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(54) **A current return assembly for railway traction and brushes therefor.**

(57) A current return assembly (15,29) for railway traction and brushes therefor, wherein the brushes comprise a conductive body of metalgraphite (1,40) and a small plate of a lightweight material (2,46) coupled to the conductive body by means of a centering wedge (5,47), the resultant brushes having reduced weight and being adapted for reliable utilization at an optimum contact pressure and with a consequently increased service life even under severe conditions of operation and acceleration stresses on the order of 20 g.

The reduction in weight of the brushes and consequent reduction in the mechanical stresses caused thereby, enable the assembly (15,29) to be made of light alloy.

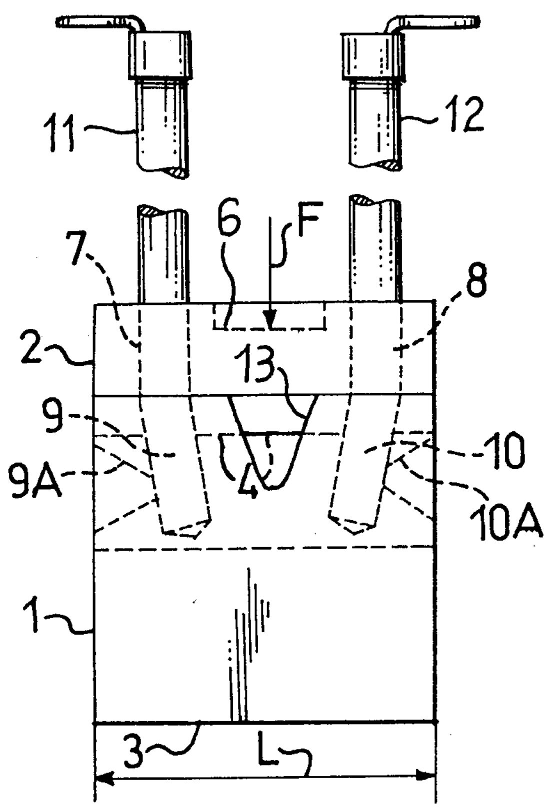

FIG.1

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The present invention relates to a current return assembly for railway traction, and to brushes therefor.

It is known that electric locomotives must be ensured a ground return path for their power supplies through the locomotive own wheels and the rails.

This return path should be able to carry, with but minimal voltage drops, currents of high intensity, on the order of 2000 to 3000A, which must not be flowed through the bearings of wheel-carrying axles to which the wheels are keyed.

For this purpose, current return assemblies are mounted on the bogies of electric locomotives which can transfer, by means of electric contact brushes housed slidably in sockets of a brush holder body, electric current to the end of the axle through a collector which comprises a contact cap of bronze secured on the axle end.

While the load current of an electric locomotive can be, and usually is, distributed over a plurality of return paths, each return path should be capable of transferring large currents in the 500 to 600A range, usually split among several brushes.

The design and fabrication of such return assemblies for rail traction requires that a plurality of conflicting problems be reconciled.

The return assemblies should be mechanically robust and easy to take down for inspection and servicing.

The life allowance of the brushes should be quite long and ensure a coverage of no less than one million kilometers, in order to cut the inspection and maintenance operations down to a minimum.

The brushes should have high electric conductivity, minimal contact loss, and a minimal frictional coefficient.

Additionally to being robust, the whole of the return assemblies should be capable of withstanding the multivarious adverse actions of their environment: varying temperature and moisture, weather and saline agents, dirt, sand, external shocks, etc.

With the ever growing speeds of rail transportation, in particular fast and high-speed rail, added to these problems is that of reducing the mass of the mechanical parts to a minimum, especially of those anchored directly on the bogie.

In fact, due to the combined effects of the train speed around a bend and the bogie rotation relative to the car structure, large centrifugal forces can easily develop, with accelerations in the 20g range.

To the centrifugal effects, there add accelerations, mainly in a transverse direction thereto, due to vibrations of the bogie generated by rail gaps, rail switches, lack of planarity of the rails, etc.

These accelerations induce mechanical stresses in the parts involved which are proportional to the mass of such parts and which, even when constrained within admissible limits to avoid straining and failure of the materials, may cause ageing phenomena and the risk of failure from fatigue on account of their periodical character.

A further consideration should be added which is specific to the contact brushes of the current return assemblies, which are held pressed against the axle ends by pressure springs and are slidable axially substantially in the same direction as that in which the centrifugal forces develop.

