SEARCH ROOM

June 3, 1969 G. L. HAHN 3,448,373

WELL LOGGING TOOL WITH A TRANSVERSELY SHIFTABLE MEMBER CARRYING A LOGGING ELEMENT AND HAVING A PIVOTALLY LINKED PAD MEMBER

Filed June 10, 1966

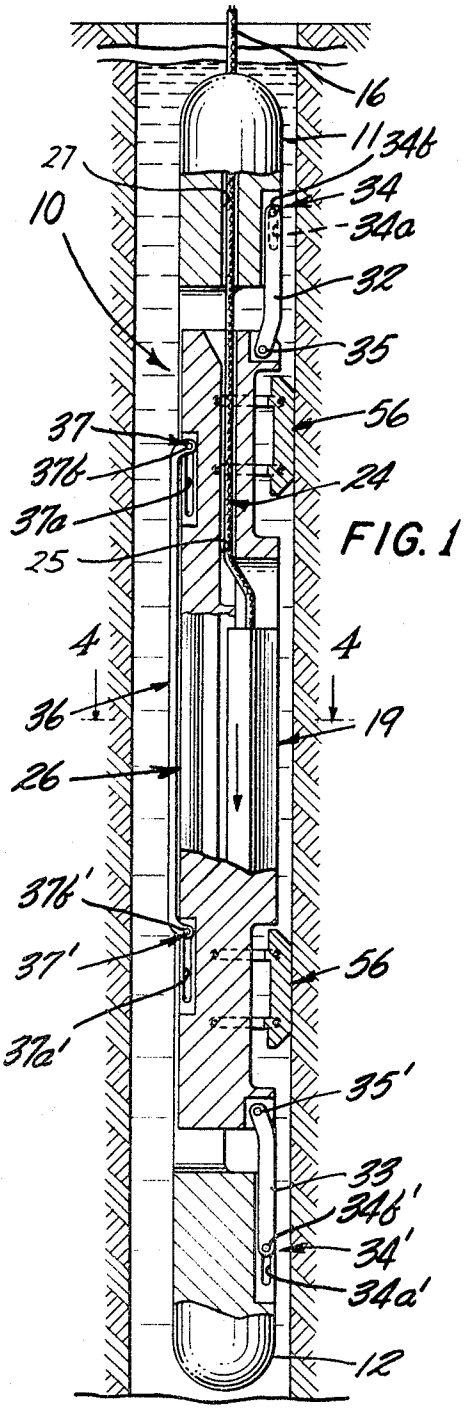


FIG. 1

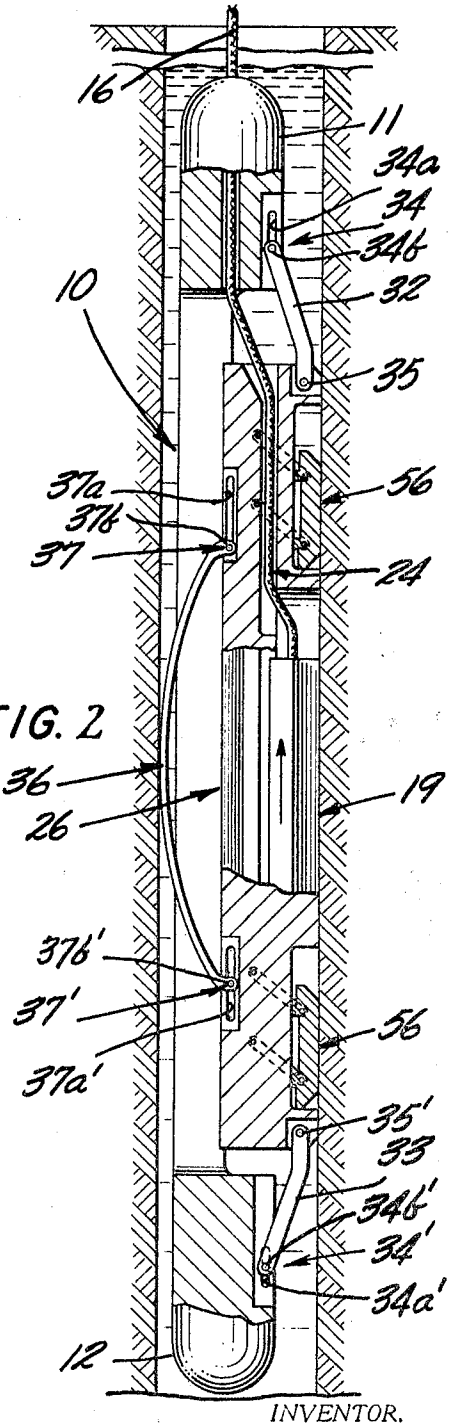


