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G. M. RAULINS
FEELER HEAD ASSEMBLY

2,925,660

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2 Sheets-Sheet 1

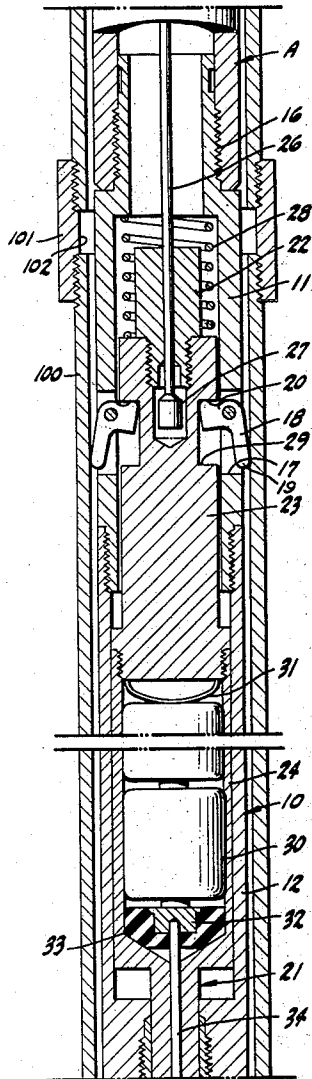
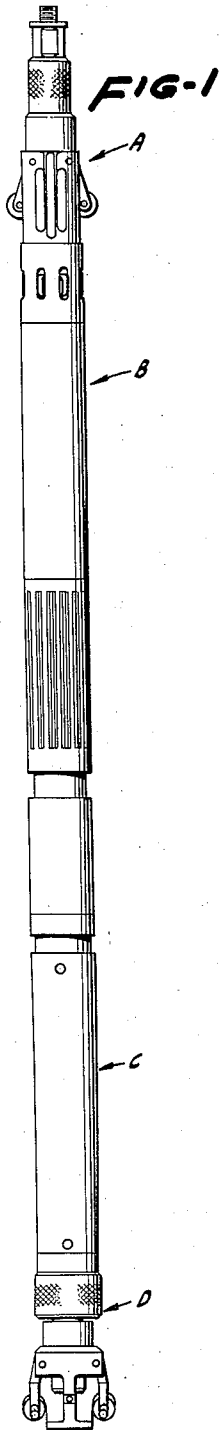


