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(54) Method to produce bimetallic contacts for electromagnet blocks for starter motors and relative bimetallic contacts

(57) Method to produce bimetallic contacts for electromagnet units in starter motors for internal combustion engines, the contacts including a head at least partly made of material with high electric conductivity and a shank at least partly made of material with high mechanical resistance, the method providing a first step wherein a bar is obtained made of material with high mechanical resistance (22), at one end of which a cavity (24) is made, the bar (22) being of a desired shape which does not directly resemble the final shape of the bimetallic contact, a second step wherein a cylinder (23) made of material with high electric conductivity is inserted inside the cavity (24), a third step wherein the bar (22) and the cylinder (23) are subjected to a heat treatment which causes a partial melting and mutual penetration of the two elements (22, 23) to form substantially a single body and a fourth step wherein the bar (22) with the cylinder (23) incorporated is subjected to a shaping step to obtain a desired final form of the bimetallic contact (10).

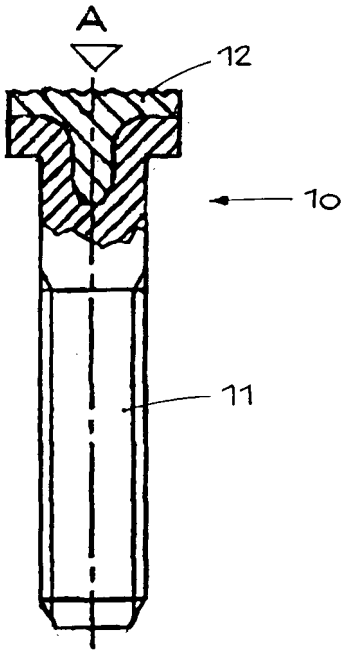

fig.2

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Description

FIELD OF THE INVENTION

[0001] This invention concerns a method to produce "bimetallic contacts" for electromagnet blocks for starter motors and the "bimetallic contacts" produced with this method, as set forth in the respective main claims.

[0002] The invention is applied in the field of production of components for motor vehicles, boats, motorbikes and similar, or more generally in any application where there is a starter motor which activates the ignition of an engine, particularly an internal combustion engine.

[0003] More specifically, the invention is applied to the electromagnet units which, by means of an activation command, engage and establish the necessary electric connection to the starter motor in order to start the engine.

BACKGROUND OF THE INVENTION

[0004] The state of the art includes the standard configuration of electromagnet units, commonly known more simply as starter electromagnets or starters.

[0005] These "electromagnets" substantially consist of a metal container inside which there is a coil which surrounds a movable core, which has one end protruding from the container.

[0006] On the other end of the movable core, inside the coil, there is a conductor disk, usually made of copper.

[0007] In the container of the electromagnet there are also two fixed contacts, usually consisting of two metal bolts separated from each other, with the shank protruding from one side of the container and the head inside the container and facing the conductor disk. One of the two metal bolts is electrically connected to the starter motor and the other to the feed battery.

[0008] The "electromagnets" substantially function as follows:

[0009] When the ignition mechanism is activated, normally with a key, the coil is energised and causes an axial return movement of the movable core inside the container. The first effect of this axial movement, by means of lever systems associated with the outer end of the movable core, is to engage a pinion on the crown of the engine.

[0010] A second effect is to take the conductor disk to a position of proximity with the heads of the "fixed bolts" which protrude from the container of the electromagnet.

[0011] When the key is further rotated, to take the disk into contact with the conductor heads of the bolts, this closes the electric circuit of the battery and starter motor through the fixed contacts consisting of the bolts, with the conductor disk acting as a bridge.

[0012] One problem which constructors of these components particularly have to face is that the bolts used as fixed contacts have to have at the same time high characteristics of electric conductivity, particularly in the area of contact with the conductor disk, and high characteristics of mechanical resistance, particularly resistance to torsion.

[0013] The high conductivity is necessary to ensure that the electric current is always transmitted with maximum efficiency and yield, even as time passes, so as to guarantee the perfect working order of the ignition mechanism.

[0014] The high resistance ensures that, during the installation step, no damage is caused to the structure of the fixed contacts due to torsional stresses caused by the clamping tools being used too energetically.

[0015] The result is that if contacts made entirely of steel are used, then the electric conductivity is low, with problems of oxidation as time passes and therefore a loss of efficiency in the electromagnet or starter. However, if contacts made entirely of copper are used, these have an extremely low mechanical resistance, about a third of that of steel contacts, and therefore they are easily damaged when they are installed and when maintenance is carried out.

