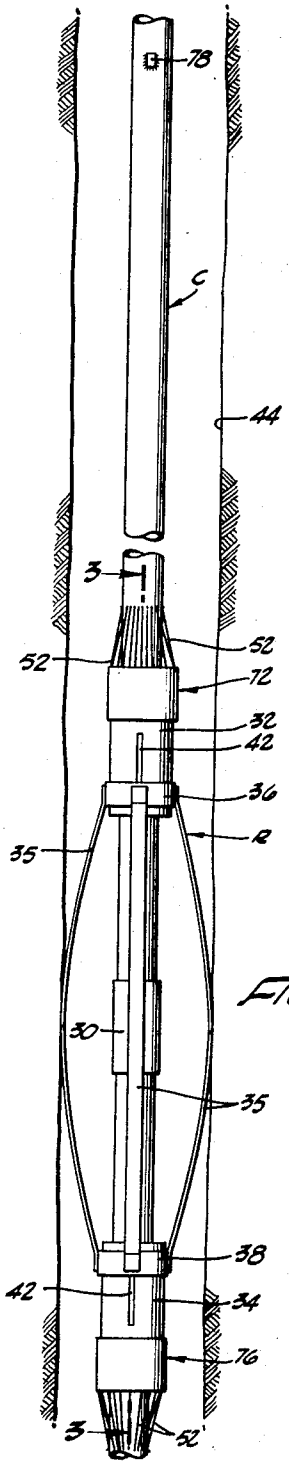
Jan. 6, 1959 F. D. DE JARNETT 2,867,280

SCRATCHER CONSTRUCTION FOR ABRADING WELL BORE HOLES

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FIG. 1.



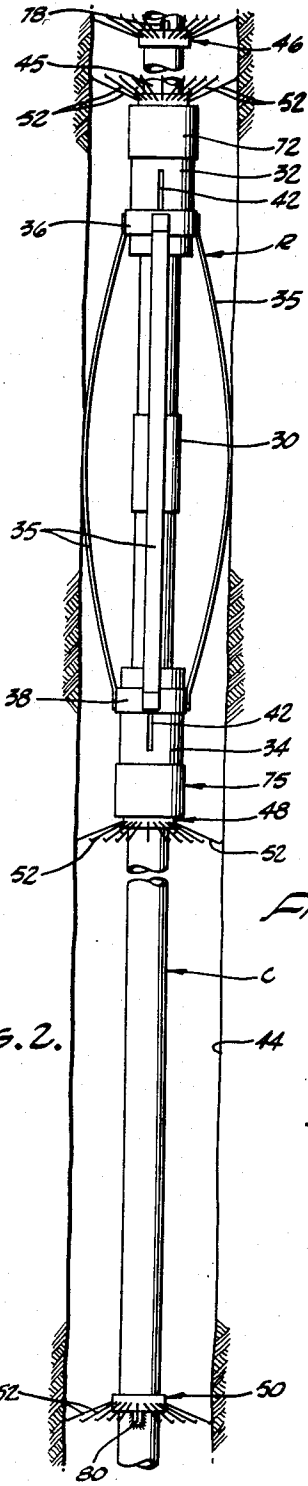


FIG. 2.

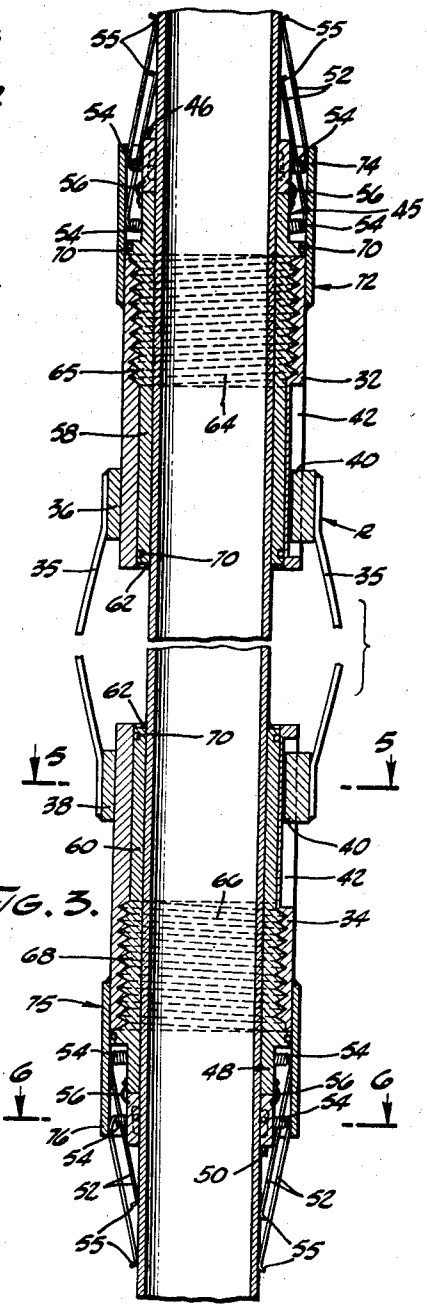


FIG. 3.

FRANK D. DE JARNETT
INVENTOR.

