Sept. 4, 1962

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3,052,297

WELL TOOL

Filed Feb. 25, 1959

2 Sheets-Sheet 1

FIG. 1.

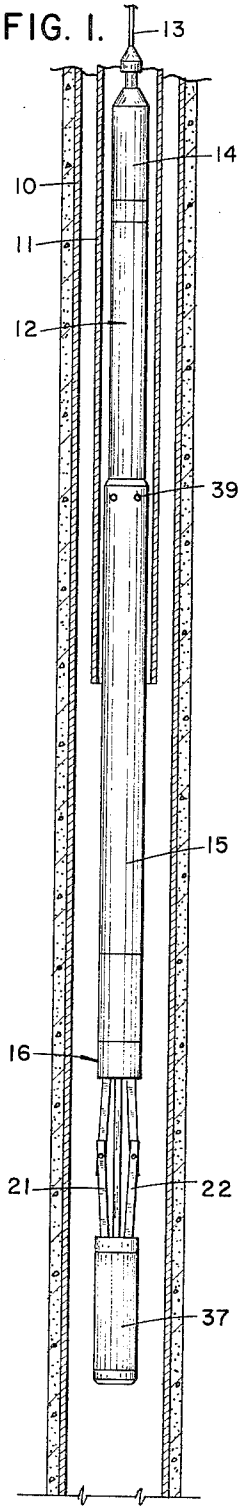


FIG. 2.

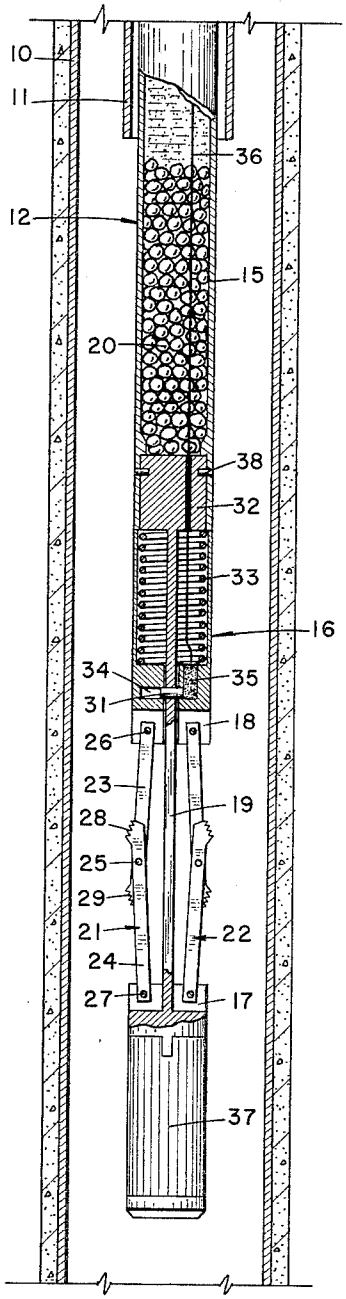
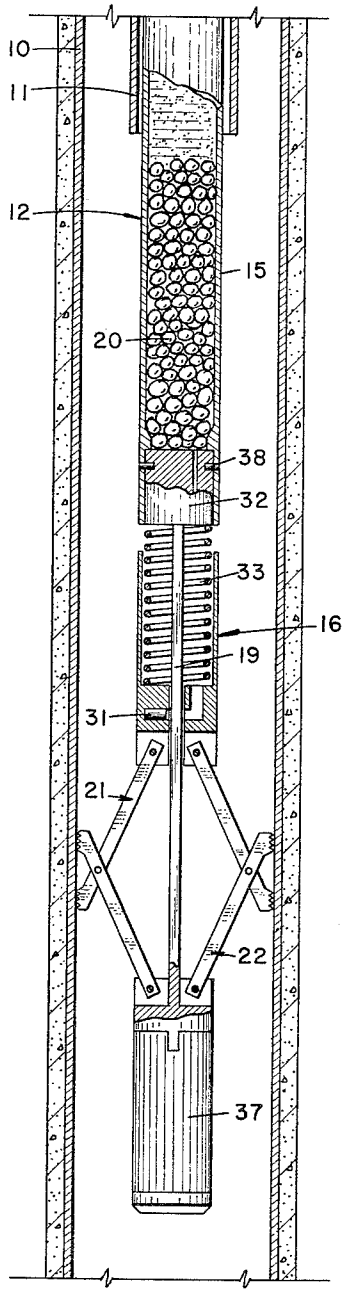


FIG. 3.