FIG. 2

INVENTOR.
Guerry L. Hahn
BY David L. Moseley
ATTORNEY

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FIG. 3

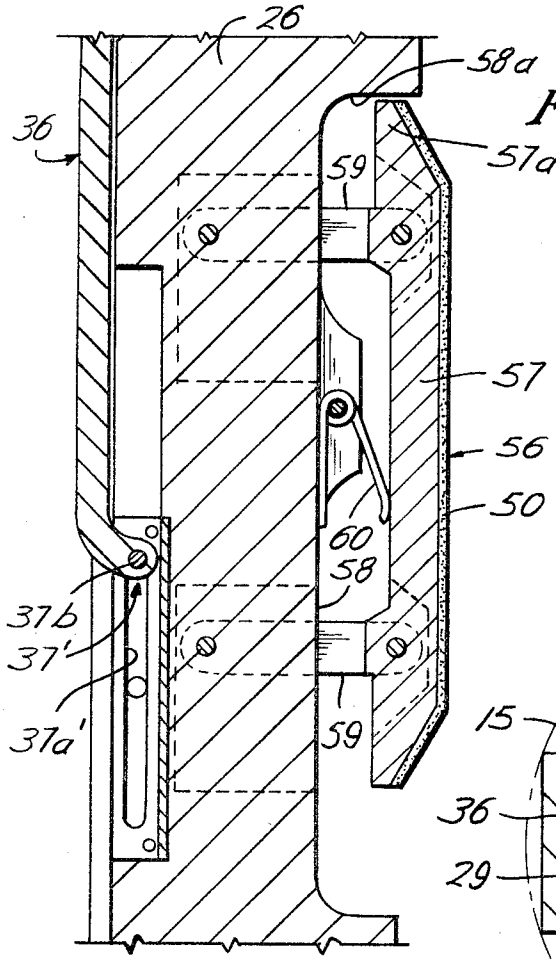


FIG. 4

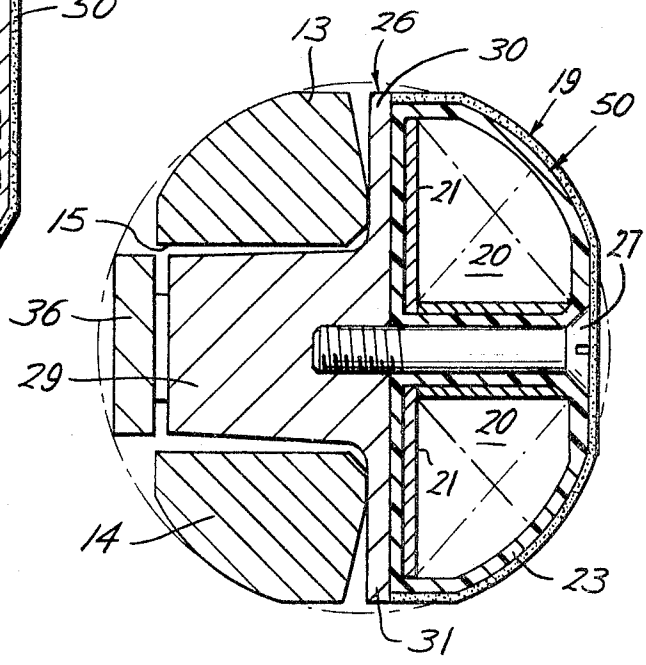
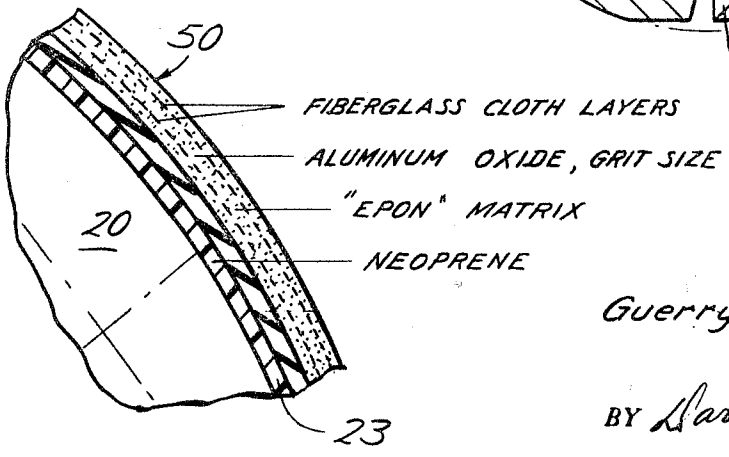