BY

ATTORNEY

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SCRATCHER CONSTRUCTION FOR ABRADING WELL BORE HOLES

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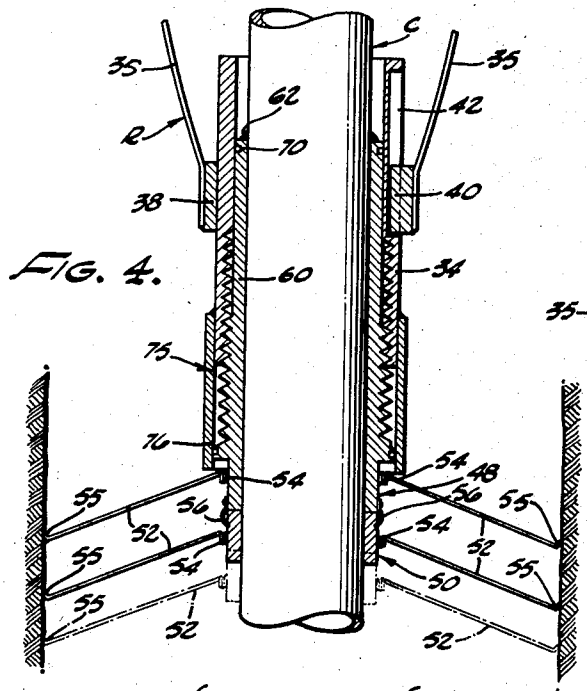


FIG. 4.

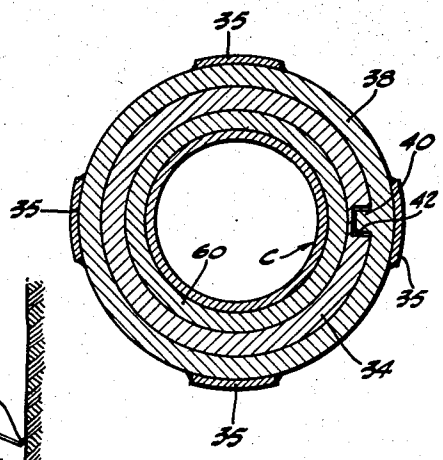
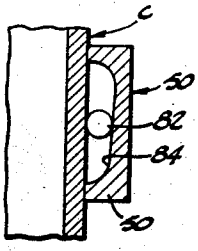


FIG. 5.



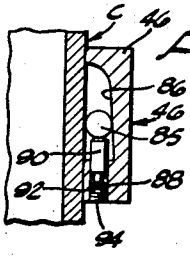


FIG. 8.

FIG. 7.

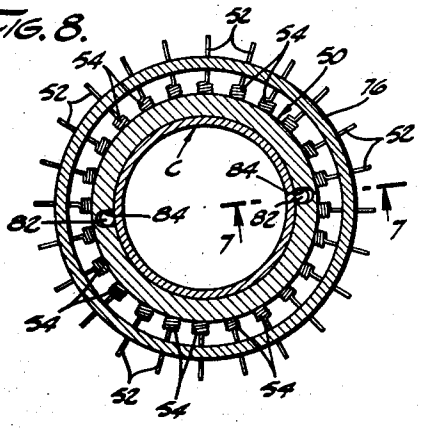


FIG. 6.

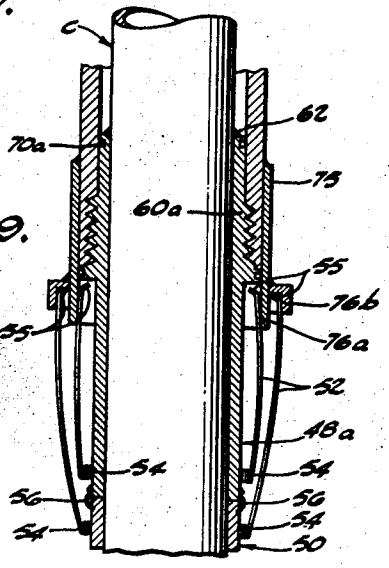


FIG. 9.

FRANK D. DE JARNETT
INVENTOR.

BY

ATTORNEY

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SCRATCHER CONSTRUCTION FOR ABRADING WELL BORE HOLES

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FIG. 10.