To ensure minimum wear of the brushes and at the same time a good electric contact, the brush pressure should be held within an optimum range.

In fact, brush wear is due essentially to two components: an electrical component which causes wear at an inversely varying rate with the contact pressure, and a mechanical component which is substantially proportional to the contact pressure.

In a condition of perfect sliding of the contact surfaces and no vibrations, the optimum range is 100 to 200 g/cm^2 for the contact pressures.

Contact pressure is imposed by constant pressure springs (which do not change their force as the axial length of the brushes changes due to wear).

However, it will be apparent that when the brush contact arrangement is caused to vibrate and the brushes are subjected to accelerations, the inertia of the brushes may induce forces which oppose the contact pressure to reduce or cancel it altogether.

This must not be allowed to happen, lest arcing and overtemperatures may occur and lead to quick destruction of the brushes.

For this reason, in brush contact arrangements subjected to vibrations, e.g. in bar commutator machines and even more so in rail transportation systems or on vehicles, it is necessary that higher contact pressures on the order of 300/400 g per cm^2 be adopted which are the higher, the greater the brush mass in relation to the contact surface, and hence, the brush inertia.

This obviously results in increased wear of the same.

It will therefore be apparent that the mass or weight of the brushes becomes an important and critical factor in certain applications.

A reduction in the mass/weight of the brushes enables, for the same anticipated acceleration stresses, the required contact pressure to be reduced to approach the optimum conditions, thereby reducing wear, the range of variability of the contact pressure due to vibrations, and ultimately improving the service life of the brushes.

A reduction in the mass/weight of the brushes also affects the housings, which become less stressed by the brushes striking the walls and can, therefore, be sized accordingly to save material, and in the extreme, with the adoption for the housings of construction materials which are less strong mechanically but much lighter in weight.

As a further induced aspect, the brush holder assemblies, being thus lightened, will stress the anchoring members and supporting structures to a lesser extent, such that these can be, in turn, made lighter or operated under conditions of improved safety.

The present invention has for its subject-matter a current return assembly for railway traction and brushes therefor, which solves the problems and achieves the benefits indicated, while conforming to regulations and standards imposed by railway agencies, that is without requiring structural and dimensional changes of the assembly support and other members of the electric locomotive bogie.

According to the invention these results are obtained by adopting "composite" brushes consisting of a conductive body of metalgraphite coupled by juxtaposition with a small plate of a light material, the plane of juxtaposition being shaped as a centering wedge so as to form a brush of preferably standard size, and hence, with the same installability characteristics but being, for the same volume, lighter.

This enables, for the same maximum acceleration stresses, operation at a lower contact pressure, with the benefit of a longer life duration or, for the same contact pressure, operation under conditions of boosted acceleration such as are to be found in high-speed rail, for instance.

As a further aspect of the present invention the brushes, thus lightened, can be used in a return assembly which, being benefited by the lower stresses brought into play, is constructed from light alloy and allows anchoring on conventional supports by anchor members (studs and nuts) which are much less stressed, to the advantage of safety, reduction of the fastening torques, and consequently of ease of assembly and disassembly for maintenance and servicing operations.

The features and advantages of the present invention will be more clearly apparent from the following description of a preferred embodiment of the invention with reference to the accompanying drawings, in which:

Figures 1 and 2 show respectively a front and a side view of a brush constructed in accordance with the present invention;

Figures 3 and 4 show respectively a front and a side view of a variation of a brush constructed in accordance with the present invention;

Figure 5 shows a front view of a brush holder body constructed in accordance with the present invention;

Figure 6 shows in section the assembly of Figure 5 along the view I-I of that figure.

With reference to Figures 1 and 2, a brush constructed in accordance with the present invention comprises a conductive body 1, having the shape of a right parallelepipedon, with a base of width L, tangential thickness ST and height H1. The tangential thickness ST corresponds to the relative sliding direction provided for the brush.

The conductive body consists of metalgraphite, a sintered compound of copper/graphite, preferably to a ratio of 87%, 13% by weight.

This material has a high electric conductivity, low contact voltage drop on the order of 0.7 volts, low friction coefficient owing to its graphite content, and high resistance to wear which makes it preferable compared to graphite and electrographite.

On the other hand, this material has, compared to graphite, a high specific density of 5.2 g per cm^2, approximately three times as high as that of graphite-based materials.

