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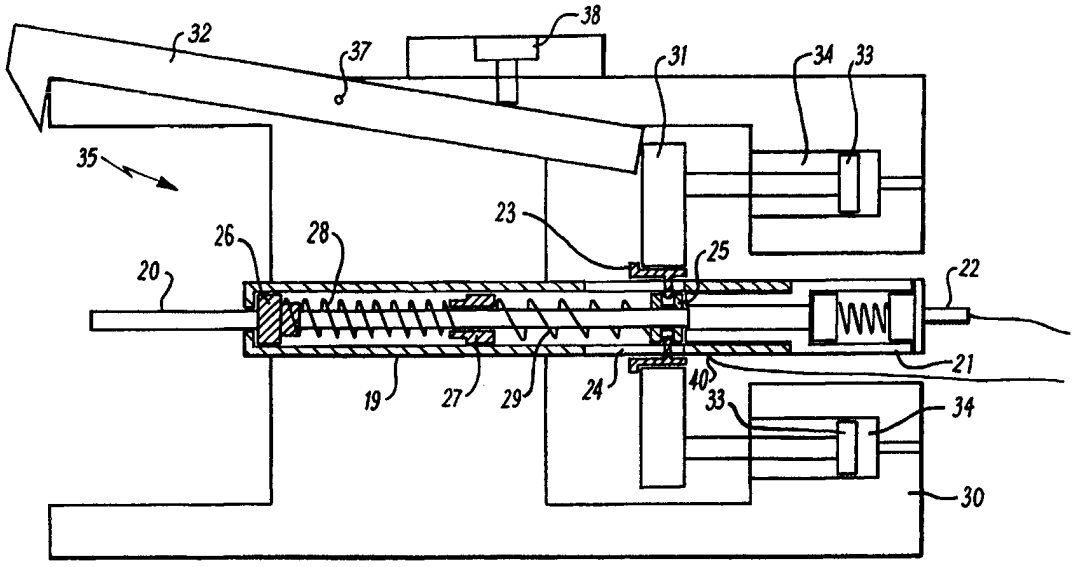
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(57) Abstract

Apparatus for testing the mechanical integrity of a terminal by urging a terminal (18) and test probe (2) together to subject a terminal (18) to a force. A latch (17) is provided to retain a terminal (18) relative to the test probe (2). The latch (17) is arranged so that the apparatus may not be operated to urge the test probe (2) and a terminal (18) together unless the latch (17) is in a position whereby a terminal (18) may be so retained.

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# A TEST PROBE

The present invention relates to a test probe. The probe is particularly although not exclusively intended for use in the testing of automotive wiring harnesses.

Test probes are known, in general they comprise a spring loaded contact enabling a temporary electrical connection to be made with a terminal or other electrical conductor. The probe also having provision for a permanent electrical connection to some other equipment, for example, electrical test equipment.

Automotive wiring harnesses are known, comprising a wiring network fitted with terminals, housed in connectors. Wiring harnesses are complex and in order to ensure accurate and correct assembly it is desirable that they are tested prior to fitment to vehicles.

In an existing system wiring harnesses are assembled on a jig board or multiple boards, the boards having interfaces designed to retain specific types of connector as fitted to the harness. The positioning of the interfaces ensures that the harness is dimensionally correct. These interfaces are also fitted with test probes, the test probes make electrical contact with terminals which are placed into the connectors, against the spring force of the test probe contact.

The test probes mounted in the interfaces are connected to electrical test

equipment arranged to allow a small electrical current to flow into the wiring harness. This allows the test equipment to determine correct or incorrect assembly of the harness, and continuity of the constituent wires. In particular this system allows for testing of the harness during assembly, any faults indicated can then be rectified.

In another existing system wiring harnesses are assembled on jig boards or multiple boards having interfaces which are not fitted with test probes. In this system when the harness is assembled it is then tested at a separate electrical test station. This test comprises fitting the connectors of the harness to test interfaces fitted with test probes. The test probes are connected to electrical testing equipment and the test probe contacts are further fitted with high force springs. In one arrangement, in order to provide a sufficient force for the testing of a connector, a probe is mounted on a pneumatically operated ram which advances the probe into the connector body and the connector is retained in the test interface by means of a pneumatically operated clamp which grips the connector when the probe is advanced.