FIG. 5



Guerry L. Hahn
INVENTOR

BY David L. Moseley

ATTORNEY

United States Patent Office

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WELL LOGGING TOOL WITH A TRANSVERSELY SHIFTABLE MEMBER CARRYING A LOGGING ELEMENT AND HAVING A PIVOTALLY LINKED PAD MEMBER

Guerry L. Hahn, Houston, Tex., assignor to Schlumberger Technology Corporation, Houston, Tex., a corporation of Texas

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Int. Cl. G01v 3/18
U.S. Cl. 324—1 8 Claims

ABSTRACT OF THE DISCLOSURE

As embodied in the form shown in the drawings and described in detail, a well logging tool comprises a body adapted to be moved longitudinally in a well bore and a member mounted on the body for movement transversely relative to it between a retracted position out of engagement with the well bore wall and an extended position in engagement with the well bore wall. The surface of the member contacting the wall is overlaid with a wear-resisting, non-conductive and non-magnetic material. Stand-off pad members normally extending from the member engage the well bore wall and maintain the member out of engagement with it, but the pad members are retractable to permit the member to engage the well bore wall when operations are conducted with the tool. The member is resiliently urged into engagement with the well bore by a bow spring or the like linked to the member and selectively engageable with the well bore wall at a point generally opposite the point engaged by the member.

This invention relates to well logging apparatus and, more particularly, to a novel and improved well logging tool adapted to be run into a well bore carrying detecting equipment for determining characteristics of the earth formation in the well.

Certain logging operations conducted in oil and gas well bores involve the use of down-hole detection devices which are brought into engagement with the walls of the well bore during the actual taking of measurements. For example, one type of logging operation, nuclear magnetism logging, involves measurements of certain characteristics of the precession of hydrogen nuclei upon the termination of an electromagnetically induced magnetic field which changes the spin axis of the nuclei. For this purpose, a logging tool is run into a well bore carrying elongated coil means which serves to both induce a magnetic field in the well bore and, upon termination of the field, to detect the magnetic effects of precession of the nuclei as their spin axes return to normal alignment, and the coil means must be held as closely as possible against the wall of the well bore during this operation. Other well-known operations, such as radioactivity or electrical characteristic measurements, also require a tool having an elongated detecting device or other operative portion which is held in close engagement with the well wall. Usually, however, it is desirable to bring the operative portion of the tool into engagement with the well wall only after the logging tool has reached the desired location, keeping the operative portion retracted out of engagement with the bore when the tool is being run into the well. This eliminates wear on and possible damage to the detection device as it is run in and permits the tool to be run at a greater speed than would be possible if the detection device were positioned for engagement with the well bore.