A critical factor in the making of electrically conductive brushes which are to be guided slidingly axially in the direction of the height H1, within suitable housings, is the height/base dimension ratio in the relative sliding direction of the brush which cannot be allowed to drop below certain limits if uneven wear is to be avoided as may result, for example, from the application of a contact thrust which is not aligned true to the brush, from a not truly axial positioning in its housing, etc.

In general, it is advisable that the height of a brush be greater than the tangential thickness, even when the brush is worn.

This would dictate for a brush having a contact area LxST = 40x20mm, a height H1 of no less than than 45 mm, with a useful height H3 susceptible to wear of no more than 20:25 mm (actually, a brush with these dimensions can be regarded to be a standard type) and a heavy brush weight of about 190 g, if made of metalgraphite.

According to the invention, the height of the conductive body H1 is less, e.g. 35 mm, the necessary brush height being achieved with a small plate 2 of a light material which fits on top of the conductive body 1.

The plate 2 in the shape of a right parallelepipedon with the same dimensions L and ST as those of the body 1, has a height H2 such that the two elements coupled together form a brush of adequate height but much lighter weight. The height H2 may be 10 mm, for example.

The material comprising the plate 2 may be selected from a broad spectrum and is preferably bakelized cloth, easy to work, but may be plastics materials, comparatively resilient, such as ABS, DELRIN, NYLON or silicon rubbers, which can be worked mechanically or formed in a mold.

For proper coupling of the two elements, the upper face of the conductive body 1, opposite from the contact and rubbing surface 3 of the brush, has a wedge-shaped recess with a corner edge 4 parallel with the larger dimension of the contact surface 3 and a spread angle on the order of 130-150°.

The plate 2 has, in turn, an engagement wedge 5 mating with the wedge-shaped recess.

The opposite face of the plate 2 from the engagement wedge 5 has an undercut 6 in the shape of a cylinder segment for housing a constant pressure spring therein which applies a thrust force F. The undercut 6 ensures thrust centering on the brush.

The orientation of the wedge-shaped recess and the corresponding engagement wedge, which is shown here parallel with the larger dimension of the contact surface, is preferably but not necessarily perpendicular to the relative sliding direction between the brush and the collector, and hence to the tangential thickness ST, so as to avoid even small relative movements between the conductive body 1 and the plate 2 in the sliding direction, with displacements of the point of application of the thrust F. In practice, the relative sliding direction may not be coincident with the thickness or the width of the brush and may largely depart therefrom.

The plate 2 is also provided with two cylindrical through-holes 7, 8 aligned to corresponding cylindrical sockets 9, 10 open on the upper face of the conductive body for the insertion of two copper braids 11, 12 which ensure the electric connection of the brush to a brush holder body.

The ends of the copper braids 11, 12 are secured in the sockets 9 and 10 by soldering with a tin alloy, preferably introduced into the sockets 9 and 10 through two gates 9A and 10A, respectively, open on a side wall of the conductive body and communicated to the sockets 9 and 10.

With this type of anchoring the depth of the sockets 9 and 10 can be limited to a few millimeters, on the order of ten mm, thereby increasing the useful height of the conductive body which may be raised to 25 mm.

To ensure a better holding for the anchoring, the braid ends can be first forced into copper bushes which are inserted into the sockets 9 and 10.

By these expedients, a conductive brush is obtained which ensures maximum operation reliability and uniform wear, with a reduced weight equal illustratively to 80% of a brush of the same size and material.

A further reduction in weight can be obtained by providing, in the body 1, a wedge-shaped undercut 13 disposed between the two openings 9, 10 with the apical corner edge perpendicular to the larger base dimension L.

The benefit to be derived from the weight reduction, which may appear negligible at first sight, is instead an essential one.

A brush having the dimensions indicated and constructed in accordance with the present invention, has a weight/mass of about 150 g and when subjected to an acceleration of 20 g generates a thrust force of 3 kg.

If a constant pressure spring applies a force F of 3.2 kg to the brush, the operative thrust/reaction conditions between the brush and the commutator will vary from a minimum of 0.2 kg to a maximum of 6.2 kg, which correspond to a contact pressure of 25 to 780 g per cm^2 at an average pressure of 400 g per cm^2 when the brush is not subjected to accelerations.