FIG-5

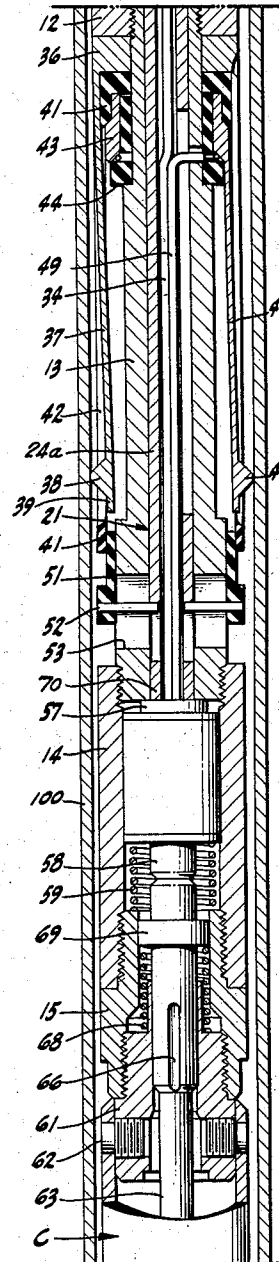


FIG-6

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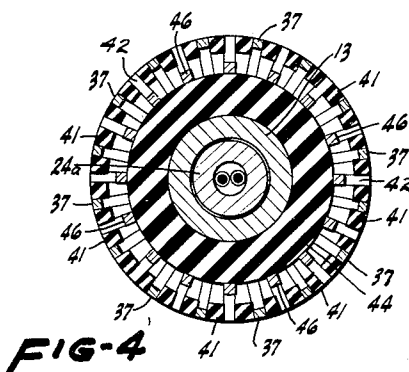
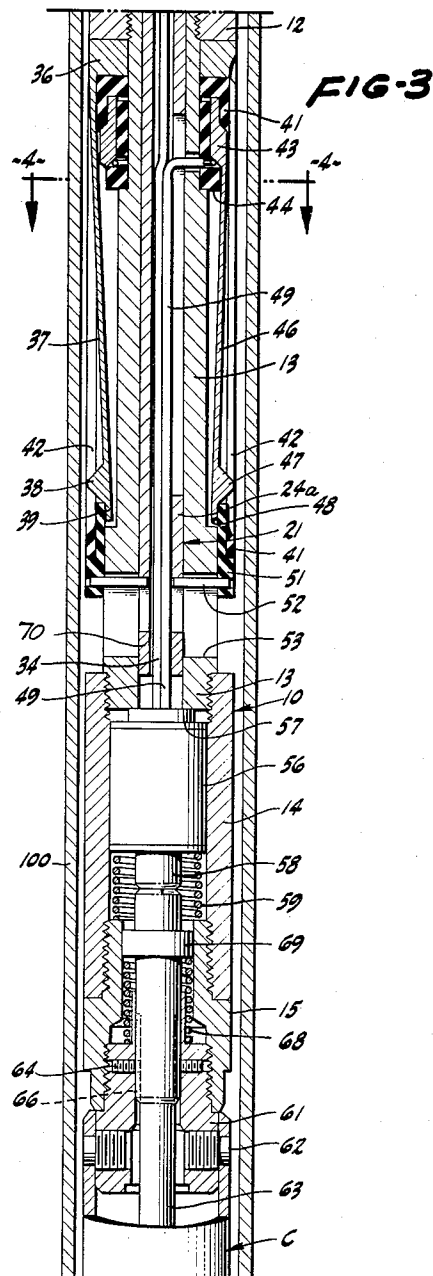
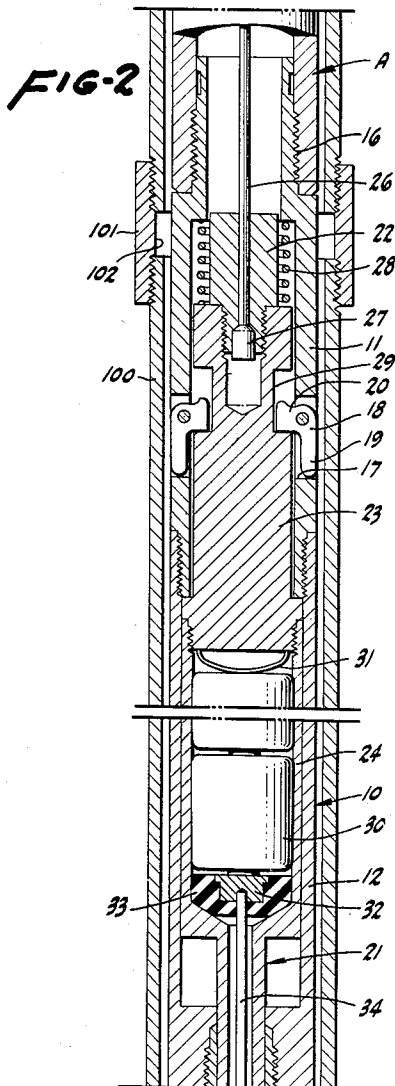
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FEELER HEAD ASSEMBLY

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8 Claims. (Cl. 33—178)

This invention relates to apparatus for surveying interiorly coated well tubing, and, more specifically, to a feeler head assembly usable with a tubing caliper for surveying such tubing.

