

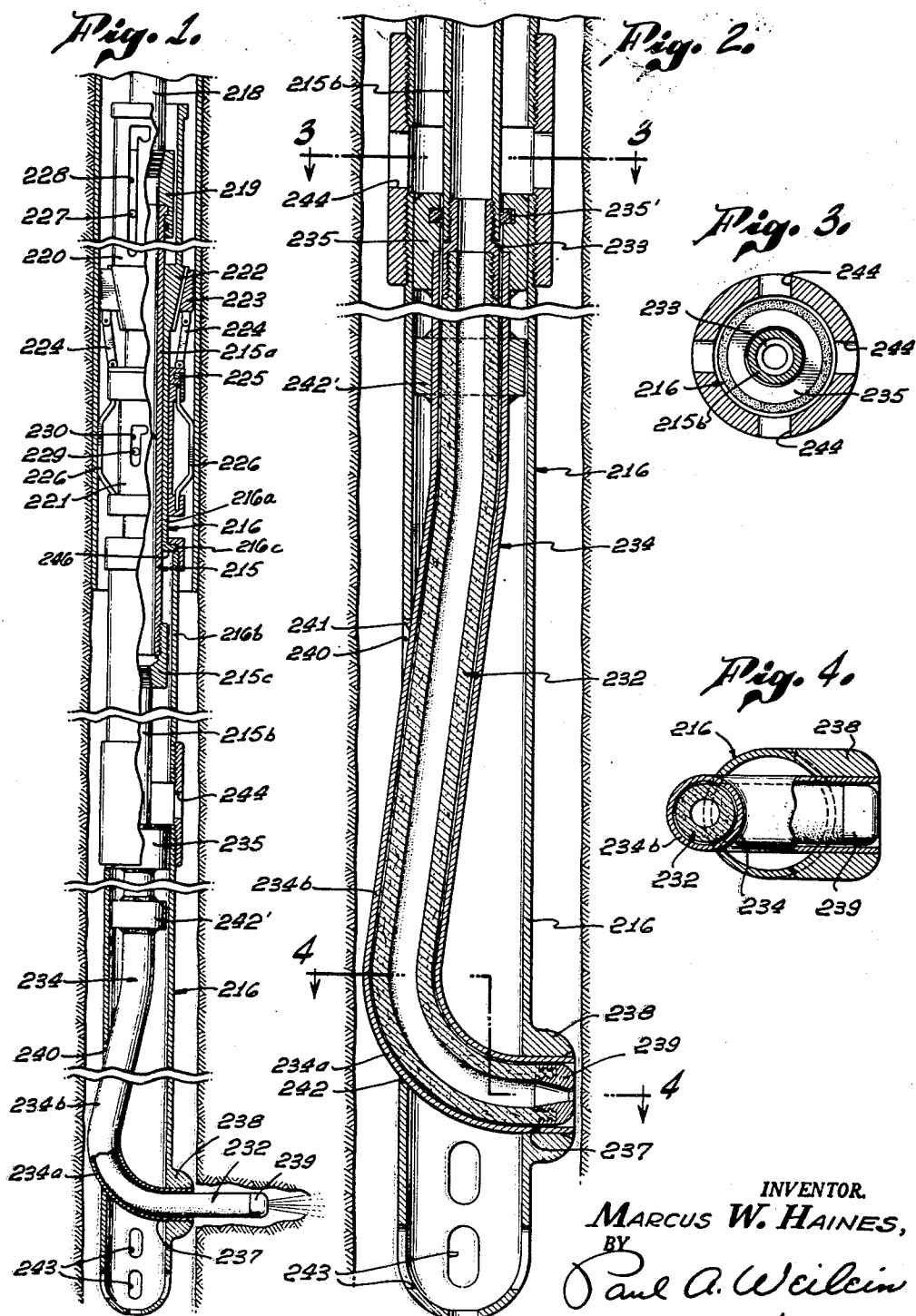
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M. W. HAINES

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SUBSURFACE EARTH FORMATION TREATING TOOL

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INVENTOR.
MARCUS W. HAINES,
 BY
Paul A. Weik
 ATTORNEY.

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SUBSURFACE EARTH FORMATION TREATING TOOL

Marcus W. Haines, Long Beach, Calif., assignor to McGaffey-Taylor Corporation, Long Beach, Calif., a corporation of California

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4 Claims. (Cl. 175-81)

This application is a division of application, Serial No. 394,928, filed November 30, 1953, now Patent No. 3,012,611, granted December 12, 1961.

This invention has for an object thereof the provision of a well tool which is adapted to be anchored to the casing of a well and operated in a highly efficient manner to perform useful work in the open formation below the casing.

