APPARATUS FOR REPAIRING WELL CASING

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This invention relates to the art of repairing leaks in well casings. More particularly, it concerns means of making casing repairs wherein a sleeve of a settable patching material is expanded inside the casing at the leak and held in place until setting occurs. The present invention embodies an apparatus which protects the settable material from mechanical damage while the assembly is being lowered into the well.

In recent years a method has been developed for patching holes in well casing by expanding a sleeve containing a settable material against the surface of the casing. Partially polymerized epoxy resins have been found to be particularly suitable, owing to their inertness to well fluids and their property of forming a strong bond with the metal casing. The sleeve of patching material is prepared on an expandable tool, then lowered into the well opposite the leak. The tool is then expanded to press the patching material against the casing, filling the leak with the settable material. The tool is maintained in its expanded position until the resin had hardened. This method is described in U.S. Patent 3,026,915, Jennings.

In addition to the resin, the patch usually contains a fabric, such as wire mesh, glass cloth and the like, to increase the strength of the patch as well as to provide permeability for the viscous, resin-forming material during the placement of the patch. Additionally, the fabric retards sagging of the resin-forming material and reduces the erosive effect of the well fluids on the resin-forming material as the tool is lowered into the well.

Centralizers above and below the patch assembly are helpful in preventing damage to the sleeve as it is run in the well; nevertheless, some repair jobs have been unsuccessful for the reason that the partially polymerized material was deformed somewhat while being run. Presumably, the turbulence of well fluids displaced through the narrow annular space between the tool and the casing, as well as the obstructions on the wall of the casing, contributed to the deformation. There is a further possibility that droplets of well fluids become entrained in the partially polymerized resin, effectively diluting it and weakening the strength of its bond with the casing.

It is therefore an object of my invention to provide apparatus for placing a patch containing a partially-polymerized resin in a well without subjecting the patch to abrasion and erosion by solids and fluids in the well. It is also an object of my invention to prevent contamination of the resinous material with the well fluids. These and other objects may be accomplished by my invention described in greater detail hereafter.

FIGURE 1 is a view in cross-section of the apparatus of my invention as it is being run into the well.

FIGURE 2 is a view in cross-section showing the apparatus as pressure is being applied to hold the patch against the casing.

FIG. 3 shows the apparatus as it might be assembled to run in a well.

Brieferly described, the invention comprises a protective cover for the patch sleeve which is slipped off the sleeve at the start of the expansion of the setting tool.

Referring to FIGURE 1 for a description of the apparatus, elastic tube 20 is covered with patch sleeve 21. The sleeve may comprise layers of glass fibers impregnated with a viscous, partially-polymerized epoxy resin and a curing agent. The glass fabric is folded or wound such that the sleeve may be expanded. The structure of the sleeve, and the application of the sleeve and resin to the elastic tube are described in more detail in U.S. Patent 3,026,915, Jennings. Upper and lower clamps, 22 and 23, respectively, hold the ends of elastic tube 20 on tubular body 13, whereby fluid in the tubular body can pass through perforations 19 to inflate the elastic tube. Housing 16 surrounds the patch sleeve. Ports 18 in the tubular body above upper clamp 22 admit fluid to the space between head 17 of housing 16 and upper clamp 22. O-ring 24 confines the fluid to the space above the upper clamp. Stop 15 on the tubular body limits the upward travel of housing 16. The tool assembly may be lowered into casing 31 on tubing. Check valve 14 in the lower end of the tubular body provides a bypass through the tool for well fluids while the tool is being run in the well.

FIGURE 2 shows the positions of the various components after the patch sleeve has been expanded against the casing and before the setting tool is removed from the well. Housing 16 is held in the upper position with head 17 against stop 15 by inflating fluid 25. O-ring 24 seals the space between the upper clamp and the housing. The inflating fluid also holds the elastic tube and patch sleeve expanded to the set position.

In using my invention to repair a leak in casing, the tool is first assembled at the surface. As shown in FIGURE 3, centralizers 27 and 28 may be installed on tubular body 13 above and below the patch sleeve to keep the tool from dragging against the casing when it is lowered into the well. Also, centralizer 29 may be placed above the upper centralizer to permit displacement through check valve 14 and tubular body 13 when the tool is run in the well. It is preferable to use a housing which does not fit snugly over the patch sleeve in order that the housing can be displaced with low fluid pressure.