In accordance with the invention. a tool for use in well bore operations includes an elongated frame or body, a support member adapted to carry an operative logging element which is normally retracted but which is mounted on the body in a manner such that it is movable into engagement with the well bore, and a mechanism for moving the member into an extended position in engagement with the well bore wall when desired. The support member is carried by the body but is independently movable so that it can follow the contour of a well bore independently of the position of the body in the well bore.

In a representative embodiment of the invention, one or more pad members carried by the support member on which the detection device is mounted are arranged to engage the well bore wall and hold the detection device out of its extended, operative position in contact with the well bore. Each pad member is coupled to the support member by links, and is arranged for limited movement in one direction relative to the body such that it is held extended relative to the body and engages the wall of a well bore when the support member is moved in the opposite direction. Preferably, the pad member is located relative to the support members such that pivotal rotation of the links in one direction relative to the support member moves the pad member into a retracted position relative to the support member, and rotation in the other direction moves the pad member into an extended position in which one end abuts the support member and further relative movement is prevented.

Since the detection device and the one or more pad members may be required to slide along several thousands of feet of well bore wall, even during a single logging operation, it is desirable that they be particularly constructed and arranged to be rugged and wear resistant. Moreover, it is desirable that the parts be made to include materials having nonmagnetic properties so as not to have a disturbing effect on flux lines being set up in the well bore and traveling into the formation. Also, the materials should have nonconductive properties since a loop of electricity conductive material can have a disturbing effect upon any measurements being taken.

Accordingly, in the representative embodiment of the invention above referred to, the peripheral surfaces of the detection device and the one or more pad members which are adapted to be positioned in intimate sliding contact with a well bore wall may be overlaid with a material including a metallic oxide impregnated with a plastic binding agent so as to form a wear resistant, nonconductive and nonmagnetic hard surface thereon.

For a better understanding of the invention, reference may be made to the following description of an exemplary embodiment, taken in conjunction with the figures of the accompanying drawings, in which:

FIG. 1 is a diagrammatic elevational view of a logging tool in accordance with the present invention with its parts shown in a configuration for lowering into the well bore;

FIG. 2 is a diagrammatic elevational view of the tool with its parts in a configuration for coming out of the well bore during a logging operation;

FIG. 3 is an enlarged cross-sectional view of a pad member according to the present invention;

FIG. 4 is an enlarged cross-section taken on line 4—4 of FIG. 1; and

FIG. 5 is a further enlarged fragmentary cross-sectional view to illustrate in detail the surfacing materials of the present invention.

In the figures of the drawing, the reference numeral **10** designates the frame or body of the tool which consists of upper and lower sections **11** and **12**, respectively, which

are generally cylindrical in cross-section, and an intermediate portion composed of spaced-apart members **13** and **14** (FIG. 4) joined to the upper and lower sections and defining an elongated slot **15** therebetween. The body **10** includes other housing sections above upper section **11** for electronic equipment or the like. The electrical and electronic equipment and other components of the tool associated with the detection device form no part of the present invention and are therefore not illustrated in the drawings or described in detail. The tool is adapted to be run into the well bore on a cable **16** which is capable of supporting the loads of running in and retrieving the tool, and which also carries conductors for transmitting power for and signals to and from the electrical and electronic parts of the tool.

As illustrated in various figures of the drawings, the logging tool carries a detection device which, in the embodiment described and illustrated herein, is an elongated coil structure **19** carried by a support member **26**. The coil structure includes electrically conductive windings **20** mounted on a base **21** made of a nonconductive, nonmagnetic material and enclosed in a protective case **23**, also made of nonmagnetic, nonconductive material such as fiber glass. The windings lead from the upper end of the coil and are coupled to conductors of a cable **24**; the cable **24** passes upwardly to the electronic apparatus in the upper body section **11** through a bore **25** formed in the support member **26** and a bore **27** in the upper body section **11**.