In many oil well installations, the tubing string is provided with an interior plastic coating to prevent corrosion of the string and also to prevent paraffin deposits from forming on the string. In the use of such coated tubing, the normal passage of well tools through the tubing or the corrosive effects of the well fluids will remove the coating from portions of the tubing, thus destroying the effectiveness of such coatings.

The present invention provides a feeler head assembly which is designed to be used with a tubing caliper assembly to detect the uncoated portions, if any, in the tubing string. The caliper assembly is run through a desired portion of the tubing and the bare spots where the coating has been removed are detected by the feeler head assembly and recorded on a chart in the caliper assembly. After the run has been completed, the indication on the chart will reveal which, if any, of the tubing sections should be replaced.

The feeler head assembly of the present invention has been designed for use specifically with the tubing caliper shown in the patent to John V. Fredd, No. 2,708,316, in which the feeler head assembly of the present invention is substituted for the feeler head assembly generally indicated at B in the above patent. However, it should be understood that the present invention is not limited to use in that specific tubing caliper, but may be used in any other similar caliper.

It is a primary object of this invention to provide a feeler head assembly capable of detecting uncoated portions of coated well tubing.

Another object of the invention is to provide a feeler head assembly adapted to be run through a length of coated well tubing and which detects uncoated portions of the tubing and which is also actuated upon passing joints of the tubing.

A further object is to provide a feeler head assembly for use in a tubing caliper which is run through a coated well tubing, in which the feeler head assembly has a stylus actuating rod adapted to produce stylus markings upon vertical movement of the stylus actuating rod, and in which the rod is moved downwardly upon passing uncoated portions of the tubing or upon passing tubing joints.

Still another object of the invention is to provide a feeler head assembly adapted to pass through an extended length of an electrically conductive well tubing having an electrically non-conductive coating therein and which comprises a tubular housing, a stylus actuating rod mounted for axial movement in said housing and spring biased upwardly within said housing, a plurality of members mounted on and biased outwardly from said housing to engage the inner wall of said tubing, means responsive to simultaneous contact of preselected ones of said members with uncoated portions of the inner wall

2

of said tubing to move said rod downwardly within said housing, and means responsive to outward movement of preselected ones of said members into radial enlargements of said tubing to move said rod downwardly within said housing.

Other objects and advantages will become apparent in the course of the following detailed description.

In the drawings, forming a part of this application, and in which like parts are designated by like reference numerals throughout the same,

Fig. 1 is an elevational view of a tubing caliper employing the feeler head assembly of this invention.

Figs. 2 and 3 are consecutive elevational sectional views of a feeler head assembly constructed in accordance with the invention and with parts shown in inoperative position.

Fig. 4 is a cross-sectional view of the device, taken on line 4—4 of Fig. 3.

Figs. 5 and 6 are similar to Figs. 2 and 3, illustrating the parts in operative position.

Referring now to the drawings, the feeler head assembly includes a generally tubular housing member, indicated at 10, made up of an upper tubular sub 11, cylinder 12, mandrel 13, solenoid housing 14 and a lower tubular sub 15, all threadedly connected, one to another, in the above descending order.

The upper sub 11 is externally threaded at 16 for connection to a suitable release head assembly, as, for example, that indicated at A. A plurality of longitudinal slots 17 are formed circumferentially around the upper sub 11, each of said slots having a bell crank shaped locating member 18 pivotally mounted therein. Each locating member has an arm 19 adapted to project outwardly from the surface of the upper sub 11, and an inner arm 20 projecting inwardly of the upper sub.

An inner assembly 21, comprising an interconnected spring guide 22, plunger 23 and battery housing 24, is mounted for longitudinal slidable movement within the housing member 10. The battery housing 24 has a lower, reduced diameter, tubular extension 24a integral therewith. A release rod 26 projects slidably downwardly through spring guide 22, and is provided with an enlarged head 27 to prevent upward withdrawal thereof from the spring guide. In the inoperative position of the instrument (Figs. 2 and 3), the release rod is pulled upwardly into and by the above mentioned release head assembly A. Spring 28 is provided to force the inner assembly 21 downwardly when the release rod is released, so that the upper shoulder of the groove 29 is forced downwardly to engage the inwardly extending arms 20 of the locating members 18.