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FIG. 4.

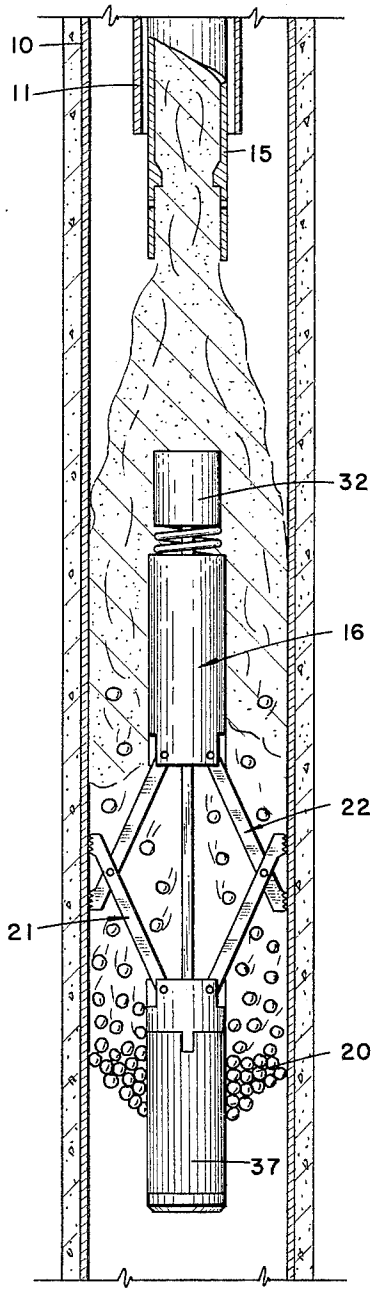
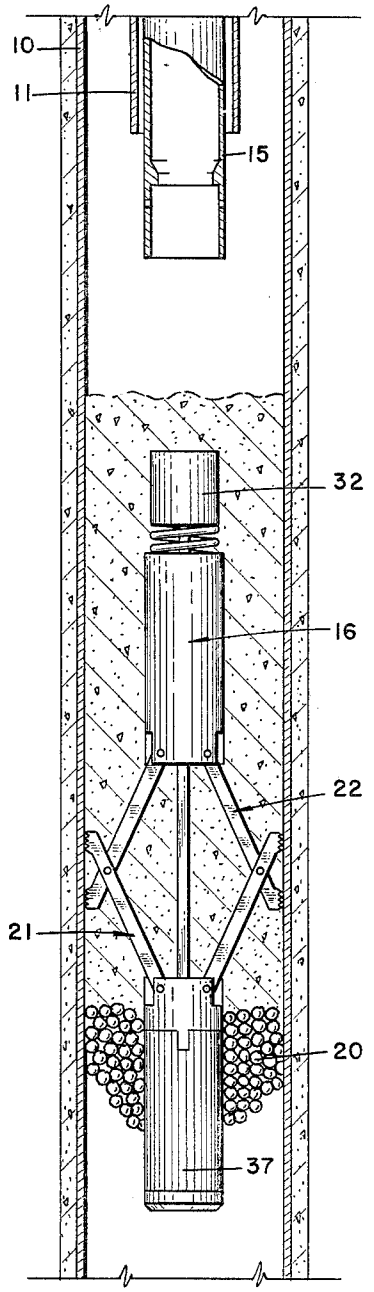


FIG. 5.



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WELL TOOL

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5 Claims. (Cl. 166—21)

This invention relates to well tools, and to methods of use thereof, and more particularly to an apparatus and method for forming a plug in a pipe

In some instances it is desirable to form a cement plug in a casing below the production tubing after the tubing has been run in the hole For instance, in the so-called permanent completion of a well it is sometimes desirable to set a plug below the production tubing Due to the small size of the tubing, and particularly due to the relative difference in size between the tubing and the casing, it is difficult to operate through the small diameter tubing and set a plug in the relatively large diameter casing.