Accordingly, a well tool embodying this invention includes means operable responsive to such relative movement for acidizing or otherwise treating the open formation.

Thus, the accompanying drawings and specification illustrate and describe as embodiments of this invention, an acidizing tool operable without the use of packers for forming drain holes in the open formation of a well. This acidizing tool is illustrative of the use of the novel tool embodying the present invention for performing useful work in the open formation below the casing other than the setting and releasing of packers as shown and claimed in my above identified patent, as well as in my co-pending companion application, Serial No. 102,330, filed February 14, 1961.

A further object of this invention is the provision in tools such as described, of anchoring means which anchors one member of the tool to the well casing on the initial downward movement of the run-in string and maintains this member anchored in the casing upon continued downward movement of the string and a second tool member connected with the string, whereby portions of said members will coact upon such continued downward movement to operate tool elements for performing useful work in the formation below the casing.

The present invention contemplates the provision, among other features which will hereinafter be described or become apparent to those skilled in the art, of an assembly including independently operated slip and expander means for securing the tool in a well casing and operating means for the acidizing or other fluid injection tool, hereinafter referred to simply as an acidizing tool, combined with independent supporting structures and independent lock mechanisms for releasably locking the slips to the mandrel or body and for locking the acidizing tool to the mandrel or body, whereby the device may be secured in a well independently of whether the acidizing tool is to be set or not set.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of the embodiment of the invention as shown in the accompanying drawing. This embodiment will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIG. 1 is a fragmentary vertical sectional view, partly in elevation, of the tool of this invention as it would appear when in use;

FIG. 2 is a view similar to FIG. 1, showing only the

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lower end of the tool on an enlarged scale, and with the acidizing nozzle retracted;

FIG. 3 is a cross sectional view taken on the line 3—3 of FIG. 2; and FIG. 4 is a cross sectional view taken on the line 4—4 of FIG. 2.

The illustrative embodiment of the invention as shown constitutes a tool, which, without the use of packers, may be advantageously used to inject fluid under pressure into the open formation below the casing to which latter the tool is anchored in the same manner as in the previously described tools. This modified tool is particularly adapted for acidizing limestone and other formations where acidizing may be desired. It provides a flexible tube which is adapted to be projected from the tool laterally into the formation, while discharging fluid under pressure, responsive to relative movement between members of the tool as effected by manipulation of the tubing string in the same manner as in operating the packers in the previously described tools hereof. This flexible discharge tube is progressively moved laterally into the formation as the acid dissolves or "eats" a path therefor. With this arrangement the tool may be operated to provide a series of lateral drain holes opening into the well bore for draining oil into the latter. The rate of lateral progression of the flexible discharge tube into the formation is determined by rate of penetration action of the acid and the rate of movement of the string and the member of the tool connecting the flexible tube with the string, while the other member of the tool is anchored to the casing. As the acid is pumped down the string the action of the pump (back pressure) will enable the operator at the top of the well to properly govern the lowering of the tubing string best to form the lateral drain holes in the formation.

Referring more specifically to the tool as illustrated, it is seen that it includes a pair of telescopically connected inner and outer tubular members 215 and 216. The inner member 215 comprises an upper section 215a and a lower section 215b joined by means of a coupling 215c. The upper section 215a is adapted to be connected at its upper end to a tubing string 218 by means of a coupling member 219 corresponding to the coupling 3 in the first described form of this invention, whereby the tubing string may be rotated relative to the upper section 215a. The outer tool member 216 includes an upper section 216a joined to a lower section 216b by means of a rotative coupling 216c.

Mounted on the outer member 216 are the J-lock sleeves 220 and 221, the slip expander 222, the slips 223, the links 224 connecting the slips with the sleeve 221 through a rotative coupling 225, and the drag springs 226 carried by the sleeve 221. The coupling member 219, is provided with a J-lock pin 227 operable in the J-slot 228 in the sleeve 220, whereas the member 216 is provided with a J-lock pin 229 operable in the J-slot 230 in the sleeve 221. These two J-locks are operated responsive to rotation of the string 218. This is to say that the pin 227 in J-slot 228 constitutes a releasable means interconnecting the members 215 and 216 for joint axial movement within the well casing or well bore and releasable to allow axial movement of the member 215 within the member 216; while the pin 229 in J-slot 230 constitutes releasable means interconnecting the member 216 and the sleeve 221 on which the drag springs 226 are carried, and releasable to allow joint axial movement of the members 215 and 216 relative to the sleeve 221, whereby the slips 223 which constitute anchor means will be expanded into anchoring engagement with the well casing.