These high force springs enable the connectors to be tested for mechanical build quality. If a terminal is incorrectly fitted to a connector it will be dislodged by the test probe, the test probe is arranged so that this results in electrical contact with the test equipment being broken and so continuity lost, indicating a fault. This system allows more comprehensive testing of the harness, although at this stage it is hard to rectify faults and the entire harness

may have to be scrapped if faults are discovered. Probes fitted with high force springs are not employed with the first system as when sufficient force is applied by the probe contact to test build quality this makes insertion of terminals into connectors difficult.

According to a first aspect of the present invention there is provided apparatus for testing the mechanical integrity of a terminal comprising a test probe, means for urging the test probe and a terminal to be tested together to subject a terminal to a force and a latch operative in a first position to retain a terminal relative to the probe and operative in a second position to permit a terminal to be displaced from the probe, wherein the latch is arranged such that the means for urging the test probe and a terminal together may only operate when the latch is in the first position.

Preferably the latch is further arranged so that it may not be operated from the first position whilst the means for urging the test probe and a terminal together is operative.

In one embodiment the latch comprises a pivoting member.

According to a second aspect of the present invention, there is provided a test probe for electrically and mechanically testing an electrical terminal comprising an electrically conductive contact for electrically contacting the terminal, means for urging the contact and the terminal together to make

electrical contact between contact and terminal and means for increasing the force with which the contact and terminal are urged together to test the mechanical integrity of the terminal.

In a preferred embodiment of the invention the means for urging the contact and terminal together comprises a resilient member and the means for increasing the force with which the terminal and contact are urged together comprises of means for compressing the resilient member.

In particular the resilient member may be effected by a spring or springs. The means for increasing the force may comprise a mechanical means acting to compress the resilient member usually in the direction that the increased force is to be applied.

The electrically conductive contact may comprise a rod, having a collar forming a radially projecting shoulder fixed relative to the rod. The rod may be slidably mounted within a cylindrical probe body, one end of which has an opening of larger diameter than the rod but of smaller diameter than the collar, the opposite end of the probe body being closed by means of a retaining plug. The end of the rod protrudes through the open end of the probe body. The rod and probe body are preferably constructed from stainless steel although they could be constructed from any other suitable material. The rod has a head style or cross section in order to satisfactorily engage with a terminal for testing. The retaining plug is constructed from an insulating material, for example nylon, and

incorporates a sliding electrical contact with which the rod makes contact when moved into the probe body, the retaining plug also having an external contact, to which electrical test equipment may be connected, which is electrically connected to the sliding electrical contact. A second, permanent, electrical contact may be provided to the probe body, which may be in electrical contact with the probe shaft.

The resilient means may comprise a helical spring mounted around the rod between the fixed collar and the end of the body closed by the retaining plug. As such this spring bears on both the retaining plug and the collar and urges the rod towards the open end of the probe body. The probe body is further mounted in a probe housing having means for retaining a terminal relative to the housing, against which the rod is brought to bear. These means may be arranged so as to only allow the force applied by the rod to be increased when the terminal or connector housing the terminal is correctly located and retained in the probe housing.

Means for increasing the force applied by the rod may comprise a pneumatic cylinder and piston, arranged to move the probe body within the probe housing in the direction of the protruding rod. When the rod is bearing against a terminal the effect of moving the probe body towards the protruding rod is to further compress the spring, increasing the force which urges the rod against the terminal. Other embodiments are possible where the means for increasing the force applied by the rod is effected by different means for

example hydraulic cylinder, electrical solenoid or mechanical lever.

Where there is also provided an electrical contact comprising a rod, having a fixed collar, and where this is mounted within a probe body having an open end and an opposite end closed by a retaining plug the resilient means may comprise two helical springs.