While the invention will be described in conjunction with a previously run tubing, it will be understood that it might be used before the tubing is run, but it is contemplated that its principal use will be in setting plugs below a previously run tubing.

It is an object of this invention to provide a method and apparatus for setting a cement plug in a casing below a previously run tubing.

Another object is to provide a method and apparatus for running a device in a well pipe on a wire line and manipulating the device to provide a cement plug at an intermediate position in the pipe all in a single run.

Another object is to provide a method and apparatus for forming a bridge of magnetic material in a pipe which will accommodate itself to the size and configuration of the pipe and thereafter supporting cement slurry with this bridge until the slurry sets.

Other objects, features and advantages of this invention will be apparent from the specification, the claims and the drawings.

In accordance with the method of this invention a small diameter permanent magnet is lowered into the well through the production tubing to a position below the bottom end of the tubing and in the open cased well. This magnet is attached to a hook wall anchor and the anchor is actuated to engage the wall of the casing and position the magnet in the casing. If desired, a collar locating device may be utilized to determine the exact location for placement of the magnet, as will be understood by those skilled in the art.

After the magnet has been anchored in the casing, particles of magnetic material, preferably ferrous material, are dumped onto the magnet and form a bridge between the magnet and casing due to the magnetic field exerted by the magnet. Cement may accompany the magnetic particles, or cement may be dumped onto the previously prepared bridge. In the former case, the magnetic material would be dispersed throughout the cement and a homogeneous mass of magnetic particles and cement would surround the magnet and provide a bridge. In the latter case, the magnetic material would first form a bridge of magnetic material between the magnet and the casing and support the cement thereafter dumped onto the magnet and magnetic particles.

Preferably the method is carried out by utilizing a tool such as illustrated in the accompanying drawings, but it will be appreciated that other tools might be employed, and that, instead of a single run cementing procedure, a dual run might be employed in which the magnet is positioned on the first run and the magnetic material and cement dumped on the magnet in the second run.

Referring now to the drawings wherein a preferred

form of apparatus is illustrated, wherein the several steps of the preferred method are illustrated, and wherein like reference numerals indicate like parts:

FIG. 1 is a vertical sectional view through a well bore showing in elevation a tool constructed in accordance with this invention;

FIG. 2 is a fragmentary view partially in elevation and partially in cross-section on an enlarged scale of the tool shown in FIG. 1 positioned in the well and ready to form a bridge in the casing below the tubing;

FIG. 3 is a view similar to FIG. 2 in which the hook wall anchor has been actuated to position the magnet in the well;

FIG. 4 is a view similar to FIG. 3 in which the cement and magnetic particles are being dumped onto the magnet;

FIG. 5 is a view similar to FIG. 4 illustrating the completed cement plug.

In the illustrated embodiment the bore has been cased with a casing 10 which is cemented in place in the usual manner. A production pipe or tubing 11 is in position in the well. The casing 10 and tubing 11 may be expected to be filled with fluids such as water, oil or drilling mud.

The tool of this invention is indicated generally at 12 and is preferably run on a wire line 13 in the conventional manner. At the upper end a collar locating device 14 of conventional construction may be utilized to locate the tool in position to place the cement plug at a predetermined elevation.

Particular reference is made to FIG. 2 which shows the lower end of the tool 12. The intermediate section of the tool provides a dump bailer 15 which may be filled with any desired magnetic material 20 and any desired cement slurry. The magnetic material may be provided by ferrous particles in the lower portion of the bailer as illustrated in FIG. 3, with cement slurry above the magnetic particles. As an alternative, the cement and ferrous particles may be intimately mixed with each other. If desired the magnetic particles may be covered with any flexible plastic to better fill gaps between adjacent magnetic particles.