A mold release agent may be applied to the inside surface of housing 16 to prevent bonding of the housing to the resin, in case there is contact between them. Additionally, three or more spacer lugs may be positioned about the lower clamp to hold the patch assembly centralized within the housing. In some instances it may be desirable to provide an O-ring on the lower clamp to exclude well fluids from the patch sleeve while the tool is being run into the well.

With the housing pulled back so that head 17 is against stop 15, the fabric and resin sleeve may be applied to the elastic tube. The outside diameter of the sleeve may be about one to two inches less than the inside diameter of the casing. The tube is usually coated with a mold-release agent to facilitate its ultimate removal from the well. After the sleeve is in place on the elastic tube, the housing is moved to its position over the sleeve, as shown in FIGURE 1. The tubular body is then connected to tubing and run into the well until the patch assembly is centered over leak 12 in the casing. The circulating valve is then closed. Fluid subsequently pumped down the tubing flows through ports 18. The elasticity of tube 20 prevents any significant inflation of that member until the housing has been removed, allowing it to rest against stop 15. It is desirable that the housing covers the patch sleeve without touching it to avoid any resistance to displacement of the housing from its running-in position. Thereafter, a pressure about 100 to 500 p.s.i. greater than well pressure is applied to the elastic tube to produce the necessary expansion of the patch sleeve. A small quantity of the resin is usually extruded through the leak, forming button 26, as seen in FIGURE 2. The pressure is held on the tool for a length of time calculated to permit the setting of the resin on the sleeve. Thereafter,
the pressure is released, permitting the elastic tube to contract and be withdrawn from the well.

Housing 16 is a cylindrical member having sufficient tensile strength to withstand the pressure differential which exists across it during the patch setting step. It is desirable that the housing occupy as little space as possible, in order that the patch sleeve can be assembled for minimum expansion during placement. For example, a tool for patching 3½-inch casing can use a housing made of 16–20 gage steel plate where the plate is boiler grade. The stop is positioned on the tubular body a distance above the upper clamp, which enables the housing to clear the patch sleeve, but does not move beyond the O-ring.

While I have described my invention as a tool to be run on tubing, it should be understood that it can also be run on a wire line. In that embodiment the housing would be removed and the patch sleeve expanded by fluid pressure either stored or generated within the tool. For example, a propellant charge of the type used in wire line stimulation tools might be used. The charge could be detonated by a go-devil, or similar device, introduced at the well head. Examples of this type of equipment are illustrated in U.S. Patent 2,781,854, Boer et al.; U.S. Patent 2,842,212, Lecbre; and U.S. Patent 2,843,042, Andrus. Also, this invention may be used in repairing pipes other than those in wells. Pipelines sometimes develop leaks in locations not readily accessible, where this could be used to advantage. A leak in an underwater river crossing, for example, could be repaired in this manner. Therefore, my invention should be limited only by the scope of the appended claims when read in light of the present disclosure.

I claim:

1. Apparatus for applying a liner to the inner surface of a cylinder comprising: a perforated tubular body, an elastic tube enclosing said perforated body, means for sealing the ends of said elastic tube to said perforated body, a resin saturated expansible sleeve of laminated fibers surrounding said elastic tube, a housing loosely enclosing said expansible sleeve, means for displacing said housing axially along said tubular body to expose said expansible sleeve so said sleeve can be expanded against the inner surface of said cylinder by inflation of said elastic tube, centralizers above and below said elastic tube and housing, a check valve in the lower end of said tubular body, and a circulating joint above said elastic tube and housing for attaching a tubing string to said tubular body.

2. A tool for applying an expansible settable patch sleeve to the inner surface of a cylinder comprising: a perforated tubular body, an elastic tube enclosing said perforated body, means for sealing the ends of said elastic tube to said perforated body, a housing loosely enclosing said elastic tube, sufficient space being provided between said elastic tube and said housing for said expansible settable patch sleeve, means for displacing said housing axially along said tubular body to expose said expansible sleeve in operation of the tool, centralizers above and below said elastic tube and housing, a check valve in the lower end of said tubular body, and a circulating joint above said elastic tube and housing for attaching a tubing string to said tubular body.

3. The tool of claim 2 in which said means for displacing said housing comprises first and second fluid seals between said housing and said tubular body to define a variable volume chamber between said housing and said tubular body, a fluid port in said tubular body said port connecting the interior of said variable volume chamber to the interior of said tubular body and means to limit the movement of said housing to a position which uncovers said expansible sleeve while maintaining said second fluid seal.

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