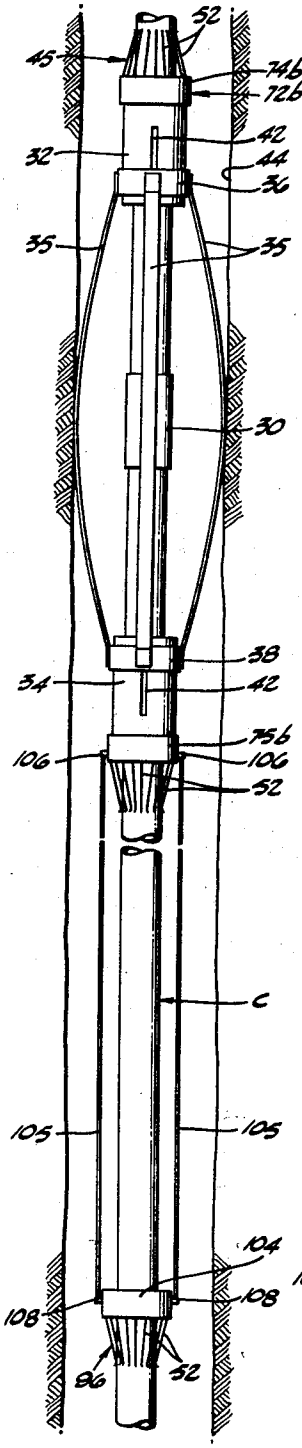
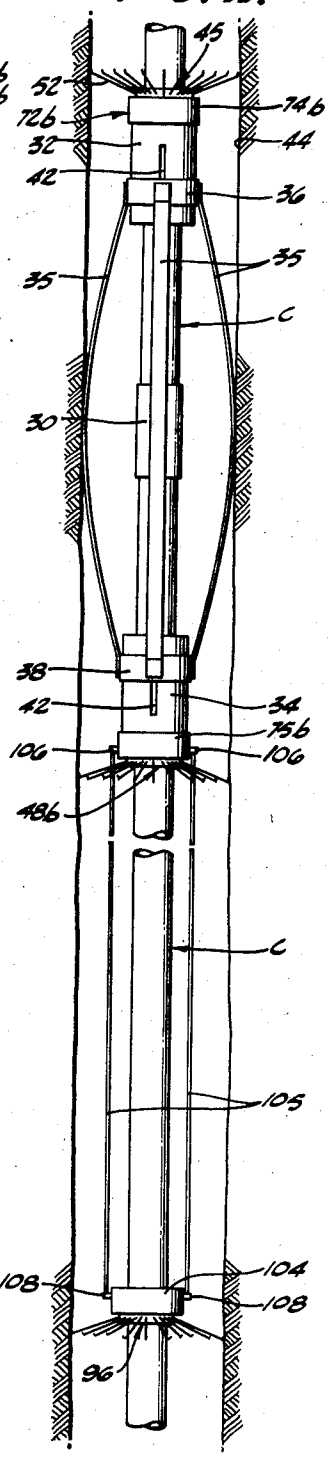


FIG. 11.



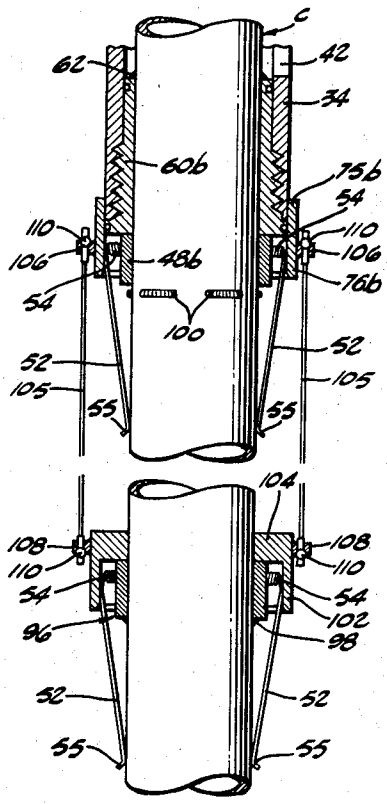


FIG. 12.

FRANK D. DE JARNETT
INVENTOR.

BY

ATTORNEY

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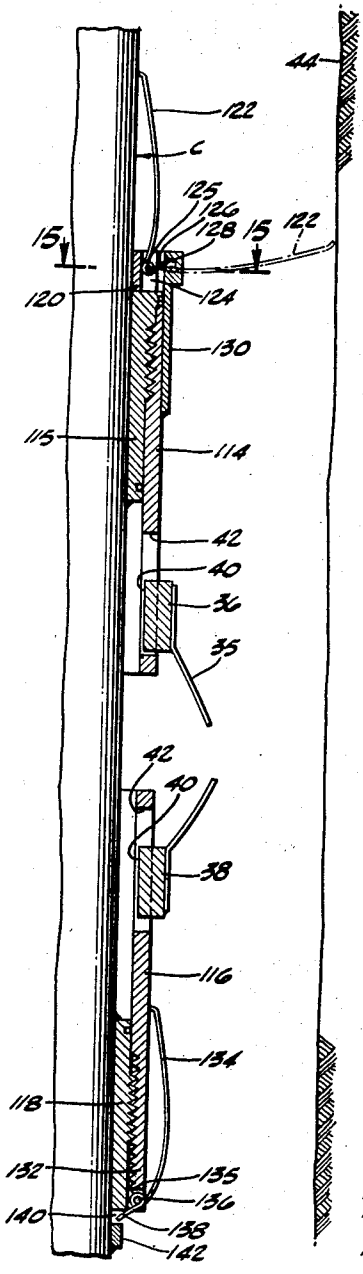


FIG. 13.