A hook wall anchoring device indicated generally at 16 is carried below the bailer 15. The anchor may take any desired form, and the form shown in the drawings is by way of illustration only. In the form illustrated a pair of collars 17 and 18 are provided with the collar 18 slidable on a longitudinal body or mandrel 19. The collar 17 is fixed to the mandrel. The two collars are joined together by pairs of knuckle arm assemblies 21 and 22. The two knuckle arm assemblies are identical and only one assembly will be explained in detail. Referring to the assembly 21, it is made up of arms 23 and 24 which are joined at an intermediate point by pivot 25. Arm 23 is pivoted at one end to slide collar or actuating block 18 as at 26. Arm 24 is in like manner pivoted to member 17 at 27. The free end of each arm 23 and 24 carries a pipe gripping surface 28 and 29, respectively. The pipe gripping surface may be provided in any desired manner, as will be apparent to those skilled in the art.

The slide collar 18 is held on the mandrel 19 by a pin 31. This pin 31 has a friction grip with a slot in mandrel 19.

Any desired means may be provided for releasing the pin 31 and setting the knuckle arms of the anchor in firm engagement with the wall of casing 10. In the illustrated embodiment, for example, a plug 32 is provided at the upper end of mandrel 19, and a spring 33 is compressed between the plug 32 and the slide collar 18. This spring provides the motive power for setting the anchor.

Any desired means may be provided for moving the pin 31 into an out-of-the-way position in sliding collar 18 within the space provided by slot 34 which is located therein. In the illustrated embodiment a squib 35 is provided, for example, and a firing cord 36 extends up through the tool and through the wire line to the surface. As best shown in FIG. 3 firing of the squib 35 forces the pin 31 into the out-of-the-way position in slot 34 and the spring 33 moves the slide collar 18 along mandrel 19 to knuckle the assemblies 21 and 22 out into firm engagement with the wall of the casing. In gripping the walls of the casing the mandrel 19 is centered in the casing, as shown in FIG. 3.

A suitable magnet 37 is carried by the anchoring device, and preferably depends from the collar 17. The magnet may be secured to the collar 17 in any desired manner, and the magnet may be of any desired composition. Tool 12, including the cement slurry and magnetic material 20, must of course be provided of sufficient weight to overcome the tendency of magnet 37 to prevent passage of the tool through 11, if of magnetic material, by adhering to its wall.

Reverting to the dump bailer 15, it will be noted that the plug 32 on the upper end of mandrel 19 provides a closure for the lower end of the dump bailer 15. This enlargement may be, for example, secured to the dump bailer by a plurality of shear pins 38. Thus, after the anchor has been secured to the casing an upward pull on the wire line will shear the pins 38 and permit the contents of the bailer to spill in the hole about the magnet 37. A breather hole 39 (FIG. 1) is provided to insure complete dumping of the contents of bailer 15. It is pointed out that both the magnet particles and cement are heavier than the fluid found in the well, and that they will dump from the bailer in the usual manner as will be understood by those skilled in the art.

Operation of the illustrated device is as follows:

The tool 12 is run in the tubing from the surface of the well in the conventional manner on the wire line 13, and collar locator 14 utilized to determine the exact position of the magnet 37 in the casing. After the magnet is properly positioned, the squib 35 is fired by a signal through line 36 and in firing the pin 31 is driven into an out-of-the-way position in slot 34. Upon firing of the squib the compressed spring 33 drives the collar 18 downwardly along mandrel 19 to extend the knuckle elements 21 and 22 into firm engagement with the wall of the casing. In this manner the mandrel and magnet will be centered and the spring is preferably of such length to exert a firm force holding the knuckle elements out against the wall of the casing 10. Thereafter the wire line is taken into raise the dump bailer, shearing pins 38. This wireline manipulation, of course, transmits a shearing force to the shear pins 38, which force may be said to be a signal in response to which the shear pins release the bailer closure plug 32. Continued raising of the bailer removes the same from about the plug thus opening the same. This permits the iron particles to fall from the bailer as illustrated in FIG. 4. The cement, of course, follows the iron particles from the bailer. Of course, if a mixture of magnet particles and cement were used, the entire mixture would fall about the magnet in the manner illustrated in FIGURE 4. Where the lower end of the bailer is filled with magnetic material and the upper with cement slurry, the magnetic particles will fall onto the magnet and will form a bridge in the manner illustrated in FIGS. 4 and 5. The cement will then be supported on this bridge of magnetic particles and magnet and will form a plug in the casing in the manner illustrated in FIG. 5.

