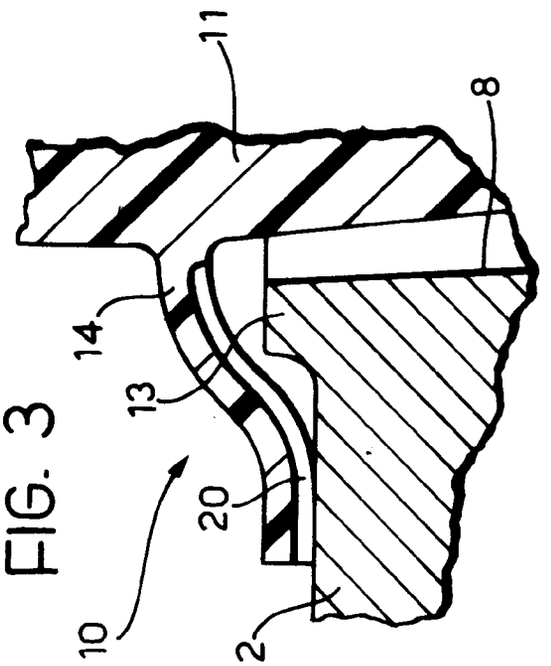


FIG. 4

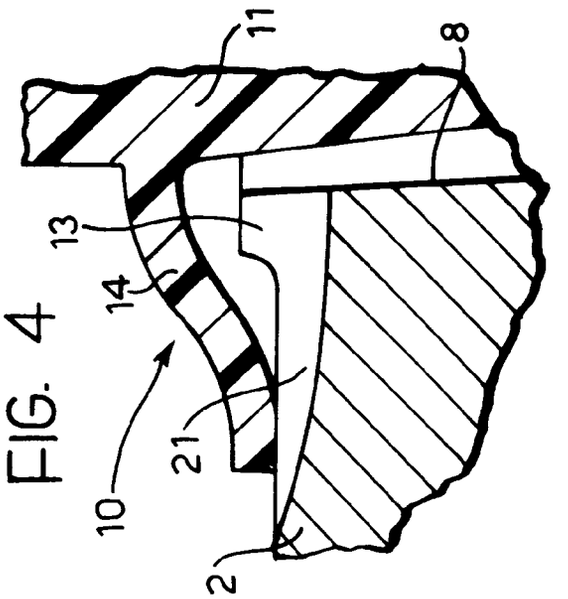
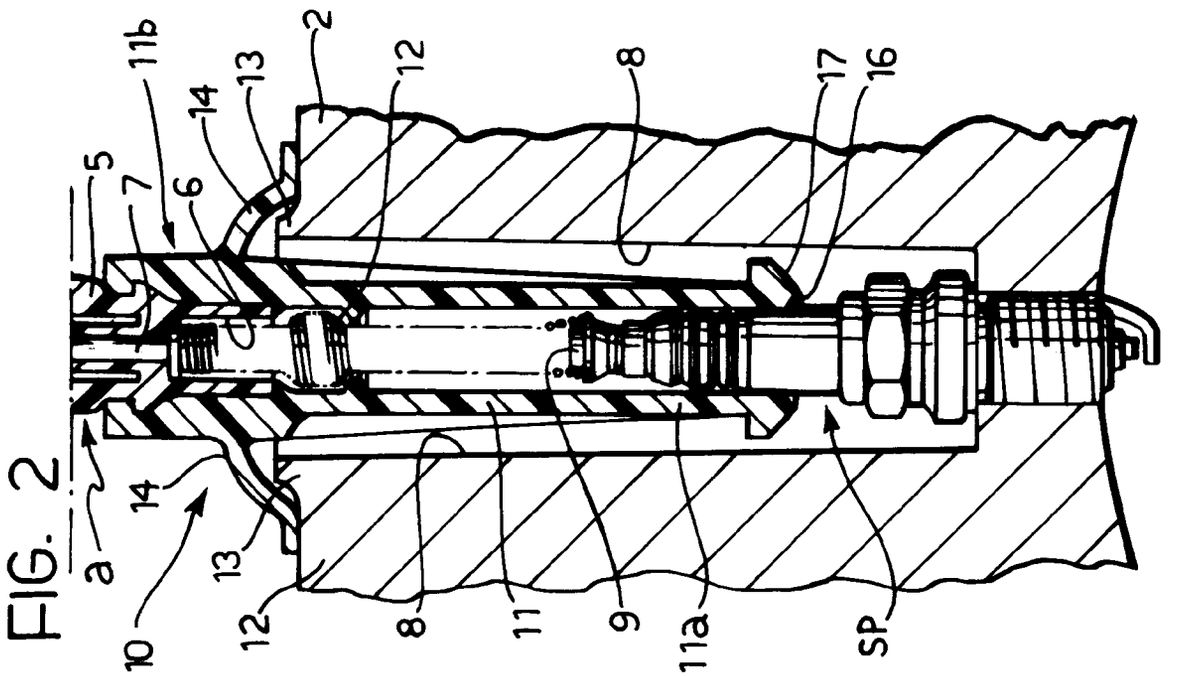


FIG. 2



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EUROPEAN SEARCH REPORT

Application Number

EP 91 83 0336

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-1 956 805 (A.J. MEYER) * The whole document *	1-3,8-10	F 02 P 7/02 H 01 T 13/06
A	US-A-1 689 690 (A.L. SANDIN) * The whole document *	1-3,8-10	
A	US-A-3 110 297 (W.M. KAUFFMANN et al.)		
A	US-A-2 686 511 (J.B. PLATNER)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F 02 P
H 01 T

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17-10-1991	LEROY C.P.

CATEGORY OF CITED DOCUMENTS

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