A plurality of mercury batteries 30 are contained within the battery housing 24, and are forced downwardly by leaf spring 31 into electrical contact with one another and with the contact button 32, the latter being insulated from the battery housing by insulation 33, and electrically connected to a power line 34.

The contact finger assembly is constructed in the following manner. A negative collet 36, surrounding mandrel 13 and abutting the cylinder 12, has a plurality of negative spring fingers 37 attached thereto, such fingers, when unrestrained, being adapted to spring outwardly from the housing member, as shown in Fig. 6. Each of the spring fingers 37 is provided with an outwardly projecting contact head 38, and a downwardly extending extension 39. The terms "negative" and "positive" as applied to the collets 36 and 43 are used in their electrical sense.

A generally cylindrical insulation member 41 abuts the lower end of the negative collet 36 and extends downwardly along the housing member to below the spring fingers 37. A plurality of longitudinal slots 42 are

3

formed through the insulation member to allow free inward and outward movement of the spring fingers.

A positive collet 43 is disposed between the upper end of the slotted insulation member 41 and the inner insulation member 44, so as to be completely insulated from the housing member 10. A plurality of positive spring fingers 46 are attached to the positive collet, in a manner as above described in connection with the negative spring fingers 37, and, again, each positive spring finger 46 has a contact head 47 and an extension 48 integral therewith. The positive spring fingers also extend through the slots 42 in the slotted insulation member, and are arranged with respect to the negative fingers 37 so that the positive and negative fingers alternate circumferentially around the instrument, as illustrated in Fig. 4. A power line 49 is electrically connected to the positive collet 43.

A finger retainer 51, formed preferably from insulating material, surrounds mandrel 13 and is connected by roll pins 52 to the inner assembly 21 for longitudinal movement therewith, such movement being allowable by means of the slot 53 in mandrel 13. As will be noted in Fig. 3, when the inner assembly is in its upper, inoperative position, the finger retainer can be moved upwardly on mandrel 13 so that the finger retainer encompasses the finger extensions 39 and 48 of the spring fingers 37 and 46 to retain these in their inner, inoperative position. When the inner assembly is later moved downwardly, the finger retainer will be carried therewith to release the spring fingers for outward movement thereof.

A solenoid 56 is disposed for longitudinal movement within the solenoid housing 14, and is provided with an electrical connector 57 which connects the power lines 34 and 49 to the solenoid. The solenoid used in this instrument has a core piece 58 which will move downwardly from the solenoid upon electrical energization thereof. Compression spring 59 biases the solenoid upwardly within the solenoid housing, with upward movement being limited by the engagement of the connector 57 with the lower end of mandrel 13.

A stylus rod bushing 61 is threaded into the lower end of the lower sub 15, to enable the housing member to be telescoped into engagement with a suitable chart chamber assembly, such as that indicated at C. Circumferentially spaced chamber screws 62 are provided in the stylus rod bushing to project into mating apertures in such chart chamber assembly to lock the two together.

A stylus actuating rod 63 is longitudinally and slidably disposed in the lower sub 15 and stylus rod bushing 61, and is prevented from rotating with respect thereto by the setscrews 64 carried by the stylus rod bushing and which project inwardly into the longitudinal grooves 66 formed in the stylus rod. The stylus actuating rod is internally threaded at its lower end (not shown) for connection with the stylus in the chart chamber assembly C.

A stylus lift spring 68, confined between the top of the stylus rod bushing 61 and the radially enlarged flange 69 on the stylus actuating rod, biases the rod upwardly so that the top thereof is held against the core piece 58 of the solenoid for movement therewith.