[0016] The state of the art includes "bimetallic contacts" wherein a little seating is made on the front part of a steel body wherein a head or disk made of copper is inserted and mechanically coupled, to serve as a conductor element.

[0017] The copper head is installed in the relative seating by means of lateral and frontal percussion so as to give the copper a rounded shape which protrudes from the seating, thus improving the conduction contact with the disk on the movable core. Although this solution is better than the one with a single material, it does not solve the problem inasmuch as the mechanical coupling still has interstices inside which, with time, humidity generates oxidation and therefore reduces the conductive capacity.

[0018] Moreover, due to the dilation of the materials caused by changes in temperature, with time the size of the interstices increases, reducing the copper-steel conduction area and increasing the risk of oxidation due to the infiltration of humidity.

[0019] An example of this embodiment is given in the document EP-A-0 059 341.

[0020] This document teaches to achieve bimetallic contacts consisting of a first body, made of iron and shaped like a bar, including a pre-shaped, cylindrical blind seating in correspondence with its head, and a second body made of copper and suitable to be inserted into the said pre-shaped seating by means of plastic deformation created by closing an element of a mold.

[0021] The initial shape of the second, copper body is higher and narrower than that of the seating into which it is inserted, so that, when the mold is closed, the second body is plastically deformed and crushed, and fills the seating in the head of the first body.

[0022] Although on the one hand this embodiment guarantees a certain level of certainty that the second body will not become detached from the first, on the other hand it does not guarantee an optimum capacity of electric conduction, since it is impossible to ensure, with this method, that all the interstices between the first and second body are completely filled.

[0023] Moreover, this coupling through plastic deformation can guarantee satisfactory results, both in terms of a lasting connection in time and in terms of electric conduction, only if the second copper body occupies the zone of the head of the first body, but not if the copper body also penetrates into the shank of the first body.

[0024] In this case, in fact, it becomes substantially impossible to guarantee an optimum adherence over the whole contact surface between the two metals and therefore the correct passage of the electric current.

[0025] Document US-A-2,755,368 describes a welding method to couple two metallic bodies having melting points located close to each other by means of the combined action of pressure and electric current.

[0026] This method has the disadvantage that it causes an extremely high increase in temperature, with the production of an intermetallic component with a high carbon content in the zone of transition between the two metals which causes a limitation to the electric conduction of the contact.

[0027] Another disadvantage which is common to all the embodiments in the state of the art is the fact that the coupling between the two bodies is carried out with the bodies already in the final form in which they will be used; for this reason, if any mistakes, damage or partial deformations occur during the pressing and/or welding operations, it may no longer be possible to correct these mistakes and this may therefore lead to the piece being eliminated.

[0028] The present Applicant has designed and embodied this invention to solve these problems and to obtain further advantages.

SUMMARY OF THE INVENTION

[0029] The invention is set forth and characterised in the respective main claims, while the dependent claims describe other characteristics of the idea of the main embodiment.

[0030] The purpose of the invention is to obtain bimetallic contacts for electromagnet units in starter motors for internal combustion engines which will guarantee on the one hand high characteristics of electric conductivity and mechanical resistance, particularly to torsion, and on the other hand will guarantee that these characteristics will remain substantially unchanged in time, even after an extremely high number of ignition cycles.

[0031] According to the invention, the bimetallic contact is made starting from a steel bar, of a desired shape which may even be standardised, on the top of which a cavity is made of a desired depth and with a flared top.

[0032] When we use the word "steel", we also mean materials other than steel but with the same or similar mechanical characteristics.

[0033] The steel bar may substantially be of any shape whatsoever, and may not even have a direct resemblance to the shape of the bimetallic contact in its definitive configuration.

[0034] Inside the cavity, in a second step, a small copper cylinder is inserted, in a substantially free manner, of a shape mating with that of the cavity. In this case too, when we use the word "copper", we mean other materials too, which have similar characteristics of electric conductivity.

[0035] The third step is to subject the steel bar and the copper cylinder to a heat treatment, for example thermo-welding, whereby the two materials are made solid with each other in a single piece.

[0036] In a preferential embodiment of the invention, the heat treatment provides a treatment of thermal diffusion with at least partial molecular exchange between the two metals, or a similar treatment, whereby the two materials are partly melted and penetrate each other in the areas of reciprocal contact.