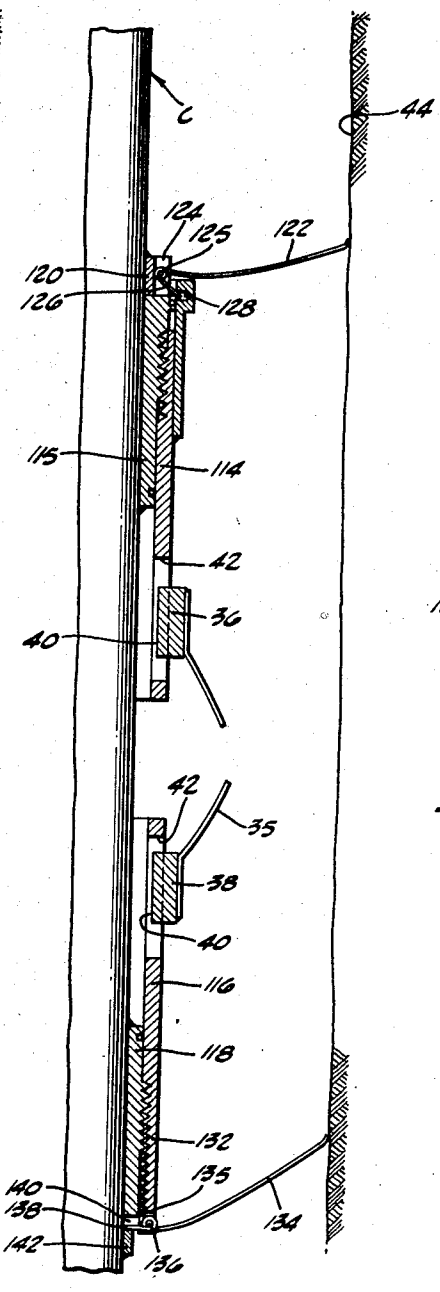


FIG. 14.

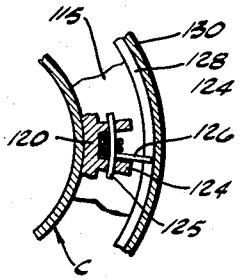


FIG. 15.

FRANK D. DE JARNETT
INVENTOR.

BY

ATTORNEY

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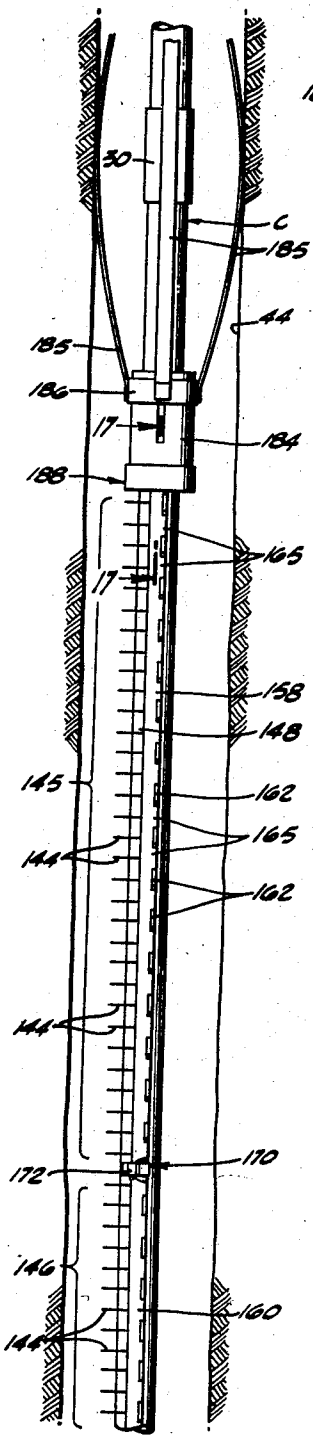


FIG. 16.

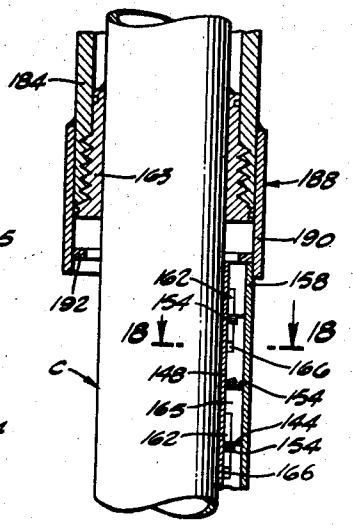


FIG. 17.

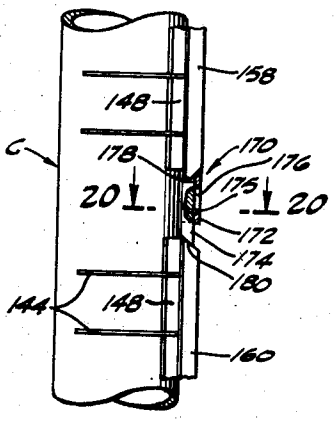


FIG. 19.

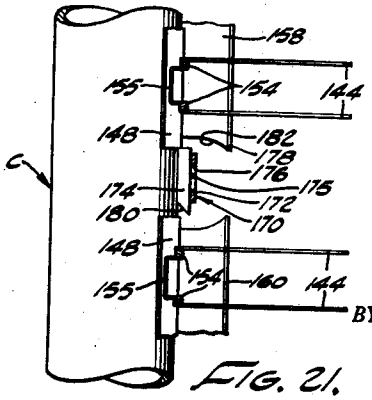
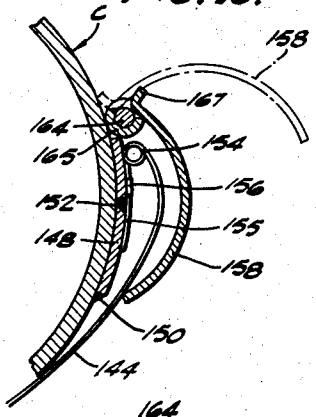


FIG. 21.