In the use of the device, the above described feeler head assembly is connected in a tubing caliper, as illustrated generally in Fig. 1, in which A indicates the release head assembly, B is the present feeler head assembly, C is the chart chamber assembly, and D is the drive assembly. Since the assemblies A, C and D are operationally the same as the corresponding assemblies described fully in the above referred to Patent No. 2,708,316, it is not thought necessary to redescribe these assemblies in detail here. The stylus rod 63 is connected to the stylus of the chart chamber assembly C so that any vertical movement of the stylus rod 63 will produce appropriate markings on the chart. The release rod 26 is held in its upper, or inoperative, position by the release head assembly A, so that the lower surface of

4

groove 29 will bear against the inwardly projecting arms 20 of the locating members 18 to pivot these members inwardly and flush with the housing member 10 in order that the tubing caliper may be lowered through the tubing string to its initial operating position.

With the tubing caliper in its initial operating position in the well, and prior to the commencement of its upward travel, the arrangement of parts of the feeler head assembly is as shown in Figs. 2 and 3.

The caliper is then moved upwardly until the release head assembly passes a junction of two sections of tubing 100, at which time the release head assembly will be actuated to release the release rod 26 from its upper position, again as fully described in the above referred to patent. The spring 28 then acts upon the plunger 23 to force the inner assembly downwardly until the upper surface of slot 29 engages the arm 20 of the locating members 18 to pivot the arms 19 thereof outwardly into engagement with the tubing wall 100. The spring finger retainer 51 moves downwardly with the inner assembly to free the spring fingers 37 and 46 so they may spring outwardly into engagement with the tubing wall. The downward movement of the inner assembly 21 also causes the lower end 70 thereof to abut the solenoid connector 57. This operative arrangement of parts of the feeler head assembly is illustrated in Figs. 5 and 6.

As the caliper continues in its upward movement, the stylus actuating rod 63 can be moved downwardly by two separate means, with such downward movement causing appropriate markings to be made by the stylus connected thereto.

First of all, the rod 63 is moved downwardly in response to the feeler head assembly passing over tubing joints. As the feeler head assembly passes a tubing joint 101, the locating members 18 will be pivoted outwardly into the circumferential depression 102 of the joint by spring 28, allowing the spring to move the inner assembly 21 downwardly to displace the solenoid and core piece thereof downwardly against the bias spring 49 and to displace the stylus rod 63 downwardly against the bias of stylus lift spring 68. After the locating members 18 pass upwardly beyond the tubing joint, they will be forced inwardly by engagement with the tubing wall to force the inner assembly 21 upwardly against the bias of spring 28. The solenoid 56 and stylus rod 63 will be returned to their normal upward position by their respective springs 59 and 68. Among other things, this downward and upward movement of stylus rod 63 serves as a means of indicating on the chart the number of joints of tubing surveyed, and the relative location of defective areas in the coating on the wall of the tubing, as determined by the following means.

The stylus rod 63 will also be moved downwardly upon the presence of uncoated areas of the tubing. As has been mentioned before, the inner wall of the tubing, being surveyed with this device, is coated with an electrically non-conductive material. If this coating is removed from the inner tubing wall sufficiently to allow one or more of the negative fingers and one or more of the positive fingers to contact the bare wall of the tubing simultaneously, then an electrical circuit will be completed through the batteries 30, power line 34, solenoid 56, power line 49, positive finger 46, the tubing wall 100, and negative finger 37 back through the housing member 10 and battery housing 24 to the batteries 30, to energize the solenoid 56. The energization of the solenoid causes the core piece 58 thereof to move downwardly, forcing the stylus rod 63 downwardly against the bias of the stylus lift spring 68. As the caliper continues to move upwardly, the stylus rod will continue to be held in its downward position as long as a positive and a negative finger both contact the bare tubing wall. When either of these fingers is separated from the bare wall, then the above described circuit will be broken to deenergize the solenoid, and the stylus lift spring 68 will return the stylus rod 63 to its normal upper position.