[0037] The said heat treatment guarantees absolute adherence over the whole contact area, which can also be prolonged for a long segment of the bar and therefore can be not limited to the area of the head alone.

[0038] The mutual penetration of the two metals with at least a partial molecular exchange guarantees that there are no interstices or zones of non-adherence between the two bodies, thus optimising the characteristics of electric conduction of the contact even after a large number of cycles and even when there are environmental conditions of wear.

[0039] When the heat treatment has been carried out, the bimetallic half-finished product, as a single piece and still in the form of a substantially cylindrical bar of standardised shape, is sent to molding and rolling to obtain the definitive form with the copper part acting as the head and penetrating to a desired depth into the steel body, ensuring a sufficient area of contact for the due transmission of electric current.

[0040] Since the molding and rolling step is carried out with the two materials already substantially solid, it is possible to correct any possible flashes and deformations caused during the coupling step, thus obtaining a final product which has no surface defects and which therefore guarantees optimum functioning in every application.

[0041] The molding and rolling step finishes off the coupling between the two materials, particularly in the parts of the copper head which protrude from the cavity made in the steel bar.

[0042] The surface configuration of the copper head may have various patterns and or knurling, according to the specifications of the purchaser; the shape and section of the copper part may also vary according to the technological and operational requirements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] The attached Figures are given as a non-restrictive example, and show a preferential embodiment of the invention as follows:

Figs. 1a-1d show in diagram form the steps of the method to achieve the bimetallic contact according to the invention;
Fig. 2 shows in part section a bimetallic contact according to the invention;
Fig. 3 shows a view from A of Fig. 2;
Fig. 4 shows an enlarged detail of Fig. 2;
Fig. 5 shows in part section an electromagnet unit which adopts the bimetallic contact according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0044] The electromagnet unit, or simply electromagnet, 20 shown in Fig. 5 has a container 19 which houses a movable core 18, one end 18a of which protrudes from the side of the container 19. Around the movable core 18 there is a coil 17, the ends 17a of which are associated with electric feed means connected to the ignition key.

[0045] Inside the container 19 there is also a cup-shaped support 16, axially hollow, inside which there is a rod 15, axially movable and protruding from the cup-shaped support 16 towards the movable core 18. On the face of the cup-shaped support 16 which is opposite the movable core 18 there is mounted a conductor disk 14, normally made of copper.

[0046] On the side of the container 19 opposite that where the movable core 18 protrudes, the shank 11 of two metallic contacts 10 emerges; the head 12 is located inside the container 19 in a position adjacent to the conductor disk 14.

[0047] A first metallic contact 10 is electrically connected to the engine of the automobile, while a second metallic contact 10 is electrically connected to the battery.

[0048] When the driver turns the key or other ignition mechanism, the coil 17 is energised, and this generates a return movement of the movable core 18 inside the container 19.

[0049] The movable core 18 is connected on the outside to a system of levers, which is not shown here as it has no effect as far as the invention is concerned, by means of which the return movement causes a pinion to engage on the crown of the engine.

[0050] A further return movement of the movable core 18 inside the container 19 causes the rod 15 to thrust and displace the conductor disk 14 in the direction of the heads 12 of the metallic contacts 10. When contact is achieved, the electric circuit between the engine and the battery is completed through the contacts 10 and the conductor disk 14, thus giving power to the engine which starts, and makes the pinion rotate.

[0051] When the coil 17 is no longer energised, after the automobile has been stopped, the movable core 18 is returned to its inactive position by the spring 21. All this is covered by the state of the art.

[0052] A bimetallic contact 10 according to the invention, shown in part section in Fig. 2, comprises a shank 11 made of steel or similar material and a head 12 made of copper or similar material.

[0053] The copper head 12 extends inside the steel shank 11 for a desired depth, which may even be considerable with respect to the overall length of the shank 11 itself, in such a manner as to ensure the necessary contact area for the current to be transmitted, and may be of any shape whatsoever, for example square (Fig. 3), circular or otherwise. The surface of the head 12 has knurls 13 which reduce over-heating as the current passes through.

[0054] The shape of the head 12, the inclusion and pattern of the knurls 13, the depth of the head 12 inside the shank 11 are part of the design specifications of the contact 10 and may vary from case to case according to the requirements of the specific user.

[0055] The method to achieve the bimetallic contact 10 is articulated in four essential steps and is shown in diagram form in Fig. 1.