As shown in FIG. 4, the support member **26**, to which a coil structure **19** is fastened by screws **27**, made of a nonconductive, nonmagnetic material, is generally T shaped in section and includes a web or base portion **29** which is received in the slot **15** between the intermediate frame members **13** and **14**, and has flange portions **30** and **31**. The support member **26** is coupled to the upper and lower body sections **11** and **12** by links **32** and **33** which have upper and lower pin and slot connections **34** and **34'**, respectively, to the body sections **11** and **12** and pin connections **35** and **35'** to the member **26**. Thus, the support member for the coil structure is movably transversely toward and away from the intermediate members **13** and **14** of the body **10** in and out of the slot **15** therebetween.

While the logging tool is being run into the well, the support member **26** and coil structure **19** are held in a retracted position in which the flanges **30** and **31** of the support member are engaged against the adjacent surfaces of the intermediate body member **13** and **14**. Upon reaching the desired location in the well bore where logging operations are to be commenced, the support member is moved outwardly to bring the coil into engagement with the wall of the well bore. For this purpose, an elongated spring **36** is attached to the base **29** of the support member **26** by means of pin and slot connections **37** and **37'** at its upper and lower ends, respectively. The spring **36** in its normal operating condition, is bowed outwardly as shown in FIG. 2, but in its running-in condition, as shown in FIG. 1, is held in a substantially flat, retracted position by a suitable releasing mechanism (not shown).

Returning to FIGS. 1 to 3, means for holding the coil structure out of engagement with the well bore when the tool is run into the well can be provided to limit wearing and the possibility of damage to the tool and to permit the tool to be run into the well at a relatively high speed. For this purpose, two identical stand-off mechanisms **56**, one above and one below the coil structure, are carried by the support member **26**. Each of the stand-off mechanisms comprises a shoe or pad member **57** installed in a recess **58** in the support member by means of a pair of pivotable links **59**, and a spring **60** urges the pad member outwardly into engagement with the well bore. When the tool is run into the well, the frictional forces between the pad members and the well bore wall tend to pivot them upwardly and outwardly and, accordingly, tends to also hold them in their extended positions, as illustrated in FIGS. 1 and 3. In this position, the upper ends **57*a*** of the pad members **57** engage shoulders **58*a*** on the support member **26**. When the tool is moved upwardly in the well bore, the frictional forces acting on the pad members tend to move them downwardly into retracted positions. Moreover, the force of the spring **36** urging the mounting member and coil structure into engagement with the wall of the well bore is considerably larger than the forces of the springs **60** of the stand-off mechanisms, and thus the pad members are held retracted during upward movement in the well bore during the logging operation.

As described thus far, the logging tool operates in the following manner. As shown in FIG. 1, the tool is lowered into the well bore with the coil structure **19** held in retracted position, the spring **36** being held flat against the support member **26** by a release mechanism (not shown). The coil structure is protected from the wearing action of the well bore walls by the stand-off mechanisms **56**, which are extended by their springs **60**, in cooperation with the frictional forces on the pad members **57**, into operative positions. When the tool has reached the desired position for the commencement of logging operations, an electrical signal is initiated at the well surface to operate the releasing mechanism. Upon release, the spring **36** resiles into engagement with the wall of the well bore and urges the coil structure **19** into engagement with the opposite wall of the well bore. The logging operation is then commenced, the tool being moved upwardly at a suitable rate of speed with the parts in the configuration illustrated in FIG. 2. In particular, the stand-off mechanisms **56** are in retracted position due to the opposing force of the main actuating spring and the frictional forces acting on the stand-off shoes, which tend to cause the shoes to retract.

As shown in FIG. 2 each of the pin and slot connections **37** and **37'** between the spring **36** and the support member **26** includes, respectively, an elongated slot **37*a***, **37*a'*** in the support member **26** and a pin **37*b***, **37*b'*** at the end of the spring **36**. When the spring **36** is in a retracted position, the pins **37*b*** and **37*b'*** are both near the upper ends of the slots **37*a*** and **37*a'***. When the spring **36** is released it will bow out and foreshorten the distance between the pins. During the logging operation, as shown in FIG. 2, the spring **36** frictionally engages the wall of the well bore, and the spring is dragged so that the upper pin **37*b*** is pulled to the lower end of the slot **37*a***. The lower pin **37*b*** appropriately positions itself somewhere between the ends of the slot **37*a'*** depending upon the extent of flexure of the spring. The slots **37*a*** and **37*a'*** are located on supported member **26** relative to the length of spring **36** between the pins **37*b*** and **37*b'*** so that the spring is nearly flat when the respective pins are in either the upper or lower ends of the slots. The effect of this arrangement is that when the spring is released, the slots permit the spring **36** to disengage, should obstructions be encountered while moving in either direction, and also permits the use of relatively uniform spring pressure since the spring will move inwardly and outwardly without significantly affecting its spring action.