This plug will permit production of the well above the plug in the conventional manner, and the casing may be perforated above the plug and the formation may be fractured or other completion methods may be employed as the plug will function as an effective bottom of the open hole.

From the above it will be seen that all of the objects of this invention have been attained. There has been provided a tool which is of small enough diameter to pass through a small diameter production tubing and by way of example the tool diameter may be limited to $1\frac{11}{16}$ inches. Of course, the casing is usually much larger in internal diameter, for example, five inches, and the construction of the tool is such that the anchoring device will expand out to engage the much larger diameter casing. Thereafter, regardless of the particular size of the casing the magnet particles will gather around the magnet and provide support for the cement. It is particularly pointed out that only a single size tool is needed for substantially all diameter casing, as the size of the annulus between the magnet and casing will be filled with the magnetic particles and whether this area be large or small is immaterial. The knuckle type of anchoring members illustrated also readily lend themselves to use with various diameter casing. If desired, of course, the knuckle members 21 and 22 may be exchanged for others of different lengths to accommodate diverse sizes of casing.

While a one-run tool may be employed, it is apparent that the method may be practiced by setting the magnet in position on a first run and thereafter dumping the magnetic material and cement on a second run. It is also apparent that the magnet might be positioned in the well in any desired manner, but a hook wall anchor of inexpensive construction such as illustrated in the drawings is preferred.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What I claim is:

1. The method of bridging a pipe comprising, placing a permanent magnet at a desired location within said pipe, releasing magnetic particles and cement slurry about said magnet, said magnetic particles adhering to said magnet and forming a coherent mass thereabout for support of said slurry, and allowing said slurry to harden into a bridge within said pipe at said desired location.

2. As a sub-combination, apparatus for bridging a pipe comprising, a permanent magnet, a hook wall anchor attached to said magnet for positioning said magnet in supported relation within said pipe, and means for setting said anchor at a selected position within said pipe.

3. Pipe bridging apparatus comprising: a dump bailer adapted to carry and release magnetic and cementitious materials; an anchor assembly including a permanent magnet spaced from said bailer; and means releasably closing said bailer and interconnecting said bailer and assembly; said anchor assembly further including a body connecting said magnet and said means, anchor elements connected to said assembly and biased for radial outward movement with respect to said body and adapted to engage the bore of a pipe, latching means normally restraining said elements against said movement and release means adapted to explosively release said latching means in response to an electrical impulse; said anchor assembly adapted in response to said impulse to engage the bore of a pipe and position said magnet therein.

4. Apparatus for bridging a pipe comprising: a dump bailer adapted to carry and release magnetic and cementitious material; an anchor assembly suspended from said bailer and including a body, a spring in coextensive releation and biased with respect to said body, anchor arms connected to said body and arranged for radial movement with respect thereto in response to bias of said spring, latch means connected with said body and normally re-

straining said bias, and electrically responsive means operably asscciated with said latch means adapted to release said latch means when energized to thereby permit said bias to motivate said anchor arms into engagement with the bore of said pipe; and a permanent magnet suspended from said assembly such that when said anchor arms are in engagement with the bore of the pipe, the magnet is located with respect thereto.

5. Apparatus for bridging a pipe comprising: a dump bailer adapted to carry and release magnetic and cementitious material; an anchor assembly suspended from said bailer and including a body, a spring in coextensive relation and biased with respect to said body, anchor arms conected to said body and arranged for radial movement with respect thereto in response to bias of said spring, latch means connected with said body and normally restraining said bias and electrically responsive means operably associated with said latch means and adapted to release said latch means when energized to thereby permit said bias to motivate said anchor arms into engagement with the bore of said pipe; and a permanent magnet suspended from said assembly such that when said anchor arms are in engagement with the bore of the pipe, the magnet is located with respect thereto.

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