5

Upon completion of the survey, the caliper is removed from the well, and the chart is examined to determine if any of the tubing is defectively coated. The release head assembly A and spring finger retainer 51 are manually reset to their original positions before the next run is made.

Although the operation has been described in connection with a tubing string, it is obvious that the surveying operation may be carried out upon a coated casing string, if desired.

It is to be understood that the form of the invention, herewith shown and described, is to be taken as a preferred embodiment of the same, and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the attached claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A feeler head assembly adapted to pass through an extended length of electrically conductive well tubing having an electrically non-conductive coating therein, comprising: a tubular housing, a stylus actuating rod mounted for axial movement in said housing, spring means normally biasing said rod upwardly within said housing, a plurality of members mounted on and disposed circumferentially of said housing, said members being biased outwardly from said housing to engage the inner wall of said tubing, means responsive to simultaneous contact of preselected ones of said members with uncoated portions of the inner wall of said tubing to move said rod downwardly within said housing, and means responsive to outward movement of preselected ones of said members into radial enlargements of said tubing to move said rod downwardly within said housing.

2. A feeler head assembly adapted to pass through an extended length of tubing having an electrically non-conductive coating on the inner wall thereon, comprising: a tubular housing, a stylus actuator rod mounted for axial movement in said housing and biased upwardly therein, a first set of members carried by said housing and resiliently biased outwardly therefrom into engagement with the inner wall of said tubing, a second set of members carried by said housing and resiliently biased outwardly therefrom into engagement with the inner wall of said tubing, electrical means responsive to simultaneous contact of preselected members of said first set with uncoated portions of the inner wall of said tubing to move said stylus actuating rod downwardly within said housing, and spring biased means responsive to outward movement of said second set of members into radial enlargements of said tubing to move said stylus actuating rod downwardly within said housing.

3. A feeler head assembly adapted to pass through an extended length of tubing having an electrically non-conductive coating on the inner wall thereon, comprising: a tubular housing, a stylus actuator rod mounted for axial movement in said housing and spring biased upwardly therein, a first set of members carried by said housing and spaced circumferentially therearound, said first set of members being resiliently biased outwardly into engagement with the inner wall of said tubing, a second set of members carried by said housing and spaced circumferentially therearound, said second set of members being resiliently biased outwardly into engagement with the inner wall of said tubing, means responsive to simultaneous contact of preselected members of said first set with uncoated portions of the inner wall of said tubing to move said stylus actuating rod downwardly within said housing, and means responsive to outward movement of said second set of members into radial enlargements of said tubing to move said stylus actuating rod downwardly within said housing.

4. A feeler head assembly comprising a tubular housing adapted to pass through an extended length of interiorly coated well tubing, a stylus actuating rod mounted for

6

axial movement in said housing and spring biased upwardly therein, a plurality of resilient fingers mounted on and spaced circumferentially around said housing, said fingers extending outwardly from said housing to normally engage the inner wall of said tubing, electrical means including a solenoid connected in series with preselected ones of said fingers to move said stylus actuating rod downwardly upon simultaneous contact of said preselected fingers with an electrically conductive material, a plurality of locating members mounted on and spaced circumferentially around said housing, said locating members each having an outwardly extending portion biased outwardly into engagement with the inner wall of said tubing, and means responsive to outward movement of said locating member portions to move said stylus rod actuator downwardly.