The pin and slot connections **34** and **34'** connecting the support member **26** to the body **10** similarly include slots **34*a*** and **34*a'*** and pins **34*b*** and **34*b'***, respectively. While moving upwardly, the upper pin **34*b*** resides in the lower end of slot **34*a*** while the lower pin **34*b'***. When the support member is retracted, as the tool is run down into the well, as shown in FIG. 1, the lower pin **34*b'*** is located near the bottom of slot **34*a'***. The pin and slot connections **34** and **34'** thus are nonlocking in either direction.

The spring **36** which is arranged to have its midpoint located in the center of the support member **26**, holds the support member **26** against the wall of a well bore. Since the length of the support member **26** is short relative to the length of the entire tool **11** the support member **26** is free to move with respect to the main portion

of the tool body and adapt to irregularities in the well bore, such as crooked places or areas of washouts. Since the support member **26** is relatively small, the spring **36** can provide better wall contact under varying well bore conditions. As a matter of comparison the tool could be 25 feet in length and the member **26**, five feet or less in length.

Referring now to FIG. 5, there is provided, in accordance with the present invention, an outer surfacing **50** on the detecting device **20** and the one or more pad members **56** particularly adapted to withstand wearing as the logging tool **10** is slid along the well bore wall and which is also particularly adapted to be electrically nonconductive and nonmagnetic. The following example of specific materials for the surfacing **50** represents a practical embodiment of the present invention but is not to be considered as limiting the invention in any sense. The surfacing **50** is comprised of aluminum oxide having a grit size which is embedded or mixed with an epoxy resin (for example, the epoxy resin manufactured by Shell Chemical Company and sold under the trademark "Epon") as a matrix. The aluminum oxide and "Epon" are used with a plurality of layers, for example, six of fiber-glass cloth to form an overlay or facing over the outer surfaces of the detecting device **20** and the one or more pad members **56**. While aluminum oxide has been disclosed as preferable, in general, abrasive or granular grits which are electrically nonconductive such as silicates may be equally preferable. The epoxy resin acts as a binding agent which will harden to provide a rugged surfacing on the outer periphery of the mounting member **22** and the coil structure **21**. If desired, a layer of hard rubber-like material such as neoprene can be positioned between the coil structure case **25** and the surfacing **50** to further isolate the detection device from moisture.

Although parts of the logging tool are dragged or slid along the well bore wall, the hard surfacing **50** serves to protect them from wear and to enhance their ruggedness. Inasmuch as the surfacing materials have nonconductive and nonmagnetic properties, the surfacing **50** will have no disturbing effect on flux lines being generated or measurements being taken.

In the foregoing description, discussion has been presented for use in the tool in nuclear magnetic logging. In the construction of the tool above described, it will be appreciated that the components should be constructed of nonmagnetic materials where practical so that the logging portion of the tool is substantially nonmagnetic.

It will be understood that the above-described embodiment of the invention is merely exemplary, and those skilled in the art will be able to make many modifications and variations of it without departing from the spirit and the scope of the invention. All such modifications and variations are intended to be included within the scope of the invention as defined in the appended claims.