[0056] The step shown in Fig. 1a is the shearing to size of a steel bar 22 from a bar 122; the bar 22 is then subjected to a molding operation which tapers the lower end and makes a cavity 24 flared at the top on a segment of the upper part, so as to obtain a half-worked piece 22a.

[0057] The bar 22, as the starting body, may be substantially of any shape, even very different from the final configuration of the bimetallic contact; to be more exact, the bar 22 may be of a standardised shape from which various distinct shapes of the bimetallic contact as the final product may then be derived.

[0058] In a parallel operation (Fig. 1b), from a bar of copper 123 a cylinder 23 is sheared, with a shape mating with that of the cavity 24; the cylinder 23 is assembled mechanically with the steel bar 22, possibly by means of a slight compression which can even be performed manually, so as to achieve a pre-coupling with the flared shape of the cavity 24.

[0059] In this way we obtain a bimetallic half-worked piece 25, with a standardised shape which may not directly resemble the final shape of the bimetallic contact, which is sent (Fig. 1c) to a heat treatment process, for example, thermal diffusion, which welds together in mutual penetration the copper part 23 and the steel part 22, so that the half-worked piece 26 leaving the welding process is substantially a single bimetallic piece.

[0060] The said heat treatment, achieving an at least partial molecular exchange over the whole area of contact between the two materials, guarantees an optimum, indissoluble coupling, with no possibility of cracks

or interstices forming, with the possible infiltration of humidity.

[0061] In this way, it is guaranteed over time that the characteristics of electric conduction are constant, and that the mechanical coupling is absolutely solid.

[0062] In the last step (Fig. 1d), the half-worked piece 26 is subjected to a molding and rolling operation so as to obtain the final form of the contact 10, with the copper head 12 protruding so as to cover the top part of the shank 11 and which extends inside the shank 11 for a desired length "1" such as to ensure the necessary contact surface between the steel and copper for an efficient transmission of the electric current.

[0063] During this step, any knurls 13 are made on the piece, and/or any other profiles or patterns possibly requested by the users.

[0064] This step is also used to remove any possible flashes or slight deformations which have been generated during the coupling step of the two elements 22 and 23.

[0065] The final result obtained is a contact 10 with a coupling surface for the conductor disk 14 made entirely of copper and with an outer body made entirely of steel, thus ensuring the optimum combination of high conductivity and high mechanical resistance, particularly to torsion.

[0066] The indissoluble coupling achieved by heat treatment guarantees that the mechanical stability of the contact 10 is maintained even when there are strong heat stresses and even after an extremely high number of repeated ignition cycles, which ensures an optimum and long-lasting productivity of the electromagnet 20.

Claims

1. Method to produce bimetallic contacts for electromagnet units in starter motors for internal combustion engines, the contacts including a head at least partly made of material with high electric conductivity and a shank at least partly made of material with high mechanical resistance, the method being characterised in that it includes a first step wherein a bar is obtained made of material with high mechanical resistance (22), at one end of which a cavity (24) is made, the bar (22) being of a desired shape which does not directly resemble the final shape of the bimetallic contact, a second step wherein a cylinder (23) made of material with high electric conductivity is inserted inside the cavity (24), a third step wherein the bar (22) and the cylinder (23) are subjected to a heat treatment which causes a partial melting and mutual penetration of the two elements (22, 23) to form substantially a single body and a fourth step wherein the bar (22) with the cylinder (23) incorporated is subjected to a shaping step to obtain a desired final form of the bimetallic contact (10).

2. Method as in Claim 1, characterised in that the heat treatment performed on the bar (22) made of high mechanical resistance and on the cylinder (23) made of high electric conductivity is achieved by thermal diffusion.

3. Method as in Claim 1 or 2, characterised in that the final shaping step to obtain the final form of the bimetallic contact (10) is obtained by molding and rolling.

4. Method as in Claim 1, characterised in that it provides to use a starting bar (22) of a standardised shape to obtain, as the final shape, bimetallic contacts (10) of a different configuration.

5. Method as in Claim 1, characterised in that the step to insert the cylinder (23) into the cavity (24) provides a free insertion with an optional slight compression, even manual.

6. Bimetallic contact for electromagnet units in starter motors for internal combustion engines, including a conductor head (12) made at least partly of material with high electric conductivity and a shank (11) at least partly made of material with high mechanical resistance, the contact being characterised in that it has the part made of copper (23) inserted in a cavity (24) of desired depth "1" made in the part made of steel (22) and subsequently made indissoluble therefrom by means of heat treatment.