FIG. 18.



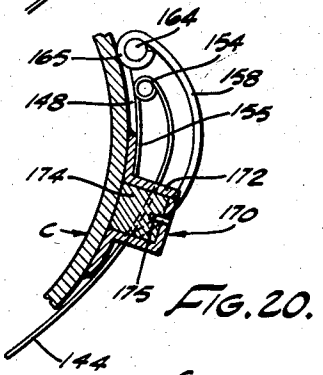


FIG. 20.

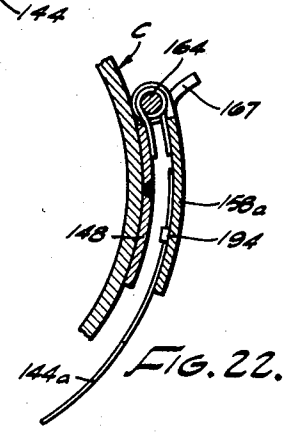


FIG. 22.

FRANK D. DE JARNETT
INVENTOR.

BY

ATTORNEY

United States Patent Office 2,867,280
Patented Jan. 6, 1959

2,867,280

SCRATCHER CONSTRUCTION FOR ABRADING WELL BORE HOLES

Frank Daniel De Jarnett, Long Beach, Calif., assignor of one-half to Paul A. Medearis

Application January 13, 1955, Serial No. 481,559

13 Claims. (Cl. 166—173)

This invention relates to a means and a method for the conditioning of an oil well bore involving the use of scratcher elements to abrade the mud cake away from the wall surface of the bore. As disclosed in the Wright Patents 2,338,372, 2,374,317 and 2,302,352, it is a well known practice to use scratcher elements in the form of numerous spring arms of wire or the like on a string of casing to abrade the mud cake away from a bore hole wall in preparation for forming a cement plug or bridge around the casing at some selected level. If the mud cake is not removed to permit the cement to bond directly with the virgin earth formation the cementing operation will fail of its purpose to provide an effective fluid-tight seal.

For example, in a well bore extending to a depth of 12,000 feet it may be desirable to seal off the bore hole around the casing by means of cement in a zone below the 10,000 foot level. To prepare for the cementing operation, the string of casing is lowered into the bore hole with suitable scratchers mounted at appropriate positions within the bottom 2,000 feet of the casing. When the scratchers reach the 10,000–12,000 foot zone the casing is either reciprocated longitudinally or rotated to cause the scratchers to abrade away the mud cake from the surrounding bore hole wall. The dislodged mud cake is washed to the surface by forcing suitable fluid down through the casing to flow upward to the surface around the outside of the casing. When the selected zone is cleared of mud cake, cement slurry is forced downward through the casing to flow upward around the casing to seal the zone.

A difficulty arises, however, because the usual scratchers such as disclosed in the above-mentioned patents, tear mud cake away from the wall of the well bore all the way down from the surface to the selected zone. One result of using the scratchers unnecessarily for the distance of 10,000 feet is that the scratchers are worn and damaged by the time they reach the selected zone. Another result is that tons of mud cake that need not be disturbed are dislodged above the selected zone and must be washed out of the well at considerable cost in time and labor. Because of the necessity of washing out this mud dislodged at the higher levels it is not feasible to lower the scratcher-equipped casing to the selected zone without pausing for washing operations at various levels.

The usual procedure for cementing such a 12,000 foot bore hole in the 10,000–12,000 foot zone is to lower the scratcher-equipped casing through the first 5,000 feet and then pause. The tons of filter cake dislodged in the first 5,000 feet is then washed to the surface by pumping fluid down through the casing and up to the surface around the casing. This pumping operation is continued until the fluid is clear of dislodged mud cake and the time required for this pumping operation may be, for example, on the order of two hours. The casing is then lowered an additional distance, say 3,000 feet to the 8,000 foot level, and pumping is resumed for another two hours or so. Again the scratcher-equipped casing is lowered,

say another 2,000 feet to the 10,000 foot level and the pumping operation is again resumed until the fluid reaching the surface is clear of dislodged cake. When the scratchers are finally lowered to the selected zone below the 10,000 foot level, the casing is reciprocated and/or rotated to cause the scratchers on the casing to abrade away the mud cake for exposure of the virgin earth formation. The pumping is again resumed until the returning fluid is clear of foreign material. The well bore is then in proper condition for the usual cementing operation.

The general object of the present invention is to avoid unnecessary wear and damage on the part of the scratcher elements. An additional object of the invention is to save time and labor by mounting the scratcher elements on the casing in a retractible manner and by further providing an arrangement which permits the scratchers to be extended from retracted state whenever desired by remote control exercised at the top of the well. The invention makes possible a simple procedure in which the casing is lowered into the well bore with the scratchers thereon retracted and then the scratchers are extended into initial contact with the wall cake by remote control when, and not before, the scratchers descend to the selected zone. The casing is then reciprocated longitudinally and/or rotated to cause the scratchers thereon to scour the well bore wall free of mud cake and fluid is pumped in the usual manner to carry the dislodged cake to the surface. In this manner the scratcher elements are conserved until they reach the selected area and the time and labor required for clearing the well bore of dislodged mud cake is reduced as much as 75% or more.

In general the broad object of the invention is achieved by providing means responsive to rotation of the casing to cause the scratcher elements to extend from their retracted positions to their extended effective positions by remote control when desired. With the scratcher elements retracted, it is a simple matter to lower the casing into the well bore to the desired level and then to rotate the casing to cause the scratcher elements thereon to extend into initial abrading contact with the mud-coated wall of the bore hole.

The preferred practice of the invention is characterized by the provision of rotary means on the casing engageable with the bore hole wall. Such rotary means, for example, may be provided with yielding spring-like elements for frictional engagement with the bore hole wall to tend to keep the rotary means from rotating. With such an arrangement, relative rotation between the rotary means and the casing may be caused at any desired depth simply by rotating the casing in the bore hole. In accord with the teachings of the present invention, the scratcher elements are constructed and arranged to extend from their retracted state in response to this relative rotation.

A feature of the preferred practice of the invention is the use of centering springs on the rotary means. These springs not only serve their primary purpose of frictionally engaging the wall of the well bore to oppose rotation of the rotary means but also serve the purpose of centering the casing and scratcher elements in the well bore.

Preferably the scratcher elements are provided in the form of scratcher units, there being a multiplicity of wire-like or rod-like scratcher elements on each unit. The preferred practice of the invention is characterized by the concept of making a plurality of such units responsive to a single rotary assembly. One practice of the invention is further characterized by mounting some scratcher units on the casing for longitudinal movement relative thereto so that when a scratcher unit is extended from its retracted state at a selected depth in the bore hole the

casing may be manipulated longitudinally to shift the scratcher unit away from the rotary means. Thus a longitudinally movable scratcher unit may be positioned on the casing closely adjacent to a fixed scratcher unit with both units held in retracted state by the same rotary means. When the two units are lowered to the desired zone and are extended from their retracted states, the movable unit may be shifted longitudinally to a desired spacing from the fixed unit. A special object of the invention is to provide suitable longitudinally movable scratcher units for this mode of operation and to provide means that will maintain the movable scratcher units at the positions to which they are displaced by manipulation of the casing.

The various features, objects and advantages of the invention will be apparent in the following detailed description considered with the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

Fig. 1 is a side elevation of a portion of a string of casing equipped with one embodiment of the invention, the casing being shown in a bore hole and the scratcher units thereon being shown in retracted state;

Fig. 2 is a similar view showing the scratcher units in extended effective state;

Fig. 3 is a longitudinal axial section on an enlarged scale taken as indicated by the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary section similar to Fig. 3 showing two of the scratcher units positioned close together when initially extended to their effective states;

Fig. 5 is a transverse section taken as indicated by the line 5—5 of Fig. 3;

Fig. 6 is a transverse section taken as indicated by the line 6—6 of Fig. 3;

Fig. 7 is a fragmentary section taken as indicated by the line 7—7 of Fig. 6 showing the construction of a detent means that may be incorporated in a downwardly movable scratcher unit;

Fig. 8 is a similar view of a reversed detent means that may be incorporated in an upwardly movable scratcher unit;

Fig. 9 is a fragmentary longitudinal sectional view showing a modification of this first embodiment of the invention;

Fig. 10 is a view similar to Fig. 1 showing a second embodiment of the invention with the scratcher units on the casing in retracted state;

Fig. 11 is a similar view showing the scratcher units in extended effective state;

Fig. 12 is an enlarged fragmentary sectional view of the embodiment of the invention shown in Figs. 10 and 11;

Fig. 13 is an enlarged fragmentary longitudinal sectional view illustrating a third embodiment of the invention wtih the scratcher units on the casing in retracted state;

Fig. 14 is a similar view with the scratcher units in extended effective state;

Fig. 15 is a fragmentary transverse sectional view taken as indicated by the line 15—15 of Fig. 13;

Fig. 16 is a view similar to Fig. 1 showing a fourth embodiment of the invention;

Fig. 17 is an enlarged fragmentary longitudinal section taken as indicated by the line 17—17 of Fig. 16;

Fig. 18 is a greatly enlarged fragmentary transverse section taken as indicated by the line 18—18 of Fig. 17;

Fig. 19 is an enlarged portion of Fig. 16 with a portion of the latch structure broken away;

Fig. 20 is a greatly enlarged fragmentary transverse section taken as indicated by the line 20—20 of Fig. 19;

Fig. 21 is a view similar to Fig. 19 showing the scratcher units in their extended state; and

Fig. 22 is a view similar to Fig. 18 showing a modification of the fourth embodiment of the invention.

Figs. 1 and 2 show a string of casing, generally designated C, comprising lengths of pipe interconnected by collars 30. The invention contemplates the mounting of

a rotary means or rotary assembly, generally designated R, on the casing C and in this instance the rotary means straddles one of the collars 30. Thus the rotary assembly R in Figs. 1 and 2 comprises an upper rotary sleeve 32 above a collar 30 and a second lower rotary sleeve 34 below the collar, these two rotary sleeves being interconnected by a plurality of longitudinal bow springs 35.

The upper ends of the bow springs 35 are fixedly attached to a ring 36 that is slidingly mounted on the upper rotary sleeve 32 and the lower ends of the bow springs are attached in similar manner to a ring 38 that is slidingly mounted on the lower rotary sleeve 34. Each of the rings 36 and 38 has an integral spline 40 (Figs. 3 and 5) which is slidingly mounted in a longitudinal groove 42 in the corresponding rotary sleeve to prevent relative rotation between the bow springs and the sleeve. The bow springs 35 resiliently push outward to make frictional contact with the surface of the surrounding bore hole 44 as shown in Figs. 1 and 2 and are free to expand to various diameters by virtue of the freedom given the rings 36 and 38 for longitudinal movement relative to the two rotary sleeves.

In this first embodiment of the invention the rotary assembly R cooperates with four scratcher units and holds the scratcher units in retracted state while the casing C is being lowered through the well bore. The four scratcher units comprise an upper fixed scratcher unit 45 that is stationary on the casing, an adjacent upper movable scratcher unit 46, a lower fixed scratcher unit 48 and an adjacent lower movable scratcher unit 50.

Each of these four scratcher units is in the form of a ring or collar embracing the casing C and carrying a plurality of scratcher elements 52 in the form of spring fingers of wire-like or rod-like character. The base of each of the scratcher elements or spring fingers is suitably bonded in position. Each of the spring fingers 52 is preferably formed with a coil 54 to provide a relatively wide range of flexure within its elastic limits. Each of the spring fingers 52 is so mounted and so coiled as to tend to extend outwardly resiliently from the casing C into abrading contact with the surrounding wall of the well bore as shown in Figs. 2 and 4. Preferably, but not necessarily, each of the scratcher elements or spring fingers 52 is slightly bent at its tip as shown at 55 in Fig. 4.

The two fixed scratcher units 45 and 48 are immobilized on the casing C and the two movable scratcher units 46 and 50 are slidingly mounted on the casing for movement longitudinally thereof. In the retracted state of the scratcher units while they are being carried downward through the bore hole by the casing, the upper movable scratcher unit 46 abuts the corresponding upper fixed scratcher unit 45 and, in like manner, the lower movable scratcher unit 50 abuts the lower fixed scratcher unit 48. Preferably suitable yielding means is provided to tend to maintain each of the movable scratcher units in the abutting relationship with the corresponding fixed scratcher unit. For this purpose each of the fixed scratcher units 45 and 48 may be provided with suitable spring clips 56 in frictional engagement with the corresponding movable scratcher unit 46 or 50. Preferably each of the movable scratcher units is slightly recessed to facilitate engagement by the spring clips 56.

It is contemplated that each of the two rotary sleeves 32 and 34 will be mounted on the casing C by suitable screw threads. For this purpose a fixed cylindrical member 58 (Fig. 3) may be mounted on the casing C for cooperation with the upper rotary sleeve 32 and a second fixed cylindrical member 60 may be mounted on the casing for cooperation with the lower rotary sleeve 34. As best shown in Fig. 3 the fixed cylindrical member 58 may be integral with the upper fixed scratcher unit 45 and the fixed cylindrical member 60 may be integral with the lower fixed scratcher unit 48, the two fixed cylindrical

members being bonded to the casing by suitable welding 62.

The fixed cylindrical member 58 is snugly embraced by the corresponding upper rotary sleeve 32 and is formed with an external left-hand screw thread 64 for engagement by a corresponding left-hand internal screw thread 65 of the upper rotary sleeve. In like manner fixed cylindrical member 60 is provided with an external right-hand screw thread 66 for engagement with a right-hand internal screw thread 68 of the lower rotary sleeve 34. Preferably each of the fixed cylindrical members 58 and 60 is suitably recessed circumferentially to receive O-rings 70 for sealing contact with the inner circumferential surface of the surrounding rotary sleeve.

The upper rotary sleeve 32 has a cylinder 72 welded thereto to form an upwardly extending cylindrical skirt 74 to serve as means for holding the two upper scratcher units 45 and 46 in retracted state and, in like manner, the lower rotary sleeve 34 has a cylinder 75 welded thereto to form a downwardly extending cylindrical skirt 76 to hold the two lower scratcher units 48 and 50 in retracted state. As shown in Fig. 3 each of the cylindrical skirts 74 and 76 embraces and confines the scratcher elements 52 of the corresponding scratcher unit, to hold the scratcher elements radially retracted or flexed inwardly close to the peripheral surface of the casing C.