5. A feeler head assembly for use with well surveying equipment comprising a vertically disposed, tubular housing, a solenoid mounted for longitudinal movement in said housing and biased upwardly therein, a core piece in said solenoid movable downwardly therefrom upon energization of said solenoid, a stylus actuator rod mounted for longitudinal movement in said housing and biased upwardly into engagement with said core piece for movement therewith, a plunger mounted for longitudinal movement in said housing, spring means biasing said plunger downwardly into engagement with said solenoid to move said plunger, solenoid and rod downwardly as a unit, a locator member pivotally connected to said housing and having an arm projecting outwardly therefrom and an arm projecting inwardly into engagement with said plunger whereby pivotal movement of said outwardly projecting arm towards said housing will move said plunger upwardly against the bias of said spring means, a plurality of contact fingers mounted on, insulated from, and extending outwardly from said housing, an electrical battery, and electrical circuit means connecting one of said fingers, said battery, said solenoid and another of said fingers in series.

6. A feeler head assembly of the character described comprising a vertically disposed, tubular housing having an axial bore therethrough, said bore having an internal shoulder intermediate the ends of the bore, a solenoid mounted for longitudinal movement in said bore and biased upwardly against said shoulder, a core piece in said solenoid movable downwardly therefrom upon energization of said solenoid, a stylus actuator rod mounted for longitudinal movement in said bore and biased upwardly against said core piece for movement therewith, a plunger mounted for longitudinal movement in said bore, spring means biasing said plunger downwardly into engagement with said solenoid, said spring means being adapted to move said plunger, solenoid and rod downwardly as a unit, a plurality of locator members pivotally connected to said housing, said locator members each having an arm projecting outwardly from said housing and an arm projecting inwardly from said housing into engagement with said plunger whereby pivotal movement of said outwardly projecting arms towards said housing will move said plunger upwardly against the bias of said third spring means, a plurality of contact fingers mounted on, insulated from, and extending outwardly from said housing, an electrical battery, and electrical circuit means connecting one of said fingers, said battery, said solenoid and another of said fingers in series.

7. A feeler head assembly for use in well surveying equipment for surveying an extended length of electrically conductive tubing having an electrically non-conductive coating therein, comprising: a generally tubular housing having an axial bore therethrough, said bore having an internal shoulder intermediate the ends of the bore, a solenoid mounted for longitudinal movement in said bore and normally biased against said shoulder, a core piece in said solenoid movable in a direction away

from said shoulder upon energization of said solenoid, a stylus actuator rod mounted for longitudinal movement in said bore and biased against said core piece for movement therewith, a plunger mounted for longitudinal movement in said bore, spring means biasing said plunger into engagement with said solenoid to move said plunger, solenoid and rod as a unit in a direction away from said shoulder, a plurality of locator members pivotally connected to said housing, said locator members each having an arm projecting outwardly from said housing and an arm projecting inwardly from said housing into engagement with said plunger whereby pivotal movement of said outwardly projecting arms towards said housing will move said plunger against the bias of said spring means, a plurality of contact fingers mounted on, insulated from, and extending outwardly from said housing, an electrical battery, and electrical circuit means connecting one of said fingers, said battery, said solenoid and another of said fingers in series.

8. A feeler head assembly comprising a generally tubular housing having an axial bore therethrough, said bore having an internal shoulder intermediate the ends of the bore, a solenoid mounted for longitudinal movement in said bore, first spring means biasing said solenoid against said shoulder, a core piece in said solenoid mov-

able in a direction away from said shoulder upon energization of said solenoid, a stylus actuator rod mounted for longitudinal movement in said bore, second spring means biasing said stylus actuator rod against said core piece, a plunger mounted for longitudinal movement in said bore, third spring means biasing said plunger into engagement with said solenoid to move said plunger, solenoid and rod as a unit against the bias of said first and second spring means, a plurality of locator members pivotally connected to said housing, said locator members each having an arm projecting outwardly from said housing and an arm projecting inwardly from said housing into engagement with said plunger whereby pivotal movement of said outwardly projecting arms towards said housing will move said plunger against the bias of said third spring means, a plurality of contact fingers mounted on, insulated from, and extending outwardly from said housing, an electrical battery, and electrical circuit means connecting one of said fingers, said battery, said solenoid and another of said fingers in series.

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