7. Bimetallic contact as in Claim 6, characterised in that the head (12) includes knurls (13) and/or patterns of various profiles on the upper part.

8. Bimetallic contact as in Claim 6 or 7, characterised in that the material with high mechanical resistance is steel.

9. Bimetallic contact as in Claim 6 or 7, characterised in that the material with high electric conductivity is copper.

10. Bimetallic contact as in any claim from 6 to 9 inclusive, characterised in that the head (12) is square, circular or any other shape.

11. Bimetallic contact as in any claim from 6 to 10 inclusive, characterised in that it is substantially T-shaped with the head (12) made of material with high electric conductivity entirely covering at the upper part the shank (11) made of material with high mechanical resistance.

12. Bimetallic contact as in Claim 6, characterised in that the electromagnet units comprise at least a movable core (18) associated with an activation coil

(17) and supporting a conductor disk (14), the movable core (18) including at least a position wherein the conductor disk (14) is in contact with the heads of the contacts and closes the electric feed circuit to the starter motor.

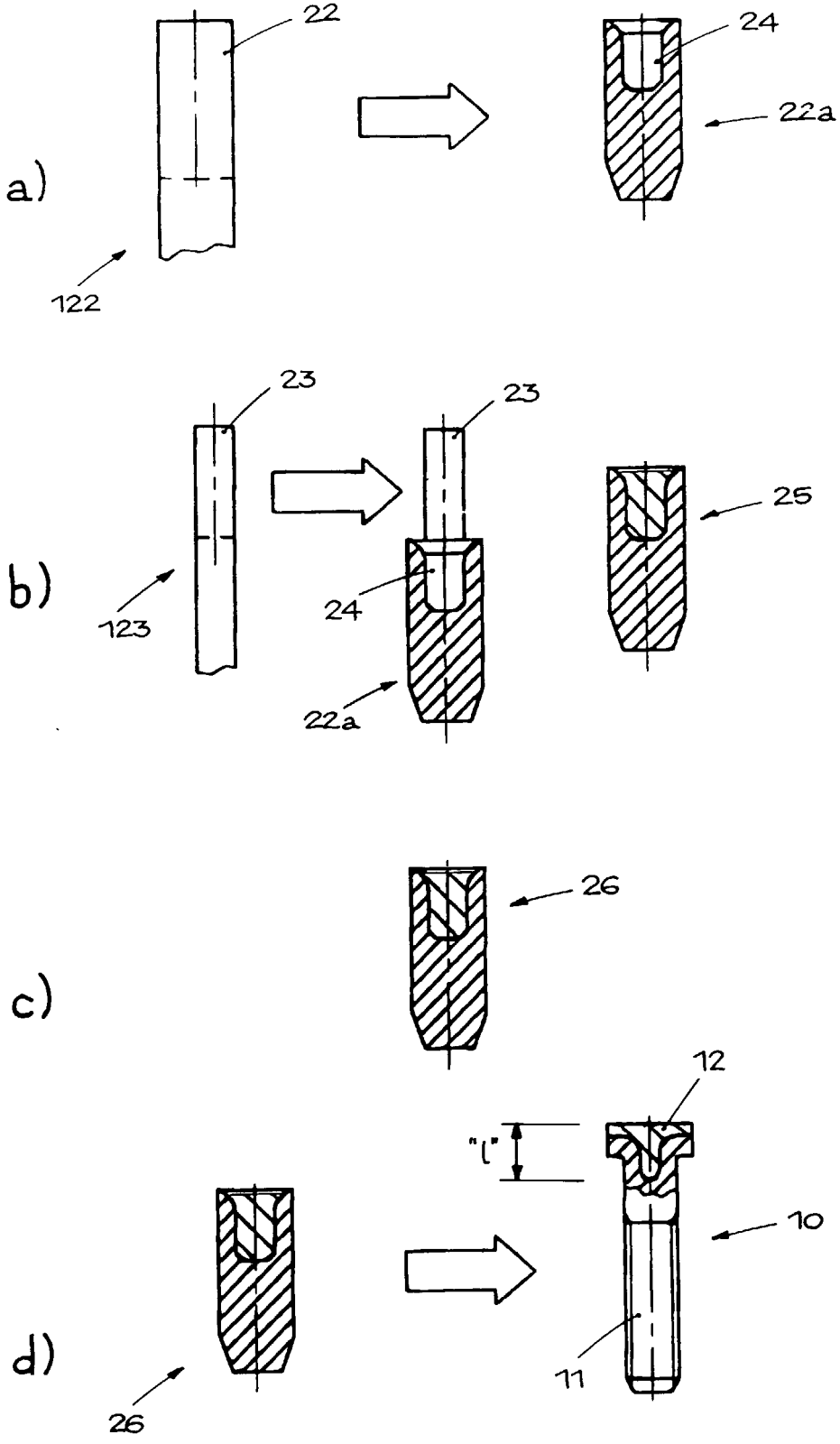

fig. 1

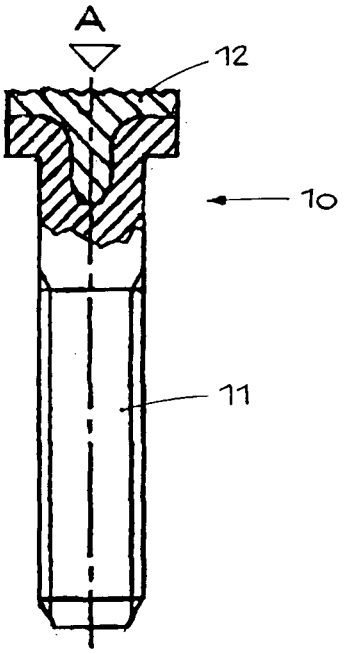

fig.2

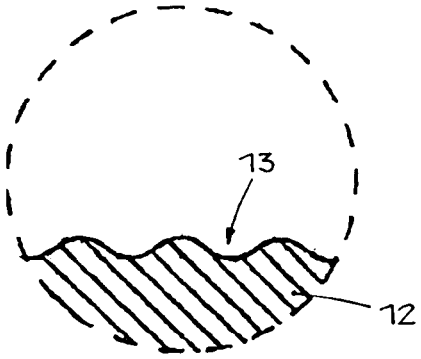

Fig.4

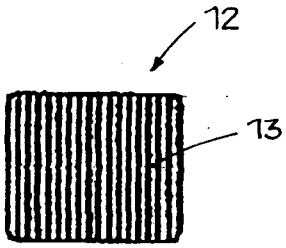

Fig.3

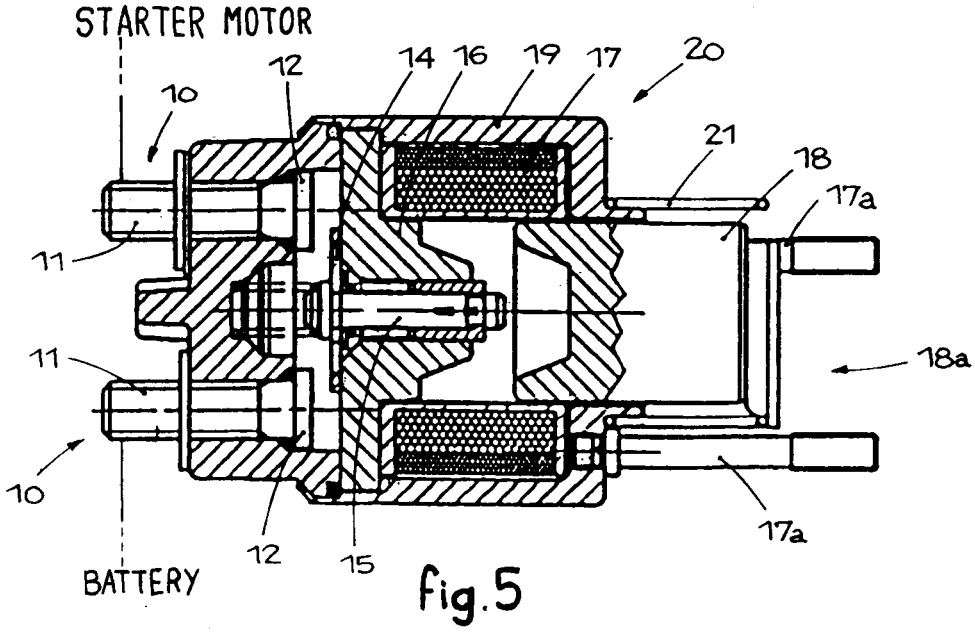

Fig.5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 11 3121

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 October 1999	Janssens De Vroom, P

CATEGORY OF CITED DOCUMENTS

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