The present invention relates to subsurface tools, and more particularly to apparatus for scratching the walls of open well bores, well casings, and similar well bore conduits.

An object of the invention is to provide an improved wall scratcher to be mounted on a string of casing, and the like, and capable of being rotated to scratch the wall of a well bore or other surrounding enclosure.

Another object of the invention is to provide a rotatable type of wall scratcher to be mounted on a string of casing which need not be elevated in the well bore during the connection of additional lengths of casing to the casing string at the top of the well bore, thereby minimizing wear on the scratcher parts and reducing the tendency of the apparatus to remove the mud cake from the wall of an open well bore during the lowering of the casing string therewith.

A further object of the invention is to provide a rotatable type of wall scratcher which is of strong and sturdy construction, but which is, nevertheless, comparatively inexpensive to manufacture.

Yet another object of the invention is to provide a rotary type of wall scratcher to be mounted on well casing and the like, in which deflection of the scratcher spring fingers past a central position is facilitated, to enable the scratcher fingers to assume a position of maximum effectiveness in scratching the wall of a confining enclosure.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such 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:

Figure 1 is a side elevational view of a scratcher apparatus mounted on a casing section, with parts being broken away to disclose a portion of the interior construction of the scratcher apparatus; Fig. 2 is an enlarged cross-section taken along the line 2—2 on Fig. 1; Fig. 3 is an enlarged side elevation of a fragment of the apparatus shown in Fig. 1, parts being broken away and removed to more clearly indicate the construction of the apparatus; Fig. 4 is a cross-section taken along the line 4—4 on Fig. 3.

As illustrated in the drawings, a wall scratcher A is mounted on a casing section B for the purpose of scratching a portion of a well bore C in which the casing string is to be disposed, and also to center the casing string in the well bore. The scratcher has the primary purpose of removing a mud cake or sheath from a particular portion of the well bore, to insure a proper bond between the formation wall and the cement slurry, or other cementitious material, which is normally pumped down the casing string for upward passage through, and deposition in the annulus around the latter. It is preferred not to disturb the mud cake in the well bore except along that portion of the formation wall at which the cementitious material is disposed. For that reason, the wall scratcher should preferably make light engagement with the wall of the well bore during lowering of the casing string through the latter, but its scratching effectiveness should be at a maximum when the scratching elements mounted on the well casing have been disposed in the well bore at the desired location at which the cementitious material is to be deposited around the well casing.

The wall scratcher A shown in the drawings is of the rotary type, in that the casing string B on which it is mounted is rotated, for the purpose of moving the scratcher elements around and along the well bore C to scratch the surface of the latter. Although only one scratcher apparatus is shown in Fig. 1, it is to be understood that a plurality of such devices may be mounted along the length of the casing string to scratch the wall of the well bore along a desired length.

In Fig. 2, several scratcher elements A may be disposed along the well casing, the scratcher elements preferably being arcuately displaced with respect to each other and being located one above the other. That is to say, it is only necessary for one scratcher device to be disposed along any given length of the casing string, since the rotation of the latter will insure that the scratcher apparatus will cover the entire circumference of the well bore along the effective length of the scratcher. There can, however, be some overlapping of the scratcher devices A if desired.

The scratcher apparatus shown in the drawings includes a guiding or outer member 10 or strip, of elongate form, having a base portion 11 which is preferably curved to conform to the curvature of the exterior of the casing section B on which the device is mounted. The base 11 merges into spaced sides 12, which, in turn, merge into inwardly directed opposed flanges 13 arranged generally parallel to the base 11 and spaced therefrom to provide opposed guiding grooves 14 for a spring supporting inner strip or member 15 of elongate form, which is somewhat shorter than the outer strip 10.

The inner strip 15 is slidable longitudinally within the outer strip 10. It includes oppositely directed flange portions 16 received within the grooves 14 formed between the outer member flanges 13 and the outer member base 11. These inner flanges 16 merge into an outwardly directed intermediate bead portion 17 of generally U-shaped, or channel, cross-section, which extends outwardly through the opening 18 bounded by the inner edges of the outer member flanges 13. This bead portion 17 is provided with a plurality, such as two, of laterally spaced rows of longitudinally spaced apertures or holes 19, 20. The holes of each row are preferably equi-distant from each other, the holes in one row being offset longitudinally with respect to the holes of another row. Scratchers elements 21 are insertable through the rows of holes 19, 20, each element being retained in appropriately assembled position on the inner member 15, with finger portions 22 of each element extending outwardly of the inner member to a substantial extent.

As shown most clearly in Fig. 3, each scratcher element 21 includes an intermediate generally U-shaped heel or base portion 23, the spaced arms 24 of which merge into coil portions 25 extending longitudinally in opposite directions from the base portion. Each coil portion 25 consists of a plurality of turns, the outer parts of which
merge into the elongate wire fingers 22. Each finger includes an inner portion 22a integral with the coil 25 and an outer portion 22b of substantial length which may be bent longitudinally with respect to the inner portion 22a to provide for the outward divergence of the elongate finger portions 22b with respect to each other.

Each scratcher element 21 is mounted on the inner member 15 from the interior thereof. It is to be noted that the U-shaped heel portion 23 of each element is disposed at an angle to the finger portions 22. Each element is inserted through selected holes in the rows of apertures formed in the elongate bead 17, the fingers 22 extending through adjacent holes 19 in one row of apertures, and the U-shaped heel or base portion 23 being inserted through an aperture 26 in the other longitudinal row. The coil portions 25 are received within the confines of the outwardly directed bend 17, as shown most clearly in Figs. 2 and 4.

The angle that the fingers 22 make with the plane in which the heel or base portion 23 lies means that the fingers and the base portion cannot be mounted simultaneously through the rows of apertures 19, 20 unless the finger 20 of the other row is between the coils 25 and each other. Such bending cannot take place without difficulty, in view of the spring like characteristics of the coils 25 interconnecting the base portion 23 to the fingers 22. The fingers and base portion are first folded toward each other. The fingers 22 themselves are moved toward a position in which their outer portions 22b are substantially parallel to each other, which enables the fingers of each element to be placed through adjacent apertures 19 in one row of holes. The base portion 23 passes through an intermediate aperture 20 of the other row of holes. Thereafter, the coil forces imparted on the spring element 22 is released, which allows the fingers 22 to spring back to their initial divergent relationship and the coils 25 to unwind, in order to increase the angle between the plane of the fingers 22 and the plane of the base portion 23. The scratcher element 21 thus re-adopts its initial shape, and cannot move back through the apertures 19, 20, inasmuch as the heel or base portion 23 will engage the inner member 15 to the right of the row of apertures 20 (as seen in the drawings), and the inner portions 22a of the fingers will engage the inner member 15 to the left of the other row of apertures 20 (as seen in the drawings). The coils 25 are confined substantially entirely within the bead portion 17 of the supporting member 15, to avoid their projection laterally inwardly of the location of the flanges 16 of the inner member, which might cause interference with the movement of the inner member 15 along the outer guide strip 10.

As disclosed, the heel portion 23 of each scratcher element 21 extends outwardly through its own individual aperture 20, but each finger 22 of a scratcher element shares an aperture 19 with a finger of the next adjacent scratcher element. Thus, the fingers 22 of a scratcher element 21 are inserted through the adjacent apertures 19 of one row, with the heel 23 extending through the aperture 26 of the other row between, and the next adjacent scratcher element 21 is mounted in place in the inner supporting strip 15, with its base portion 23 extending through an adjacent aperture 20 of the other row. The spring finger 22 at one side of this element 21 extends through the same aperture 19 as the spring finger 22 of an adjacent scratcher element. Since the fingers 22 of each element diverge from one another, the spring fingers extending through the apertures 19 overlap and cross one another, as is readily apparent from Fig. 1. One finger 22 will engage another finger of the next element, causing the fingers to mutually support one another. As a matter of fact, depending upon the extent of divergence of the fingers of each scratcher element, one finger may overlap several fingers of other scratcher elements, making the construction much stronger and possessed of a greater spring scratching force.

When all of the spring elements 21 have been mounted on the inner strip 15, it is preferred that the fingers 22 extend forward from within their respective apertures 19, 20, and engage the casing B, so that the spring fingers do not engage the formation wall with as great a force as if the fingers were radially arranged during longitudinal movement of the apparatus in the well bore C. The spring fingers and the heel portion are allowed to have a certain amount of lost motion within their respective apertures 19, 20, which allows the spring fingers 22 to swing inwardly toward the casing section to a certain extent about the axis of the coils 25, which can be limited by the engagement of each heel portion 23 with an end of the aperture 20 through which the heel portion extends. However, when the casing string B is rotated, as right, hand or in a counterclockwise direction, the spring fingers 22 tend to straighten out and will move axially through a radial plane and extend backwards, as shown in broken lines at the lower portion of Fig. 2, thus introducing a deflection or bending action in the fingers, and also winding the coil spring portions 25 of the elements 21, which will increase the spring force of the fingers 22 against the formation wall, causing it to effectively scratch the mud cake, or other material, from the wall of the well bore. The resistance to backward deflection of the spring fingers is produced by engagement of the heel portions 23 with the ends of the apertures 20 adjacent the flange 16, and by engagement of the inner portions 22a of the spring fingers 22 with the side of the finger apertures 19.

The ability of the spring fingers 22 to move from the forward position (as disclosed in full lines in Fig. 2) to the backward or bent position, disclosed in broken lines at the bottom of Fig. 2, is enhanced by the divergent finger arrangement. At the commencement of the rotation of the casing B, the outer portions 22b of the fingers will engage the wall of the well bore C, and tend to be separated or be further diverged thereby. That is to say, the upper finger 22b of each spring element will be urged in an upward direction and the lower finger 22 of each element will be urged in a downward direction, which will effectively move the upper and lower end of the upper and lower fingers, respectively, lengthwise of and toward the well casing, and away from the formation, but allowing the spring fingers to shift, and bend back to the broken line position shown at the bottom of Fig. 2, wherein the fingers of each element can move back toward each other to an extent exerting a greater scratching force against the wall of the well bore.

As stated above, the fingers 22 will engage the wall of the well bore with substantial force. This force is enhanced by the overlapping of the divergent fingers with respect to each other, one finger affording support to its neighboring or adjacent fingers. The fingers themselves are sufficient in number and are disposed sufficiently close to each other as to effectively scratch the entire length of the well bore along which they are disposed. Rotation of the casing string B will produce full circumferential coverage of the well bore by the scratcher device.

Instead of securing the inner supporting member 15 directly to the casing section, as by welding thereto, it is preferred to allow the casing section B to move longitudinally to a limited extent, to avoid the elevation of the scratcher elements 21 when the casing string is raised, to lift it out of the holding slips (not shown) at the top of the well bore, preparatory to again lower the casing string in the well bore. For that reason, the inner member 15 is slidable longitudinally within the outer member 16, this outer member being suitably secured, as by welding, to the casing section B. To provide for limited relative longitudinal movement between the inner and outer members 15, 10, stop elements or lugs 30 are provided at the upper and lower ends of the outer member. As
shown, these lugs 30 may be placed at the upper end of the outer member between the flanges 13 and the base 11, being suitably welded to both of these parts. Similarly, lower end lugs 32 may be placed at the lower end of the outer elongate member 10 between its base 11 and the interturn flange 13, also being suitably welded to these parts.

It is evident that the inner member 15 may have relative sliding movement within the outer member 10, the extent of movement being determined by engagement of the lower end of the inner member 15 with the lower stop elements 30, and its upper end with the upper stop elements 30. To distribute the force that might be transmitted between the inner and outer supporting members 15, 10, the lugs 30 are not placed at the upper and lower end of the member 10 alone. Intermediate stop elements 31, 32 may also be provided. Thus, an upper intermediate stop lug 31 may be welded between the base 11 and one interturn flange 13, being received within an elongate notch 33 formed in one of the inner member flanges 16. Similarly, a lower intermediate stop element or lug 32 may be welded to the outer member between its base 11 and other interturn flange 13, this lug 32 being received within a lower elongate notch 34 formed in the other flange 16 of the inner member 15. The two intermediate lugs 31, 32 are located on the outer member 10 to engage the upper ends 36 of the notches 33, 34, to prevent the inner member 15 from moving downwardly thereon, assurance being had that this cement slurry will make a proper bond with the face of the well bore.

It is apparent that a comparatively simple and economical rotary type of wall scraper has been provided, capable of effectively removing the mud cake from the wall of the hole through rotating the casing string. The inner and outer members 15, 10 can be formed from sheet metal and will have the proper strength to withstand the loads imposed upon them. The apertures 19, 20 are readily formed through the base 11 by removing therefrom the inner member 15 and the latter placed in proper slidable relation within the outer member 10, whereupon the stop elements or lugs 30, 31, 32 are welded in place. These elements not only function to limit the extent of relative longitudinal movement between the outer and inner members 15, 10, but they also serve to reinforce the flanges 13 by resisting any bending forces tending to move them toward the base 11 of the outer member 10 or, for that matter, away from the base of the outer member.

The inventor claims:

1. In a wall scraper adapted to be mounted on a tubular string to be disposed in a well bore: an elongate strip member adapted to be secured to the tubular string lengthwise along the latter; an elongate supporting strip member slidably mounted on said member for longitudinal movement relative thereto, said supporting member being at least as high as the stop lugs 30 of the inner member 15 and the latter placed in proper slidable relation within the outer member 10, whereupon the stop elements or lugs 30, 31, 32 are welded in place. These elements not only function to limit the extent of relative longitudinal movement between the outer and inner members 15, 10, but they also serve to reinforce the flanges 13 by resisting any bending forces tending to move them toward the base 11 of the outer member 10 or, for that matter, away from the base of the outer member.

2. In a wall scraper adapted to be mounted on a tubular string to be disposed in a well bore: an elongate outer member adapted to be secured to the tubular string lengthwise along the latter; said member having a longitudinal opening; an elongate inner member slidably mounted in said outer member for longitudinal movement relative thereto; a plurality of spring elements mounted within said inner member and including spring fingers extending outwardly therefrom and through said opening and adapted to engage the wall of the well bore; and coengageable stop means on said members to limit the extent of relative longitudinal movement between said members.

3. In a wall scraper adapted to be mounted on a tubular string to be disposed in a well bore: an elongate outer member adapted to be secured to the tubular string lengthwise along the latter and having opposed grooves therein and a longitudinal opening; an elongate inner member having oppositely directed flanges slidably longitudinally in said grooves, whereby said inner and outer members can move longitudinally with respect to each other; a plurality of spring elements mounted within said inner member and including spring fingers extending outwardly therefrom and through said opening and adapted to engage the wall of the well bore; and coengageable stop means on said members to limit the extent of relative longitudinal movement between said members.

4. In a wall scraper adapted to be mounted on a tubular string to be disposed in a well bore: an elongate outer member adapted to be secured to the tubular string lengthwise along the latter and including a base portion and inwardly directed flanges spaced from said base portion to provide a pair of opposed longitudinally extending grooves, the inner ends of said flanges being spaced from each other to provide a longitudinal opening, an elongate inner member having oppositely directed flanges slidably longitudinally in said grooves, said inner member...
ber including an intermediate portion extending through said opening; a plurality of spring elements mounted within said intermediate portion and including spring fingers extending outwardly therefrom and adapted to engage the wall of the well bore; and coengageable stop means on said members to limit the extent of relative longitudinal movement between said members.

5. In a wall scratcher adapted to be mounted on a tubular string to be disposed in a well bore; an elongate outer member adapted to be secured to the tubular string lengthwise along the latter and including a base portion and inwardly directed flanges spaced from said base portion to provide a pair of opposed longitudinally extending grooves, the inner ends of said flanges being spaced from each other to provide a longitudinal opening; an elongate inner member having oppositely directed flanges slidable longitudinally in said grooves, said inner member including an intermediate apertured bead extending through said opening; a plurality of spring elements mounted within and confined by said bead and including spring fingers extending outwardly through said bead apertures and adapted to engage the wall of the well bore; and coengageable stop means on said members to limit the extent of relative longitudinal movement between said members.

6. In a wall scratcher adapted to be mounted on a tubular string to be disposed in a well bore; an elongate member adapted to be secured to the tubular string lengthwise along the latter; an elongate supporting member slidably mounted on and interfitting with said member for longitudinal movement relative thereto and to prevent substantial lateral movement relative thereto; a plurality of spring elements mounted on said supporting member and including spring fingers extending outwardly therefrom and adapted to engage the wall of the well bore; and coengageable stop means on said members to limit the extent of relative longitudinal movement between said members.

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