The slips 223 are operated to anchor the member 216 to the casing by the weight of the member 216 and parts thereon, upon the initial downward movement of the

string 218 after release of the two J-locks. This anchoring of the member 216 is effected so that portions of the members 215 and 216 will be disposed in the open formation below the casing, whereby upon relative movement between these portions the tool may be operated.

As a means for introducing fluid under pressure, for example acid, so that it will penetrate limestone and other formations where it is desired to open oil bearing zones by means of drain holes, an elongated flexible discharge tube 232 is provided in the lower portion of the outer tool member 216. This discharge tube may be made of synthetic rubber or other suitable flexible material and is connected at its upper end by means of a suitable coupling 233 with the lower end of the lower section 215b of the inner and axially movable tool member 215. A guide tube 234 mounted in the member 216 is constructed and arranged to guide the flexible tube 232 so that it will extend laterally from member 216 into the formation when the tubing string and member 215 are lowered relative to the section 216. Accordingly, this guide tube is welded or otherwise secured at its upper end to a bushing 235 welded within the bore of the member 216. The lower section 215b is slidable in this bushing and the upper end of the guide tube responsive to lowering and raising of the tubing string, there being a suitable packing gland 235' in the bushing.

To provide for free movement of the flexible tube 232 without binding, the guide tube 234 is curved as at 234a on a large radius adjacent the discharge end thereof. This discharge end is extended substantially horizontally into an opening 237 in the side of the outer member 216 whereby the flexible tube may be projected laterally into the open formation. An annular boss 238 is formed on the exterior of the member 216 around the opening 237 so as to receive in the bore thereof the discharge end of the guide tube 234, this end being secured to the boss as by being welded thereto. A nozzle 239 formed of metal or other suitable hard material is fixed on the discharge end of the flexible tube 232 and is retracted into the bore of the boss when not in use, the boss thereby protecting the nozzle in the axial movement of the tool in the well bore.

In order that the guide tube 234 may be curved on a large radius, the outer or "anchored" member 216 of the tool is slotted as at 240 so that a portion 234b of the tool may be projected therethrough; this portion being welded as at 241 and 242 to the member 216. An additional support may be provided intermediate the ends of the guide tube in the form of an annular ring 242' welded to the tube and disposed in the member 216 so as to maintain the upper part of the tube centered in the member 216.

The lower end of the outer member 216 is provided with drain openings 243 for fluid which enters the member 216 below the bushing 235. Similar drain openings 244 are provided above the bushing 235 for fluid which enters the member 216 above the bushing 235.

It should be noted that the protruding portion 234b of the guide tube 234 and the boss 238 have a substantially equal lateral extent from the exterior of the member 216 whereby the tool will be centered in the well bore.

When this tool is lowered into the well bore, the flexible tube 232 is in the retracted position shown in FIG. 2, being so held by the two J-locks which include the sleeves 220 and 221 and associated pins 227 and 229 respectively. These J-locks hold the inner and outer members 215 and 216 against relative axial movement as well as maintain the slips 223 retracted in the same manner as in the previously described forms of the invention.

When it is determined by the usual method that the tool is in the desired position in the well bore with the lower ends of the members 215 and 216 disposed in the open formation below the casing, the operator rotates and then lowers the tubing string to release the J-locks

and cause the slips to set and anchor the outer member 216 to the casing. This setting of the slips is effected so that the member 216 will be anchored before the lower ends of the members 215 and 216 contact the bottom of the bore hole.

The working fluid, such for example as a suitable acid, is now pumped down the tubing string to scavenge the well fluid from the string through the tube 232 and nozzle 239 into the casing. When this scavenging operation is completed, the tubing string is lowered slowly whereby the inner member 215 will be lowered and cause the flexible tube 232 to be forced downwardly so that the nozzle 239 will be moved into intimate contact with the open formation. The pumping of acid to the tool is continued and it is apparent that continued lowering of the string will cause the nozzle 239 to progressively penetrate the formation as the acid discharged from the nozzle eats into the formation as indicated in FIG. 17.

With the acid flow regulated for a constant rate of discharge from the nozzle 239, the proper rate of advance of the nozzle and flexible tube into the formation may be determined by the back pressure as noted by pumping pressure variations at the top of the well. Care should be exercised to avoid a too rapid projection of the flexible tube to prevent distortion of the flexible tube and the consequent formation of an improperly sloping drain hole or cavity in the formation.

It will now be apparent that by lowering the tubing string slowly, the flexible tube 232 and nozzle 239 may be advanced as the hole is formed by the acid discharging into the formation from the nozzle, whereby an effective drain hole leading from the desired depth in the formation to the well bore, may be quickly and easily produced.

After one such hole is formed the flexible tube 232 and nozzle 239 may be retracted within the guide tube as shown in FIG. 18 by lifting the tubing string and the member 215 connected therewith. This raising of the string and member 215 sufficiently to retract the flexible tube 232 does not release the slips which therefore hold the outer member 216 anchored to the casing during the retraction of the flexible tube.

Continued lifting of the tubing string will cause the coupling member 215c to engage the shoulder 246 on the outer member 216, thereby lifting the member 216 and the slip expander 222 on the member 216, so that the slips will be released. After releasing the slips, the tubing string is rotated to lock the pins 227 and 229 in the slots therefor in the sleeves 220 and 221 whereby the members 215 and 216 are locked against relative movement. The tool may now be repositioned in the well and again operated to make another drain hole in the open formation, it being possible to make as many holes as desired with the tool, with one run of the tool into the well bore.

I claim:

1. A well tool including: a pair of elongated tubular members connected for relative axial movement; one of said members being adapted for connection with a tubing string for axial movement therewith in a well; anchor means operatively connected with the other of said members for anchoring the other of said members to the casing of the well responsive to joint axial movement of said members relative to said anchor means; first releasable means interconnecting said anchor means with said other member and releasable to allow joint axial movement of said members relative to said anchor means; second releasable means interconnecting said members for joint axial movement of said members and releasable to allow axial movement of said one member relative to said other member; and means for introducing fluid under pressure into the open formation below the well casing including a flexible tubular member connected with said one member for axial movement therewith; and a guide tube fixed to said other member; said guide tube having one end extended laterally into an opening on one side

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of said other member; said flexible tubular member being slidable through said guide tube so as to project therefrom into the open formation responsive to lowering of said string and said one member.

2. A well tool including: a pair of elongated tubular members connected for relative axial movement; one of said members being adapted for connection with a tubing string for axial movement therewith in a well; anchor means operatively connected with the other of said members for anchoring the other of said members to the casing of the well responsive to lowering of said string and said members relative to said anchor means; first releasable means interconnecting said anchor means with said other member and releasable to allow joint downward movement of said members relative to said anchor means; second releasable means interconnecting said members for joint downward movement of said members and releasable to allow downward movement of said one member relative to said other member; and means for introducing fluid under pressure into the open formation below the casing including a tubular member connected at one end with said other member for axial movement therewith; and means on said other member for guiding said last named tubular member to cause the other end thereof to be extended into and out of the open formation responsive to lowering and raising of said string and said one member while said other member is anchored to the casing.

3. A well tool including: a pair of elongated tubular members connected for relative axial movement; one of said members being adapted for connection with a tubing string for axial movement therewith in a well; anchor means operatively connected with the other of said members for anchoring the other of said members to the casing of the well responsive to joint axial movement of said members relative to said anchor means; first releasable means interconnecting said anchor means with said other member and releasable to allow joint axial movement of said members relative to said anchor means; second releasable means interconnecting said members for joint axial movement of said members and releasable to allow axial movement of said one member relative to said other member; and means for introducing fluid under pressure into the open formation below the well casing including a flexible tubular member connected with said one member for axial movement therewith; and a guide tube fixed within said other member with one end open-

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ing through a side of said other member; said guide tube being curved adjacent said one end thereof and slidably mounting said flexible tubular member for movement into and out of the open formation responsive to lowering and raising of said string and said one member.

4. A well tool including: a pair of elongated tubular members connected for relative axial movement; one of said members being adapted for connection with a tubing string for axial movement therewith in a well; anchor means operatively connected with said members for anchoring the other of said members to the casing of the well responsive to lowering of said string and said members relative to said anchor means; first releasable means interconnecting said anchor means with said other member and releasable to allow joint downward movement of said members relative to said anchor means; second releasable means interconnecting said members for joint downward movement of said members and releasable to allow downward movement of said one member relative to said other member; and means for introducing fluid under pressure into the open formation below the casing including a tubular member connected at one end with said other member for axial movement therewith; means on said other member for guiding said last named tubular member to cause the other end thereof to be extended into and out of the open formation responsive to lowering and raising of said string and said one member while said other member is anchored to the casing; a nozzle in said other end of said last named tubular member; and an annular boss on said other member through which said nozzle is extensible and retractible upon said lowering and raising of said one member.

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45 BENJAMIN HERSH, *Primary Examiner*.

CHARLES E. O'CONNELL, BENJAMIN BENDETT,
Examiners.