I claim:

1. In a well logging tool having a member adapted to be moved in either longitudinal direction in a well bore, means resiliently urging said member toward the well bore wall, means for enabling engagement of said member in sliding contact with a well bore wall during movement in one longitudinal direction and for holding said member out of engagement with the well bore wall during longitudinal movement in the other direction, including a pad member carried by said member and having a wear resistant surfacing material thereon for frictionally engaging the wall of the well bore, said pad member being movable longitudinally relative to said member between extended and retracted positions, link means pivotally coupling said pad member to said member, resilient means engaging said pad member and urging it outwardly relative to said member, pivotal rotation of said link means in one rotational direction enabling movement of said pad member and said member in opposite directions relative to one another and extension of said pad member relative to said member to correspondingly hold said member away from the well bore wall, such movement being effected solely by said spring means and by frictional forces developed between the pad member and the well bore wall and acting on said pad member as said member is moved in the well bore, and pivotal rotation of said link means in the other rotational direction enabling retraction of said pad member relative to said member to permit said member to engage the well bore wall, and means for limiting pivotal rotation of said link means in said one direction to limit the extent of longitudinal movement of said pad member and said member relative to each other with said pad member in extended position.

2. A well logging tool comprising an elongated body adapted to be moved longitudinally in a well bore, a member mounted on the body for movement transversely relative to the body between a retracted position out of engagement with a well bore wall and an extended position in engagement with the well bore wall, said member having an elongated surface thereon which contacts the wall of a well bore when the member is in extended position, said surface being overlaid with a wear resisting, nonconductive and nonmagnetic material and said surface being short as compared to the length of said elongated body, means on the member selectively engageable with the opposite side of the well bore wall from the point of engagement of said enlongated surface with the well bore wall for maintaining said member in an extended position, and means normally extending from the member and engageable with the well bore wall for holding the member away from the well bore wall and selectively movable into retracted position upon movement of the member into its extended position.

3. Apparatus according to claim **2** wherein said material comprises a metallic oxide impregnated with a plastic binding agent.

4. Apparatus according to claim **3** wherein said plastic binding agent includes an epoxy resin in combination with at least one layer of fiber-glass cloth.

5. Apparatus according to claim **3** wherein said metallic oxide is aluminum oxide having grit size.

6. Apparatus according to claim **2** wherein the normally extending means for holding the member away from the well bore comprises spaced-apart shoe elements, a pair of spaced-apart legs pivotally coupling each of the the shoe elements to the member and resilient means disposed between the member and each of the shoe elements for normal urging the shoe elements into engagement with the well bore wall.

7. Apparatus according to claim **6** wherein the shoe elements are disposed in recesses formed in the member and are engageable with the upper edges of the recesses and spaced from the lower edges of the recesses when they are in their extended positions, whereby the forces on the shoe elements due to friction tend to engage the shoe elements with the upper edges of the recesses and hold them in an extended position when the tool is moving downwardly into the well, and the forces due to friction tend to move the shoes downwardly into the recesses in their retracted positions upon upward movement of the tool in the well bore.

8. A well tool adapted for use in a well bore comprising: an elongated body member for carrying auxiliary components of a logging tool, said body member having a section with an elongated opening, a support member carrying a prime component of a logging tool and being received in said opening, said member being movable between a retracted position relative to said opening and an extended position bringing the prime component into proximity to a well bore wall, means for moving said support member to such extended position, means coupling said support member to said body member including link means, spaced-apart pad members having a material providing a nonconductive and nonmagnetic wear surface on the periphery thereof for frictionally engaging the wall

of a well bore, link means pivotally coupling said pad members to said support member, means for limiting pivotal rotation of said link means relative to said support member so that said pad member may be extended relative to said body to a first position when said pad member engages the wall of a well bore and said support member moves in one direction in a well bore yet permitting pivotal rotation of said link means relative to said support member to a second position when said pad member engages the wall of a well bore and said support member moves in the other direction in a well bore.

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RUDOLPH V. ROLINEC, *Primary Examiner.*

G. R. STRECKER, *Assistant Examiner.*

U.S. Cl. X.R.

73—152; 166—241; 250—83.6

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,448,373 Dated June 3, 1969

Inventor(s) G. L. Hahn

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 64, after "34b'" and before the period the following words have been omitted: "locates intermediate of the length of slot 34b'."

SIGNED AND
SEALED
SEP 30 1969

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents