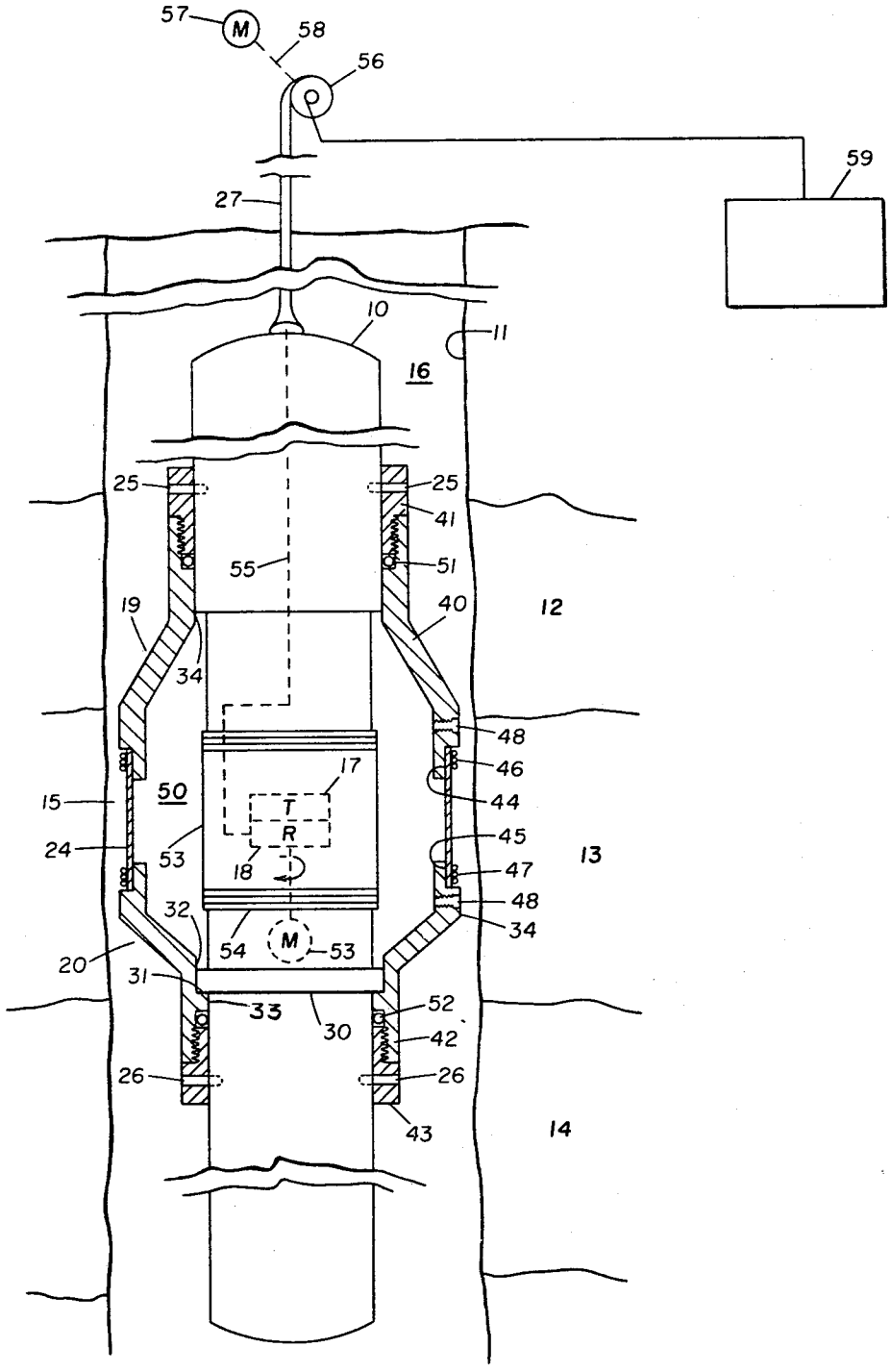
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ARRANGEMENT FOR COUPLING BOREHOLE FLUID EXCLUDER TO BOREHOLE LOGGING TOOL