The two springs are chosen to provide different forces, these being a low force spring and a high force spring. Both springs are mounted about the rod between the fixed collar and the retaining plug, between the two springs there is placed a sliding collar able to move longitudinally relative to the rod. In this embodiment both the fixed and sliding collars have two radially projecting shoulders, an inner shoulder and an outer shoulder where the inner shoulder is of smaller diameter than the outer shoulder. The collars are arranged so that the sides having the inner shoulder face each other. The low force spring is placed between the fixed collar and sliding collar, the spring having a diameter greater than the inner shoulders and smaller than the outer shoulders. As such the spring bears on the outer shoulders of the fixed collar and sliding collar, when the spring is compressed the two inner shoulders of the collars abut. The high force spring is placed between the sliding collar and the retaining plug. In this embodiment when a force is applied to rod and probe body so as to compress the springs the low force spring compresses first until the two collars abut then the high force spring is compressed. The force required to compress the springs being determined by selection of the springs. This allows the upper

and lower limits of the force exerted by the probe to be more easily selected and achieved than may be afforded by use of a single spring. The probe body is also mounted in a probe housing, having means for retaining a terminal relative to the housing, against which the rod is brought to bear. These means may be arranged so as to allow the force applied by the rod to be increased when the terminal or connector housing the terminal is correctly located and retained in the probe housing.

Means for increasing the force applied by the probe may comprise a pneumatic cylinder and piston, arranged to move the probe body, within the probe housing, in the direction of the protruding rod. When the rod is bearing against a terminal the effect of moving the probe body towards the terminal is to compress the low force spring until the two collars abut and then to compress the high force spring, applying a greater force to the rod and so increasing the force which urges the rod against the terminal.

Where there is also provided an electrically conductive contact comprising a rod, having a fixed collar, slidably mounted within a probe body having an open end and an opposite end closed by a retaining plug, this probe body may also have longitudinal slots. The resilient means may comprise one or more springs mounted between the fixed collar and a sliding collar. The sliding collar being mounted about the rod between the fixed collar and the closed end of the probe body, this sliding collar being able to move longitudinally relative to the rod and also being connected through the

longitudinal slots of the probe body to an external sliding collar mounted around the probe body. The external sliding collar having a radially projecting shoulder.

The probe body is mounted in a probe housing, having means for retaining a terminal relative to the housing against which the rod is brought to bear. These means may be arranged so as to only allow the force applied by the rod to be increased when the terminal or connector housing the terminal is correctly located and retained in the probe housing. The probe body is also mounted fixed relative to the probe housing. Means for increasing the force applied by the rod may be provided by a pneumatic cylinder and piston or other suitable means which engages with the external sliding collar. These means move the sliding collar, relative to the probe housing and therefore relative to the probe body, towards the open end of the probe body, causing the internal sliding collar to compress the spring or springs within the body and so increase the force applied by the rod.

In order that the invention may be more clearly understood two embodiments thereof will now be described by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a perspective view of a first embodiment of a test probe;

Figure 2 shows a longitudinal cross-section of a probe of the type illustrated in Figure 1;

Figure 3 shows a cross-section of a probe according to the first

embodiment mounted in a probe housing, having an interface to accommodate a connector for testing into which a connector has been inserted;

Figure 4 shows a second probe embodiment; and

Figure 5 shows a cross-section through a probe of the second embodiment mounted in a probe housing, having an interface to accommodate a connector for testing.

Referring to Figures 1 and 2, there is provided a test probe having a probe body 1 and a probe shaft 2. The probe body 1 is cylindrical and constructed in one piece, stainless steel being a suitable material. The probe shaft 2, or contact, may be manufactured to have various different head styles of cross-sections as may be required to effect a satisfactory contact with a terminal to be tested. The probe shaft 2 is constructed from a suitable electrically conductive material e.g. stainless steel.

The probe body 1 has openings at opposite ends, one of which has a smaller diameter than the other, this defining the front end of the probe body. The probe shaft 2, has a fixed collar 3, comprising two radially projecting shoulders, fixed with respect to the shaft. The collar having a greater diameter than the opening at the front end of the probe body, and hence limiting the travel of the probe shaft through the probe body. The shaft 2 and collar 3, may be produced in one piece.

Further there are disposed about the probe shaft 2 a low force spring 4,

a sliding collar 5 and a high force spring 6. The springs 4 and 6 are helical. The sliding collar 5 has two radially projecting shoulders of the same diameter as those of the fixed collar 3, and is mounted about the probe shaft 2 in opposition with the fixed collar 3. The sliding collar 5 is able to move relative to the probe shaft 2 in a longitudinal direction.

The probe shaft 2 and associated collars and springs 4,5,6 are held within the probe body 1 by means of a retaining plug 7. The probe shaft 2 and probe body 1 are in electrical contact.

The retaining plug 7 is constructed from an electrically insulating material, for example nylon. The retaining plug is engaged with the probe body 1 preventing movement of the retaining plug 7 relative to the probe body 1. This is achieved by the exterior of that portion of the retaining plug which lies within the probe body having barbs, to facilitate an interference fit with the probe body although the retaining plug could also be secured within the probe body with glue or by means of a clip.

The retaining plug 7 accommodates a sliding electrical contact 8, connected electrically by a spring 9 to the external contact 10. The external contact 8 being secured within the retaining plug 7 by way of an interference fit. The external contact 8 The external contact 10 may provide for the connection of an electrical lead or form a plug for direct connection to other equipment, for example electrical test equipment.

When the probe is an inoperative state the springs 4 and 6 urge the probe shaft 2 by way of the fixed collar 3 to its forward most position. When a force is applied to the probe shaft 2 urging it towards the probe body 1 the effect is to firstly compress the low force spring 4, until the inner shoulders of the two collars 3 and 5 touch. Further movement of the probe shaft 2 into the probe body 1 will then cause the high force spring 6 to be compressed, between the inner face of the sliding collar 5 and the front face of the retaining plug 7.

When the probe shaft 2 is moved a certain distance into the probe body 3 the rear end of the shaft 2 may contact the sliding contact 8. This establishes electrical contact between the probe shaft 2 and the external contact 10. Further movement of the probe shaft 2 into the probe body 1 will cause the sliding contact 8 to move within the retaining plug 7.

It will be noted that only a predetermined low force is required to depress the probe shaft 2 into the probe body 1 to the extent that the fixed collar 3 touches the sliding collar 5 and that a predetermined high force is then required to depress the probe shaft 2 further resulting in compression of the high force spring 6.

Referring to Figure 3, in use, the probe is mounted in a probe housing 11. The probe housing having a carriage 12 into which the probe body is secured. The carriage 12 is slidably mounted within the housing and means are provided for moving the carriage longitudinally with respect to the housing 11. These

means are preferably effected by a pneumatic cylinder 13 and piston 14 connected to the carriage although other means could be employed, for example a hydraulic cylinder, electrical solenoid or lever action. The carriage 12 enables the probe to be moved towards the test interface 15 by a predetermined amount.

The test interface 15 is designed to accept a specific design of connector 16 and has a latch 17 in order to retain the connector within the test interface 15. The latch 17 is mounted on to the probe housing 11 in order that it can pivot about point 36 and is arranged in order that when the carriage 12 is moved towards the test interface 15 one end of the latch member bears against the carriage 12. This prevents movement of the latch 17 from the closed position, as shown in Figure 3, preventing either removal of connectors from or insertion of connectors into the test interface 15. In addition when the carriage is moved away from the interface and the latch is moved to an open position, allowing passage of connectors into and out of the interface 15, one end of the latch member 17 is moved into the plane in which the carriage moves, preventing the carriage being brought towards the interface 15.

The latch serves to ensure correct operation of the probe and probe housing, in particular, preventing removal of the connector during high force testing and insertion of connectors or terminals directly against the high force springs. The latch also prevents the carriage being moved towards the test interface if it is not in the closed position, preventing potential damage to

connectors.

In use a connector 16, initially unpopulated, is placed into the test interface 15, where it is retained by means of a latch 17. A terminal 18 can then be installed into the connector. The probe is arranged so that when the carriage is in its rearmost position the installation of a terminal into the connector causes the probe shaft 2 to be depressed only against the action of the low force spring 4.

This establishes electrical contact between the terminal 18, the shaft 2 and hence the probe body 1. Any electrical test equipment connected to the probe body by way of contact 39 will, at this stage, be able to determine whether terminal 18 is connected to the correct part of the wiring harness.

When the terminal has been inserted into the connector and it is established that this terminal is correctly connected the carriage can be brought forwards, towards the test interface, by means of the pneumatic cylinder 13. This brings the test probe closer to the terminal, depressing the probe shaft 2 further into the probe body 1. The force required to move the probe towards the test interface must be sufficient to compress the high force spring 6. The probe is arranged so that when the shaft 2 is depressed further into the probe body 1 so as to depress the high force spring 6, the probe shaft 2 makes contact with the sliding contact 8. This establishes electrical contact between terminal 18, the external contact 10 and any electrical test equipment

connected thereto. When the increased force is applied by the probe shaft to the terminal 18, if the terminal is not correctly installed this force may cause it to move out of the connector. If this occurs the probe shaft will move forwards out of the probe body under the action of the springs, this will cause the connection between probe shaft 2 and sliding contact 8 to be broken, signalling a fault to the electrical test equipment connected to contact 10.

The relative positions and sizes of the probe shaft 2, collars 3 and 5, springs 4 and 6 and sliding contact 8 are determined with regard to the type of connectors and associated terminal to be tested. The spring forces are similarly chosen although preferably the low force spring can be compressed by the equivalent force of the order 100g and the high force spring by the equivalent force of the order 1kg.

A plurality of probes could be grouped into a single probe housing for the testing of connectors with more than one terminal.

Alternatively the probe and probe housing could be used to test fully or partly assembled harnesses not assembled on the test probe itself. In this arrangement the probe would be advantageous in enabling mechanical and electrical faults to be detected and rectified.

Referring to Figures 4 and 5 there is illustrated an alternative embodiment, having a probe body 19 with an electrical contact 40, a probe

shaft 20, retaining plug 21 having an external contact 22 and an external sliding collar 23, having a radially projecting shoulder. The external sliding collar 23 extends through slots 24 in the probe body and engages with an internal collar 25, slidably mounted about the probe shaft 20. The internal collar 26 being able to move longitudinally relative to the probe shaft 20. The probe shaft also has a fixed collar 26 and a second sliding collar 27, both having two corresponding radially projecting shoulders. The sliding collar 27 is able to move relative to the probe longitudinally and is placed in opposition to the fixed collar 26. A low force spring 28 is placed between the collars 26 and 27 and a high force spring between collars 27 and 25.

The probe is mounted within and fixed relative to the probe housing 30. The probe housing has an annulus 31 slidably mounted within the housing and connected to pistons 33 operating in pneumatic cylinders 34 or to some other suitable means operative to move the annulus longitudinally within the probe housing with a force greater than that necessary to compress the high force spring 29.

The internal diameter of sliding annulus 31 is greater than that of the probe body 19 but smaller than that of the external sliding collar 23. As such the annulus 31 will engage with and move relative to the probe body the sliding collar 23. Movement of the sliding collar in the direction of the probe tip will compress springs 28 and 29 and so increase the force exerted by the probe shaft when this is depressed to a position where collar 26 is not bearing on the

front section of the probe body 19.

The probe housing 30 has an interface 35 and associated latch 32 for receiving and retaining connectors for testing. The latch 32 is pivoted about point 37. When the latch is in the open position, as shown in Figure 5, this allows connectors to pass into and out of the interface 35. In the open position part of the latch 32 is moved into the plane in which the sliding annulus 31 moves, preventing the annulus moving towards the test interface. Similarly when the latch 32 is in the closed position and the sliding annulus 31 is moved towards the test interface 35 a part of the latch bears on the side of the sliding annulus, this prevents movement of the latch to the open position.

The probe housing also has a release cylinder and piston 38. This comprises a pneumatic cylinder although release may be effected by any other suitable means. The release cylinder is effective to move the latch 32 to the open position, although the latch could also be moved by other means.

The above embodiments are described by way of example only and it will be appreciated that many variations are possible without departing from the invention. For example where there has been described the use of both a low force and a high force spring it would also be possible to implement the invention using only one spring, or indeed any other suitable resilient means.

CLAIMS

1. Apparatus for testing the mechanical integrity of a terminal comprising a test probe, means for urging the test probe and a terminal to be tested together to subject a terminal to a force and a latch operative in a first position to retain a terminal relative to the probe and operative in a second position to permit a terminal to be displaced from the probe, wherein the latch is arranged such that the means for urging the test probe and a terminal together may only operate when the latch is in the first position.

2. Apparatus according to claim 1, wherein the latch is arranged in order that it may not be moved from the first position whilst the means for urging the test probe and a terminal together is operative.

3. Apparatus according to either claim 1 or 2, wherein the latch comprises a pivoting member.

4. Apparatus according to any preceding claim, wherein the apparatus is arranged to electrically test a terminal.

5. Apparatus according to claim 4, wherein the test probe comprises an electrically conductive contact and a means are provided for urging the contact and a terminal together to make electrical contact between the contact and a terminal.

6. A test probe for electrically and mechanically testing an electrical terminal comprising an electrically conductive contact for electrically contacting the terminal, means for urging the contact and the terminal together to make electrical contact between contact and terminal and means for increasing the force with which the contact and terminal are urged together to test the mechanical integrity of the terminal.

7. A test probe according to claim 6, wherein the means for urging the contact and terminal together comprises a resilient member and the means for increasing the force with which the contact and terminal are urged together comprises a means for compressing the resilient member.

8. A test probe according to either claim 6 or 7, wherein the means for increasing the force comprises a pneumatic cylinder and piston.

9. A test probe according to any of claims 6 to 8, wherein the probe is mounted in a probe housing having means for retaining the terminal relative to the housing.

10. A test probe according to claim 9, wherein the means for retaining the terminal are arranged so as to only allow the force with which the contact and terminal are urged together to be increased when the means for retaining the terminal is in a state whereby a terminal may be retained in the probe housing.

11. A test probe according to either claim 9 or 10, wherein said means for retaining the terminal comprises a latch.

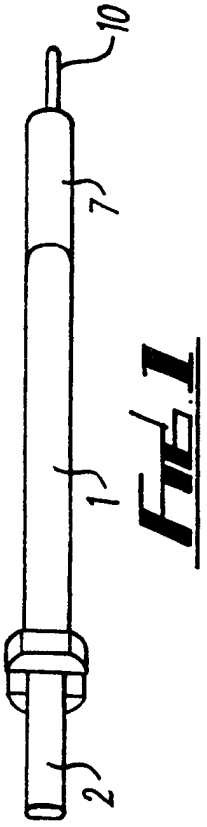



Fig.1

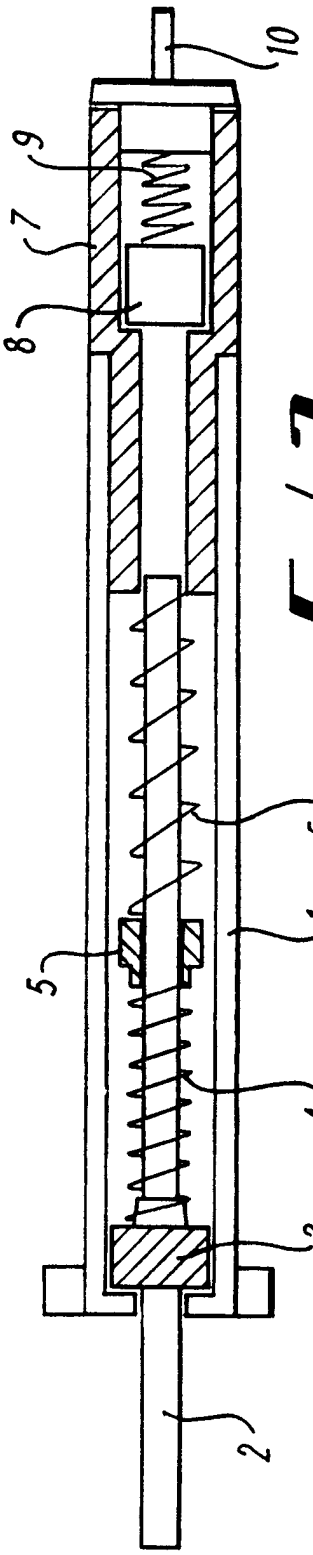



Fig.2

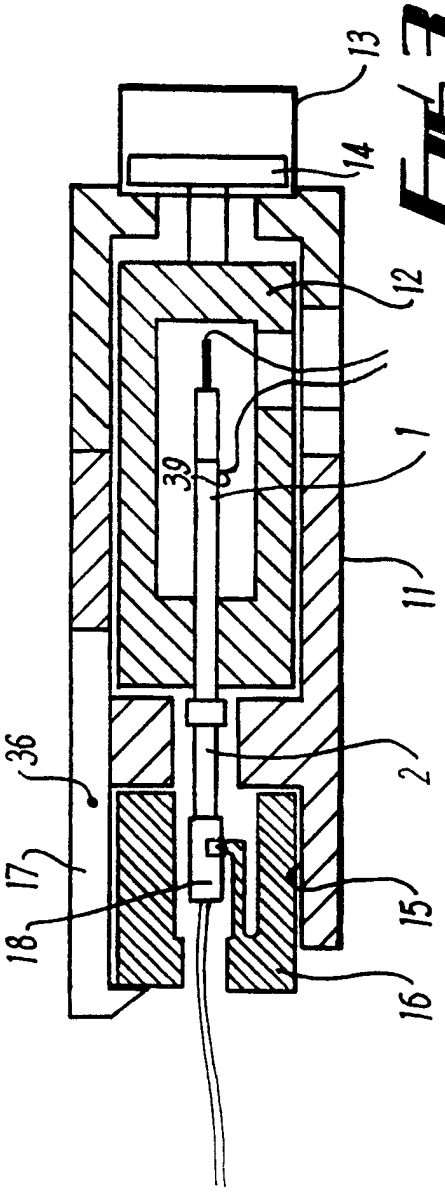



Fig.3

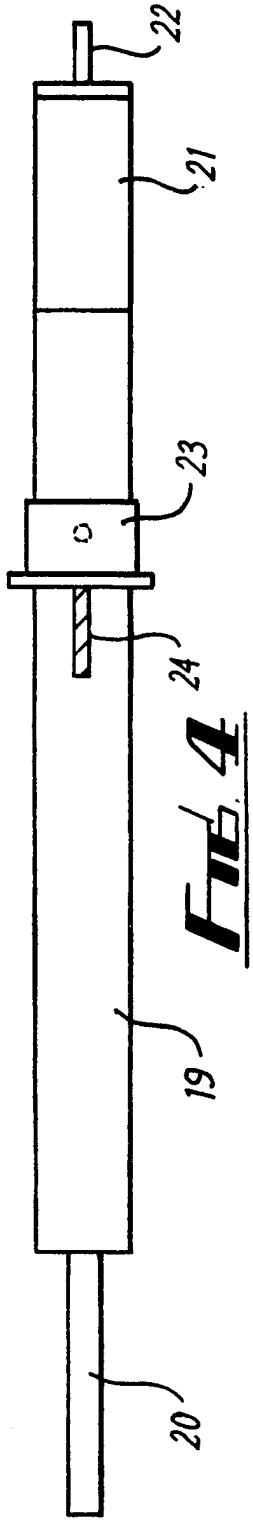

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FIG. 4

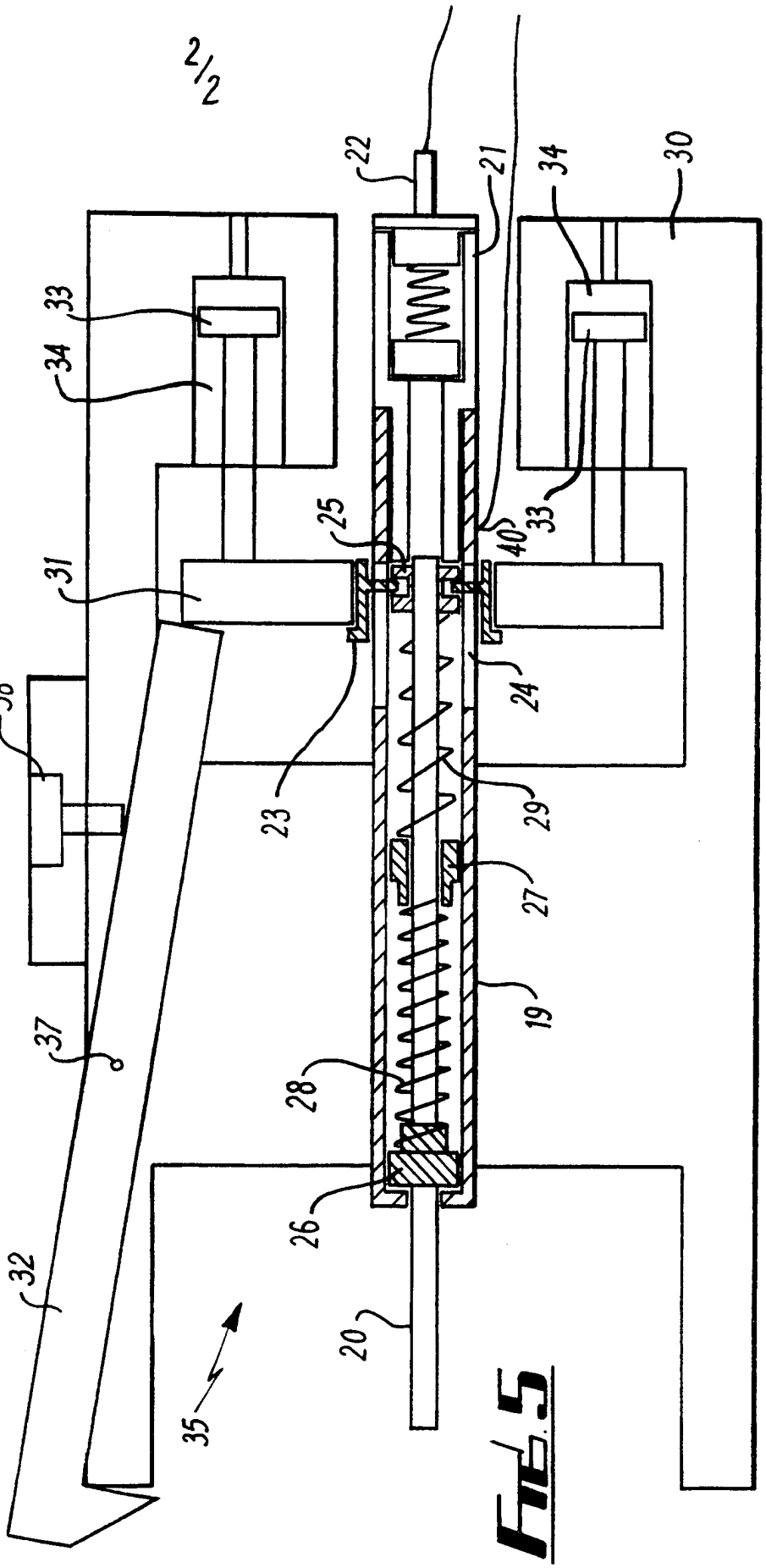

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FIG. 5

# INTERNATIONAL SEARCH REPORT

In tional Application No
PCT/GB 97/02697

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01R31/04

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

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IPC 6 G01R

Documentation searched other than minimumdocumentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | EP 0 692 718 A (SIX TAU) 17 January 1996<br>see column 5, line 5 - line 52; figures 1,2,4,5 | 6-9,11 |
| X | GB 2 170 962 A (KAHL) 13 August 1986<br>see page 1, line 111 - page 2, line 23; figures 1-3 | 6-9 |
| A | EP 0 141 305 A (HACKNER) 15 May 1985<br>see page 10, line 23 - page 11, line 36; figures 1,4,5 | 1,6 |
| A | DE 195 25 229 A (YAZAKI) 1 February 1996<br>see abstract; figures 1,4 | 1,6 |

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