For the same force F and accelerations applied, a conventional brush with the same dimensions and of the same material (metalgraphite throughout) would be unable to operate properly due to the inertial forces (3.8 kg) prevailing over the contact force F. The contact pressure range would be quite wide, between 0 and 875 g/cm^2, and consequently the brush would be subjected to a fast rate of wear due to the electrical component in a condition of zero contact pressure and to the mechanical component in a condition of maximum contact pressure.

By converse, when a contact pressure of at least 25 g/cm^2 is sought even in the worst of cases, it would be necessary that a thrust of 4 kg and hence an average contact pressure of 500 g/cm^2 be applied to the brush, obviously with increased wear and more limited life.

A variation of the brush construction shown in Figure 1, comprising two elements, is illustrated by Figures 3 and 4.

Here again the brush comprises a conductive body 40 of metalgraphite having the shape of a right parallelepipedon with a height H4, width L and tangential thickness ST.

The body 40 is provided in opposition with the contact surface 41 with a turret 42, having a height H5, terminated at the top with a wedge-shaped recess, similar to the one shown in Figure 1.

The turret 42 has a width L2 which is suitably less than L, e.g. equal to 1/2L, and is through-penetrated by a cylindrical socket 43, with its axis parallel with the width L and a diameter appropriate to receive an electric connection braid 45, possibly equipped with a copper bush 44, also housed in the socket 43.

The braid 45 and the bush 44, if any, are soldered on the conductive body by pouring a low melt alloy into the socket 43 through a conical gate 46 open on a face of the turret and communicated to the socket 43. The bush 44, where provided, is drilled at the gate to admit the molten alloy flow to the braid 45.

The turret 42 is overlaid by a small plate 46 of a lightweight material (bakelized cloth) having the same width and tangential thickness as the body 40.

Similar to the embodiment of Figures 1, 2, the plate 46 has a height H6 such that the coupling of the plate 46 to the conductive body 40 will form a brush of greater height, even when the body is worn, than the tangential thickness of the brush.

For proper coupling of the plate 46 and the body 40, or more appropriately, the turret 42, the plate 46 has an engagement wedge 47 mating with the wedge-shaped recess of the turret and being flanked in the apex direction of the wedge by two teeth 48, 49 which embrace the turret 42.

The plate is through-penetrated by two cylindrical holes 50, 51 perpendicular to the contact surface of the brush, for the insertion of the two legs of the braid 45 which come out of the socket 42, and has an undercut 52 in the shape of a cylinder segment on the opposite face from the engagement wedge 47.

For a brush with L = 40 mm and ST = 20, preferred values for the various heights are, illustratively, the following:

H4 = 25 mm
H5 = 15 mm
H6 = 10 mm

The weight of a brush thus constructed is also on the order of 150 g.

The reduction in the brush weight/mass by reducing the inertial stresses that the brush exerts on the brush holder body allows the same to be made, rather than of cast steel, of cast light alloy, preferably a silicon-aluminum alloy of the SILUMIN Beta type, as identified by Code G-AS9MG of UNI 3051 Standards.

The weight of a current return assembly so constructed is practically halved with respect to a corresponding assembly with the body made of steel.

Reduced by the same amount are the stresses imposed by the inertia of the current return assembly on the anchor members, with considerable advantages in terms of resistance to fatigue, reliability and maintenability.

Figures 5 and 6 show, respectively in plan view and in section, a preferred embodiment of a current return assembly.

The assembly comprises a flanged brush holder body 15 forming a tern of prismatic housings 16, 17, 18 distributed circumferentially around a central axis 161 for housing a tern of brushes like those already described and a tern of elastic U-shaped anchors (one of which 19 is shown) provided with hooking teeth, removable by bringing the free ends near, which support and secure in place a tern of constant pressure coil springs, one of which 20 is shown.

The flange of the body 15, having two opposite flat annular surfaces for coupling to a support and a closure cap, respectively, is provided with expansions with bosses 21, 22, 23 forming seats for corresponding anchor studs, and with an arm 24 provided with openings for securing terminals of electric connection braids.

Internally of the flange, threaded sockets 25, 26, 27 are provided for the clamping by means of screws, such as 30, of terminals of the electric connection braids of the brushes, so that the current return is ensured from the electrical apparatus to the brush holder body by means of a first aggregate of conductive braids, from the brush holder body to the brushes by means of a second set of braids, then from the latter to the axle end and thence to the rail.

In installing the brush holder body, this is suitably insulated electrically from its support and the fastening members, nut 31, stud 32, by an insulating gasket 28 and insulating bushes such as 33 to prevent current flows, even partial ones, to the support and the axle bearings contained therein.

The gasket 28 also ensures the sealing off of the brush housing to the axle end, avoiding the infiltration of dust and elements which could impair the functionality of the brushes.

A cap 29, attached by means of screws to the flange of the brush holder with a sealing gasket 34 therebetween, ensures the sealing off of the brush housing to the outside.

The cap 29 is also a light alloy casting, peferably a self-hardening aluminum alloy, identified by Code GD-AlSi12 of UNI 5076 Standard.

Thus, an assembly results which is particularly light and reliable, simple to install and optimal in use on fast traction means.

It will be apparent that the foregoing description only relates to preferred embodiments and that many variations may be introduced. In particular, in relation to the arrangement of the engagement sockets of the connection braids, to reduce to a minimum the vertical bulk of the conductive body portion used for anchoring the braid(s), the layout of the wedge-shaped recess and the corresponding engagement wedge may be reversed, as may be formed of the plate and the conductive body, respectively.

Claims

1. A current return assembly (15,19) for railway traction, comprising a flanged brush holder body (15) provided with a plurality of housings (16,17,18), a flanged closure cap (29) of said body (15) and a plurality of brushes (1,10), each housed in one of said housings (16,17,18) and connected electrically by means of a flexible electric connection (11,12) to said body (15), characterized in that said body (15) and said cap (29) are aluminum alloy castings and that each of said brushes (1,10) comprises:

a conductive body (1,40) of sintered metal-graphite in the general shape of a right parallelepipedon with a contact surface, having a width L and thickness ST, the opposite face of said parallelepipedon from said contact surface being provided with a wedge-shaped recess or an engagement wedge, with a corner edge (4) perpendicular to said thickness ST,

a centering plate (2,46) of a lightweight material in the general shape of a right parallelepipedon with a base section equal to said contact surface, provided with an engagement wedge (5,47) mating with said wedge-shaped conductive body recess and being engaged in said recess or with a wedge-shaped recess mating with said conductive body engagement wedge, said plate (2,46) coupled to said conductive body (1,40) forming a brush with a perpendicular height to said contact surface greater than said thickness ST even when the brush is worn.

2. An assembly as in Claim 1, wherein said brush holder body (15) is made of a GAS9MG aluminum alloy and said cap (29) is made of a GD-AlSi12 aluminum alloy.

3. An assembly as in the preceding claims, wherein said centering plate (2,46) is provided, on its opposite face from said engagement wedge or said wedge-shaped recess, with a recess (6,52) in the shape of a cylinder segment for housing a constant pressure spring therein.

4. An assembly as in the preceding claims, wherein said centering plate (2,46) is of bakelized cloth.

5. A brush for a current return assembly for railway traction, characterized in that it comprises:

a conductive body (1,40) of sintered metal-graphite in the shape of a right parallelepipedon with a rectangular contact surface having a width L and thickness ST, the opposite face of said parallelpipedon from said contact surface being provided with a wedge-shaped recess or an engagement wedge, with the corner edge perpendicular to said thickness ST,

a centering plate (2,46) of a lightweight material in the shape of a right parallelepipedon with a base section equal to said contact surface, provided with an engagement wedge (5,47) mating with said wedge-shaped conductive body recess and being engaged in said recess or with a wedge-shaped recess mating with said engagement wedge, said plate (2,46) coupled to said conductive body forming a brush with a perpendicular height to said contact surface greater than said thickness ST even when the brush is worn.

6. A brush as in Claim 5, wherein said centering plate (2,46) is provided, on the opposite face from said engagement wedge or said wedge-shaped recess, with a recess (5,52) in the shape of a cylinder segment for housing a constant pressure spring.

7. A brush as in Claims 5 and 6, wherein said centering plate (2,46) is of bakelized cloth.

8. A brush as in Claims 5, 6 and 7, wherein the combination of said plate (2,46) and said conductive body (1,40) forms a brush of standard height.

9. A brush as in Claims 5 to 8, wherein the spread angle of said engagement wedge is between 130° and 150°.

10. A brush as in Claims 5 to 9, wherein said conductive body (1,40) is provided, at said wedge-shaped recess or engagement wedge, with a pair of cylindrical openings (9,10) for engaging and securing a pair of connection cable terminals (11,12) and with pouring gates (9A,10A) communicated to said cylindrical openings.

11. A brush as in Claims 5 to 10, wherein said contact surface is on the order of 40x20 mm and said conductive body height is on the order of 35 mm.

12. A brush as in Claims 5 to 9, wherein said conductive body (40) is provided with a turret (42) extending in opposition with said contact surface and being terminated with said wedge-shaped recess or said engagement wedge (47), said turret (42) being through-penetrated parallel with said contact surface by a cylindrical socket (43) for insertion of an electric connection braid (45), said turret (42) being provided with a pouring gate (46) communicated to said cylindrical socket.

13. A brush as in Claim 12 comprising a copper bush (44) housed in said cylindrical socket (43) and soldered thereto, said bush being provided with at least one opening at said pouring gate (46).

14. A brush as in Claims 12 and 13, wherein said plate (46) is provided with a pair of teeth (48,49) flanking said engagement wedge or said wedge-shaped recess, co-operating with said turret (42) to locate said small plate (40) relative to said turret (42) in the direction of said width L.

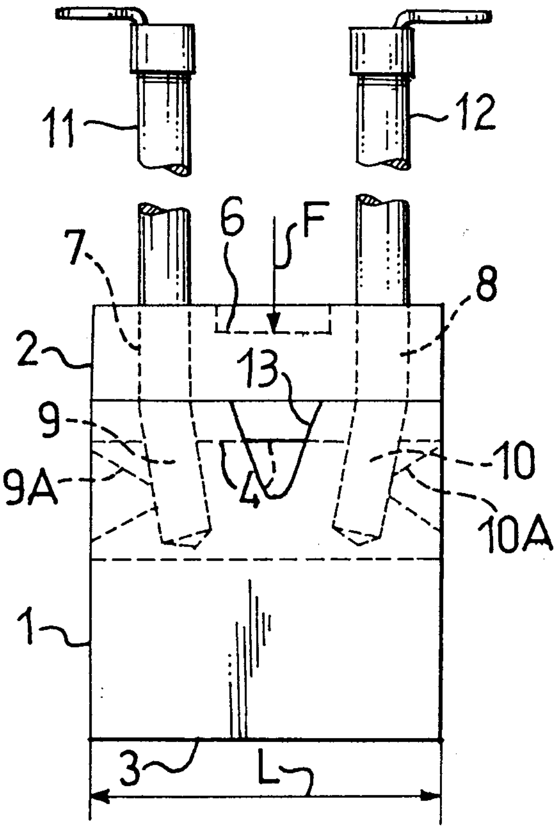

FIG.1

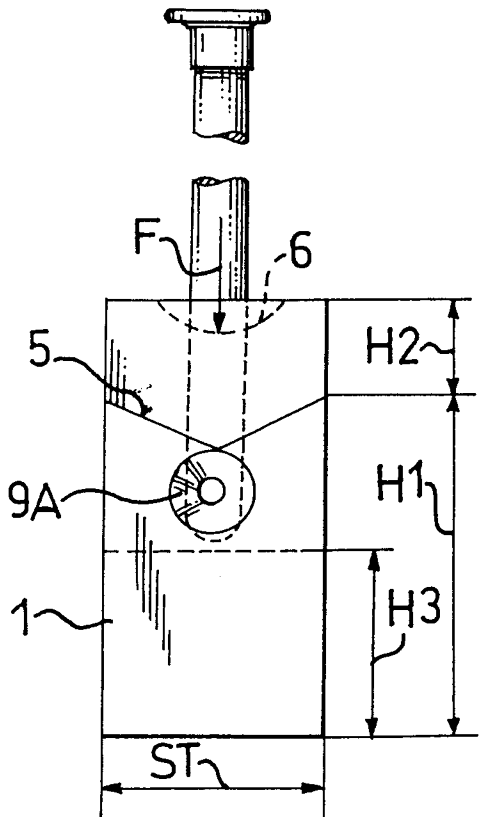

FIG.2

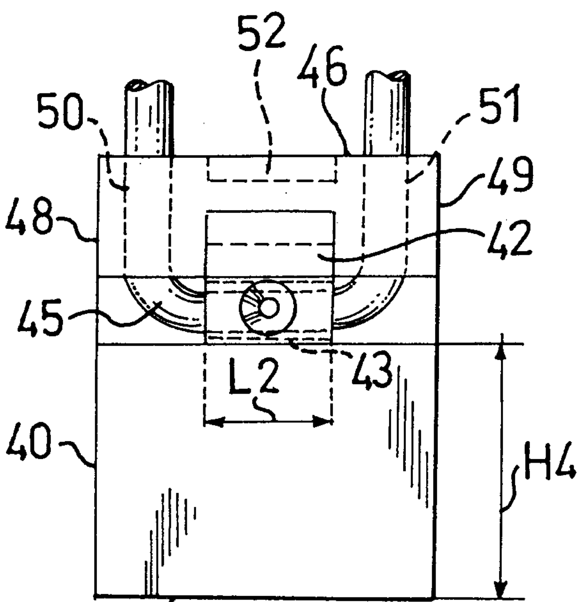

FIG.3

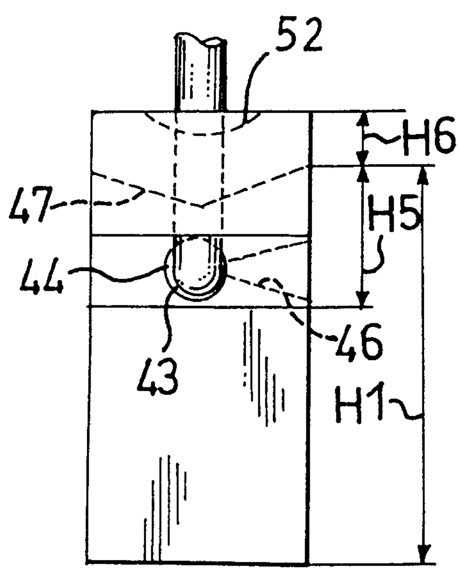

FIG.4

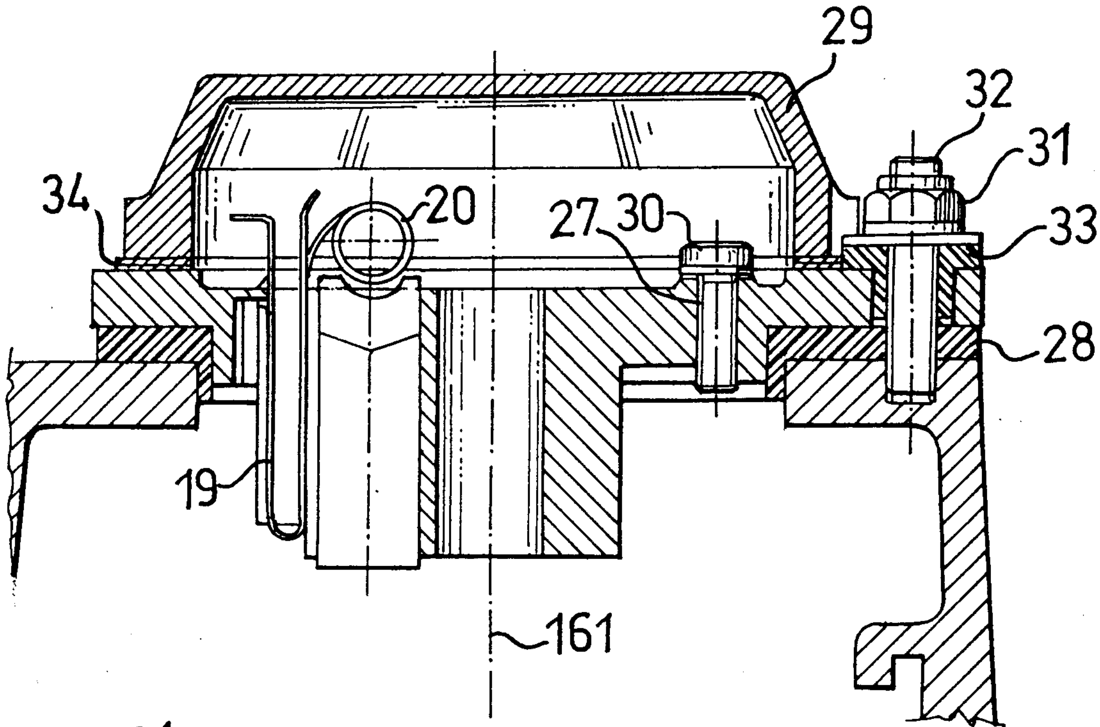
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FIG.6

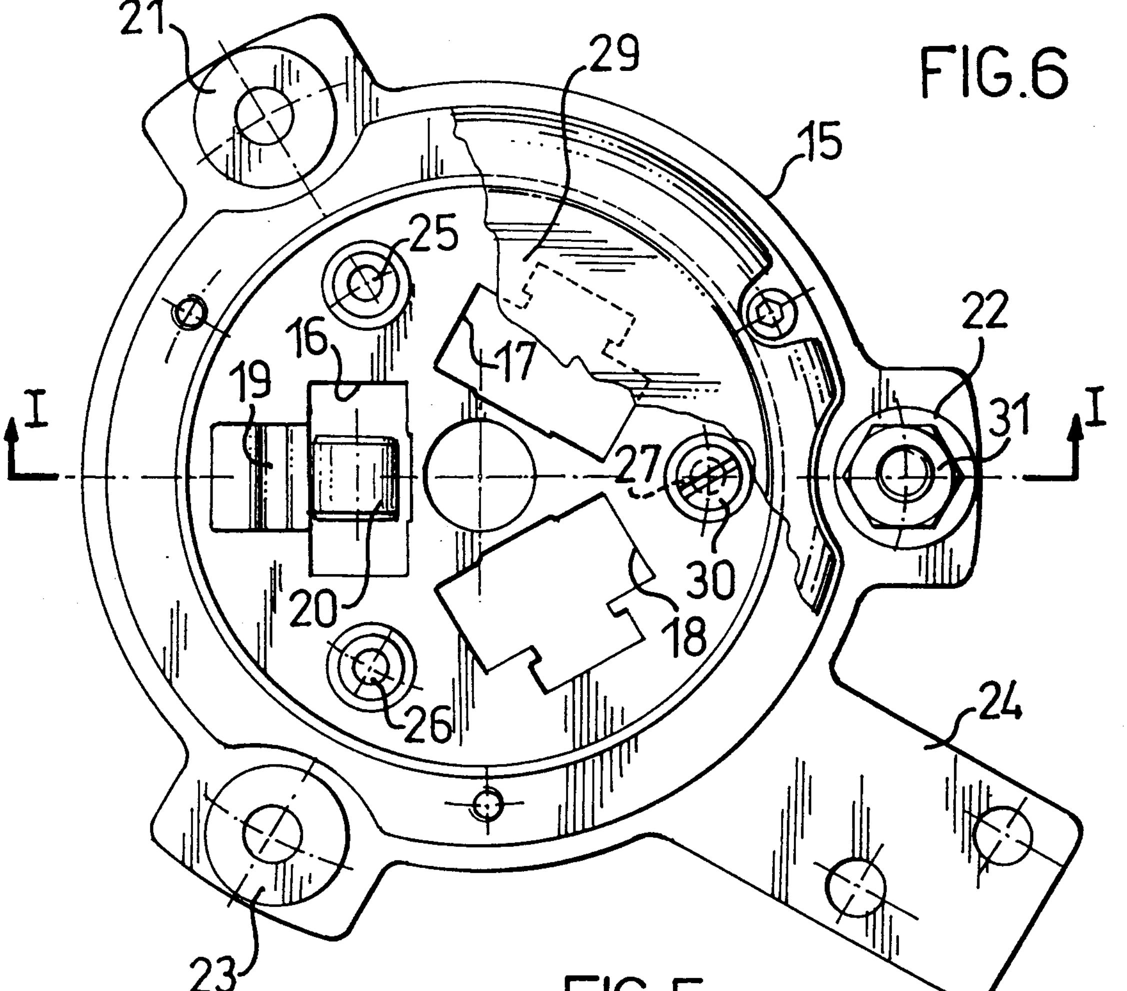
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FIG.5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 20 2585

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.6)
A	EP-A-0 297 002 (FERRAZ S. A.) * column 2, line 14 - line 57; figures 1-3 * ---	1,5	B61F15/28
A	GB-A-556 465 (THE MORGAN CRUCIBLE COMPANY LTD) * page 2, line 39 - line 45; figure 1 * ---	1,5	
A	PATENT ABSTRACTS OF JAPAN vol. 17, no. 608 (E-1457) 9 November 1993 & JP-A-51 090 240 (MITSUI MINING & SMELTING CO LTD) 30 July 1993 * abstract * -----	1,5	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B61F H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 December 1994	CHLOSTA, P

CATEGORY OF CITED DOCUMENTS

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