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ARRANGEMENT FOR COUPLING BOREHOLE FLUID EXCLUDER TO BOREHOLE LOGGING TOOL

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ABSTRACT OF THE DISCLOSURE

The specification discloses a borehole liquid excluding system for use with a borehole logging tool and which includes an excluding means adapted to surround the tool to displace undesirable borehole material from between the tool and the borehole wall. Coupling means releasably attaches the excluding means to the tool and allows the tool to be separated from the excluding means and to be moved upwardly out of the borehole in the event the excluding means becomes lodged in the borehole. In addition, means is provided for preventing the excluding means from being detached from the tool when the logging tool is being lowered into the borehole.

This invention relates to a fluid excluding system for borehole tools and which will allow a tool to become detached from the excluder and pulled up and out of the borehole in the event the excluder becomes lodged in the borehole but which prevents the tool from passing downwardly through the excluder.

In normal borehole practice, fluid excluders are not employed since they enhance the possibility of the tool assembly becoming lodged in the borehole. Subsequent removal of the lodged tool assembly from the borehole may become very difficult, hence, resulting in the loss of time and money in addition to possible damage to the borehole and tool.

Thus, for successful use of a excluder, an arrangement must be employed which will allow the tool to be easily released or detached from the excluder and pulled upward and out of the hole in the event the excluder becomes lodged. Such an arrangement is disclosed in copending United States application Ser. No. 447,263, filed Apr. 12, 1965, by Richard L. Caldwell and assigned to the same assignee as the present invention. In the system disclosed in the above-identified application, shear pins attached the excluder to the tool. In the event the excluder becomes lodged in the hole, upward tension on the cable will cause the pins to break or shear thereby allowing the tool to be pulled upward from the excluder and out of the hole. Since the excluder is formed of relatively soft material, it can be cleared from the borehole by simple drilling operations.

Normally a borehole is logged while retrieving the tool from the hole. Consequently, in order to conserve time, operating personnel in many instances lower the tool into the borehole as rapidly as possible. During the rapid lowering operation, the fluid excluder means may contact the borehole wall or obstructions so vigorously that the fluid excluder may be sheared from the logging tool. This may not be known or realized until after the tool is lowered to its maximum depth and extensive upward logging operations carried out. Thus, unsuccessful logging operations may result requiring further logging, hence, a loss of time and money.

In accordance with the present invention, the above problems are eliminated by providing, in a system comprising a borehole tool and an excluding means releasably attached to the tool to allow the tool to be moved upward and out of the excluding means, an arrangement for

preventing the excluding means from being detached from the tool when the tool is being lowered in the borehole.

The tool disclosed is an elongated member having a top and bottom end and an enlarged cross-sectional portion along the length thereof. The excluding means comprises at least one rigid member having an opening extending therethrough and having a first region in which the cross section of the opening is of a size sufficient to freely receive the tool including the enlarged cross-sectional portion. The cross section of at least a portion of the opening is less than that of the enlarged cross-sectional portion of the tool. When the tool is positioned in the borehole the enlarged cross-sectional portion of the tool is located in the opening in the first region of the rigid member and positioned above the lesser cross-sectional portion of the opening in contact with the structure of the rigid member forming the lesser cross-sectional portion. With this arrangement the enlarged cross-sectional portion of the tool and the rigid internal structure of the excluder absorbs the force which may be imparted by the borehole walls to the excluding means upon downward movement of the tool thereby preventing the tool and the excluding means from separating while the tool is being lowered.

Although this arrangement absorbs the force upon downward movement of the tool and hence protects the shear pins which may be employed, it does not prevent force being transmitted to the shear pins if upward tension is applied to the tool by the logging cable. Thus, the arrangement employed prevents the excluding means from being separated from the tool upon downward movement of the assembly but allows the tool to be separated from the excluding means with the application of upward force or tension to the tool in the event the excluding means becomes lodged in the borehole while logging.

In the embodiment disclosed, the excluding means is employed with an acoustic logging tool and comprises two rigid members surrounding the tool and spaced apart on each side of a zone containing an acoustic exploration transducer. A resilient member surrounds the tool around the zone and is secured to the two rigid members forming a fluid-tight chamber which extends outward from the zone thereby excluding borehole fluid from around the zone of the tool containing the exploratory means. In the embodiment disclosed, the resilient member is located inwardly from the outer periphery of the rigid members thereby allowing the rigid members to protect the flexible means from the borehole walls when logging operations are being carried out.

For further objects and advantages of the present invention and for a more complete understanding thereof, reference may now be had to the following detailed description taken in conjunction with FIGURE 1 of the drawing which illustrates the fluid excluding arrangement employed around a borehole tool.

Referring to FIGURE 1, there is shown a borehole tool **10** located in a borehole **11** for carrying out exploratory operations with respect to the surrounding subsurface formations illustrated at **12**, **13**, and **14**. The tool has a fluid excluding means identified generally by reference character **15** for excluding borehole fluid **16** from around a zone which contains a transducer arrangement for investigating the formations. In the embodiment disclosed, the transducer arrangement comprises an acoustic transmitter **17** for applying acoustic energy to the formations and a receiver **18** for detecting reflected acoustic energy.

As illustrated, the excluding means **15** comprises upper and lower rigid members **19** and **20**, respectively, spaced apart and located on each side of the transducer arrangement. These members support a member **24** which is a thin, resilient rubber boot for maintaining the region around the transducer arrangement free from borehole

fluid and undesirable material in the fluid which may seriously affect the acoustic energy transmitted and received.

Shear pins **25** and **26**, which shear at a stress above a predetermined limit, are employed to couple the members **19** and **20**, respectively, to the tool. In the event the excluding means becomes lodged in the borehole, upward force on the tool above the predetermined limit, applied by pulling upward on the supporting cable **27**, will cause the shear pins to break thus allowing the tool to be pulled upward and through the excluding arrangement and out of the borehole.

In accordance with the present invention, an arrangement also is employed for preventing the excluding means from being sheared from the tool upon contact with the walls during downward movement and, hence, prevents the tool from being detached and passing downward through the excluding means while the tool assembly is being lowered into the borehole. This arrangement comprises a rigid metallic collar **30** rigidly secured to the borehole tool structure. The lower surface of this collar contacts shoulder **31** formed in the interior wall structure of member **20** between an enlarged aperture **32** and a smaller aperture **33** which form an opening extending through the rigid member. Collar **30** thus resists and absorbs upward stress and force developed in lower rigid member **20** in the event this member contacts obstructions or resistance while the tool is being lowered. Thus, the lower shear pins **26** are protected from such upward forces thereby preventing shearing action to occur during downward movement of the tool. The upper shear pins **25** also are protected from this force since the external diameter of rigid member **19** is the same or less than that of member **20**. Hence, the brunt of the upward forces will be applied normally only to the rigid member **20** or to its leading edge or surface **34**.

The internal diameter of the aperture **32** of member **20** is larger than that of collar **30**. Thus, force can be transferred to the collar only by way of shoulder **31**. Since the collar **30** is located above the shoulder **31**, it does not interfere with shearing force applied to the shear pins when upward strain or stress is placed on the cable **27** in the event that the excluder becomes lodged. Thus, upward force beyond the predetermined limit can be applied to the tool by way of the cable **27** to cause the pins to break or shear if the excluder becomes lodged in the borehole while logging. The diameters both of aperture **32** and of the opening **34** extending through member **19** are larger than that of collar **30** whereby tool **10** will slide freely upwardly through members **20** and **19** once the shear pins are broken.

It now becomes clear that collar **30** will prevent the excluding means from being sheared from the tool while the tool is being lowered into the hole, but allows the lodging tool to be detached and pulled upward through the excluding means in the event the excluder becomes lodged in the borehole.

In the embodiment disclosed, the rigid member **19** comprises a cone-shaped member **40** threaded to collar **41** which in turn is attached to the tool by shear pins **25**. Similarly, member **20** comprises a cone-shaped member **42** threaded to collar **43** which, in turn, is attached to the tool by shear pins **26**. Both members **19** and **20** are made of soft metal, such as brass, which may be easily drilled out of the borehole in the event the tool is separated therefrom and pulled out of the hole. The widened ends of members **19** and **20** define a window circumscribing the zone where the transducers are located. Member **24** is secured around these ends in recessed portions **44** and **45** by turns of wire illustrated at **46** and **47** tightly wrapped about the portions of the member **24** located in the recesses to form a fluid-tight chamber. Grooves (not shown) may be formed in the recessed portions **44** and **45** under the member **24** to assist in forming a fluid-tight chamber. The recesses **44** and **45** are formed in the widened ends of members **19** and **20** to a depth whereby the exterior surface of member **24** is spaced from the outer extremity or outer periphery of members **19** and **20**. Thus, the exterior edges of members **19** and **20** prevent borehole wall from scraping against member **24**. In addition, with this arrangement the flexible member **24** is maintained a fixed distance from the transducers during a logging run.

In one embodiment, the acoustical transparent member **24** may be identified as a Hycar Buna N boot. The acoustical impedance of this member substantially matches that of the borehole liquid and is formed thin enough to allow passage of acoustic energy without significant attenuation. Its thickness may be of the order of $\frac{3}{64}$ of an inch.

In the embodiment disclosed, the chamber formed by members **19**, **20**, and **24** around the zone of the tool containing the transducer arrangement preferably is filled with oil illustrated at **50**. Two openings sealed by screws **48** are employed in filling the chamber with oil. During the filling operation, oil is injected through one opening while the other acts as a vent. Rubber O-rings **51** and **52** are provided between members **41–40** and **42–43** to aid in maintaining the chamber fluid tight. The tool employed may be $3\frac{3}{8}$ inches in diameter and thus may be employed in small holes and in large holes with the use of the excluder disclosed. A number of excluders may be provided for each tool thus extending the usefulness of the tool. The external diameter of one excluder constructed for the $3\frac{3}{8}$ inch tool was of the order of seven inches. The shear pins **25** and **26** of this assembly were of brass having a length of one-half inch and a diameter of .156 inch. The force required to shear the pins **25** and **26** is less than that required to separate the tool **10** from the cable **27** which is securely fastened to the tool.

The fluid excluder of the type disclosed is particularly useful in an acoustic well logging system of the type employing high frequency acoustic energy of the order of one megacycle as disclosed in copending United States application Ser. No. 507,630, filed Oct. 23, 1965, by Joseph Zemanek, Jr., entitled, Acoustic Borehole Logging, and assigned to the same assignee as the present invention. By employing such high frequency energy in large diametered holes filled with dense borehole liquid, problems occur since the material in the dense liquid attenuates the high frequency signals. The excluder of the present invention will exclude or displace the undesired materials to obtain improved results. The oil **50** and the resilient member **24** do not affect the high frequency signals to any extent.

As disclosed in the above-identified application, Ser. No. 507,630, an arrangement is provided comprising a motor **53** for rotating the transmitter and transducers **17** and **18**, respectively, whereby the borehole wall may be scanned while the tool is moving upward. Suitable structure is provided to allow the desired scanning operations to take place. The transducer arrangement may comprise a separate transmitter and receiver or a single transducer acting as a transmitter and receiver. These instruments are located within the tool surrounded by an acoustic transparent window formed by a thin rubber boot **54** tightly secured to the tool structure. The output of the receiver is applied to the surface by conductor **55** which extends through cable **27**. This cable is wound and unwound upon drum **56** driven by motor **57** and connection **58**. The output of the conductor **55** is taken from the cable by slip ring and brushes and applied to a suitable recording device illustrated at **59**.

Now that the invention has been described, modifications will become apparent to those skilled in the art and it is intended to cover such modifications as fall within the scope of the appended claims.

What is claimed is:

1. In a borehole liquid excluding system for use with a well logging tool having at least one zone in which means is supported for carrying out investigations of said formations, the combination comprising:

excluding means surrounding said tool at least around

said zone to displace undesirable borehole material from between said tool and the borehole wall,

coupling means for releasably attaching said excluding means to said tool,

said coupling means allowing said tool to be separated from said excluding means and to be moved upwardly out of said borehole in the event said excluding means becomes lodged in said borehole, and

means for preventing said excluding means from being detached from said tool when said logging tool is being lowered in said borehole,

said tool being an elongated member having a top and bottom end,

said tool having an enlarged cross-sectional portion along the length thereof,

said excluding means comprising at least one rigid member having an opening extending therethrough,

said rigid member having a first region in which the cross section of said opening is of a size sufficient to receive freely said tool including said enlarged cross-sectional portion,

the cross section of at least a portion of said opening being less than that of said enlarged cross-sectional portion of said tool,

the enlarged cross-sectional portion of said tool being located in the opening in said first region of said rigid member and positioned above said lesser cross-sectional portion of said opening in contact with structure of said rigid member forming said lesser cross-sectional portion when said tool is in a borehole to prevent said tool from passing downwardly through said opening of said rigid member in the event said excluding means contacts the borehole walls when said tool is being lowered in said borehole.

2. The combination of claim 1 wherein:

said enlarged portion of said tool comprises a member extending outwardly from the exterior wall of said borehole tool.

3. The combination of claim 1 wherein:

said detachable means comprises shear means releasably coupling said excluder means to said tool,

said enlarged portion of said tool contacting the structure of said rigid member forming said lesser cross-sectional portion of said opening to absorb stresses developed in the event said excluding means contacts obstructions in said borehole while said logging tool is being lowered therein and to prevent said excluding means and said tool from being sheared apart.

4. The combination of claim 3 wherein:

said rigid member is located below said zone when said tool is inserted in a borehole,

said excluding means comprising a second rigid member having an opening extending therethrough for receiving said borehole tool,

shear means for releasably coupling said second rigid member to said borehole tool above said zone when said tool is inserted in the borehole.

5. The combination of claim 4 including:

a thin resilient acoustical transparent member attached to and connecting said first and second rigid members to form a fluid-tight chamber surrounding said zone,

said resilient member being spaced from the outer periphery of said rigid members and located between said outer periphery and the exterior of said borehole tool for protection from the walls of said borehole.

6. The combination of claim 5 wherein:

said rigid members each have recesses formed in the outer circumferences thereof extending a predetermined distance from said zone toward the top and bottom ends of said tool,

said resilient member being cylindrical in form and having one end located within each recess spaced from the outer periphery of said members and a central portion extending around said zone.

7. The combination of claim 5 comprising:

acoustic transmitting and receiving means located in said zone in said tool,

said fluid-tight chamber formed being filled with oil.

8. The combination of claim 6 comprising:

acoustic transmitting and receiving means located in said zone in said tool,

said fluid-tight chamber formed being filled with oil.

9. A borehole liquid excluding system for use with a well logging tool having at least one zone in which at least one transducer means is supported for carrying out investigation of formations traversing said borehole comprising:

first and second rigid members releasably attached to said tool and extending outwardly therefrom,

said first rigid member surrounding said tool and located on one side of said zone,

said second rigid member surrounding said tool and located on the other side of said zone, and

a thin resilient acoustical transparent member attached to and connecting said first and second rigid members to form a fluid-tight chamber for maintaining the region around said zone free from borehole material which would otherwise cause undesirable interference with said investigation operations,

said acoustical transparent member being spaced from the outer periphery of said rigid members and located between said outer periphery and the exterior of said borehole tool for protection from the walls of said borehole.

10. The system of claim 9 wherein:

acoustic transmitting and receiving means is located in said zone in said tool,

said fluid-tight chamber formed being filled with oil.

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