The casing C has a stop lug 78 welded thereon at a suitable distance above the normal position of the rotary assembly R to limit the upward longitudinal movement of the upper movable scratcher unit 46 and has a similar stop lug 80 spaced below the normal position of the rotary assembly R to limit the downward longitudinal movement of the lower movable scratcher unit 50. It is contemplated that each of the movable scratcher units 46 and 50 will be provided with suitable detent means that will permit the scratcher units to be moved longitudinally towards and against the corresponding stop lugs 78 and 80 but will prevent any substantial retraction away from the stop lugs. Thus after the casing C has been lowered into a bore hole each of the movable scratcher units may be shifted to a position abutting the corresponding stop lug and will thereafter be immobilized at the stop lug.

The detent means for the lower movable scratcher unit 50 may comprise a suitable small ball 82 mounted in a short longitudinal slot 84 on the inner circumferential wall of the unit as shown in Figs. 6 and 7. The slot 84 tapers in radial thickness as shown in Fig. 7, the slot at its lower end being less in radial dimension than the diameter of the ball 82 and at its upper end being greater in radial dimension than the ball. It is apparent that any tendency for the lower movable scratcher unit 50 to move downward longitudinally of the casing C will cause the ball 82 to tend to seek the upper portion of the slot 84 so that the ball will not interfere with the downward movement of the scratcher unit. On the other hand any tendency for the scratcher unit to move upward relative to the casing will cause the ball to seek the lower end of the slot with resultant binding of the ball to prevent such movement.

The corresponding detent means for the upper movable scratcher unit 46 shown in Fig. 8 comprises a similar ball 85 in a longitudinal slot 86 that widens in radial dimension towards the bottom of the slot. Suitable means is provided to continuously urge the ball 85 towards the upper restricted end of the slot 86. For this purpose the lower end of the scratcher unit 46 may be provided with a bore 88 in which is mounted a suitable plunger 90 in contact with the ball 85. A suitable coiled spring 92 is confined in compression in the bore 88 between the plunger 90 and a threaded plug 94 to urge the plunger continuously upward. It is apparent that the arrangement in Fig. 8 will permit the upper movable scratcher unit 46 to be shifted upward against the upper stop lug 78, but that the ball 85 under pressure from the plunger 90 will bind against the periphery of the casing to prevent return downward movment of the scratcher unit.

The manner in which this first embodiment of the invention serves its purpose may be readily understood from the foregoing description. While the casing C is being lowered into the well bore to bring the various scratcher units 45, 46, 48 and 50 to the selected zone or level in the well, the various movable parts are in the positions shown in Figs. 1 and 3. The upper movable scratcher unit 46 is releasably held in abutment with the upper fixed scratcher unit 45 by the corresponding spring clips 56 and in like manner the lower movable scratcher unit 50 is held in abutment against the lower fixed scratcher unit 48 by the corresponding spring clips 56. The upper threaded rotary sleeve 32 is threaded onto the left hand screw thread 64 and the lower threaded rotary sleeve 34 is threaded onto the lower right-hand thread 66 of the lower fixed sleeve 58.

The four bow springs 35 yieldingly press outward into frictional engagement with the surface of the surrounding well bore 44 to hold the well casing centered in the well bore. Thus with the upper scratcher units 45 and 46 held in retracted state by the upper cylindrical skirt 74, and with the lower scratcher units 48 and 50 held in retracted state by the lower cylindrical skirt 76, and with the casing centered in the bore hole by the bow springs 35, it is apparent that the various scratcher elements 52 of the four scratcher units will be held out of contact with the surrounding bore hole.

When the four scratcher units reach the selected zone in the well bore and it is desired that the scratcher units change from retracted state to extended effective state, it is merely necessary to rotate the casing clockwise to bring about the desired result. As the casing rotates clockwise the bow springs 35 frictionally engage the wall of the bore hole 44 to keep the rotary assembly R from rotating. Thus the casing C rotates relative to the two rotary sleeves 32 and 34, the casing C rotating clockwise as viewed from the top of the well. This relative rotation causes the upper rotary sleeve 32 to unscrew with longitudinally downward movement away from the two upper scratcher units 45 and 46 until the upper cylindrical skirt 74 completely frees these two upper scratcher units to permit their scratcher elements 52 to flex outward into contact with the wall of the surrounding bore hole as shown in Fig. 2. In like manner the clockwise rotation of the casing C causes the lower threaded rotary sleeve 34 to unscrew with a longitudinal upward movement until the lower cylindrical skirt 76 releases the two lower scratcher units 48 and 50 to permit their scratcher elements 52 to flex outward into contact with the surrounding wall of the well bore. It is apparent that the provision for freedom for longitudinal movement of the two sleeves 32 and 34 relative to the two corresponding splined rings 36 and 38 permits the required longitudinal freedom for movement on the part of the two sleeves that carries the cylindrical skirts 74 and 76 to their retracted scratcher-freeing positions. Thus the fact that the rings 36 and 38 are slidingly keyed to the corresponding rotary sleeves 32 and 34 serves a dual purpose since it permits the bow springs 35 freedom for expansion into contact with the wall of the bore hole and at the same time permits the rotary sleeves to shift longitudinally to free the scratcher units.

Once the scratcher units are extended or expanded into abrasive contact with the surrounding well bore, the casing C may be reciprocated longitudinally to position the upper movable scratcher unit 46 against the upper stop lug 78 and to position the lower movable scratcher unit 50 against the lower stop lug 80. For this purpose the casing C may first be moved longitudinally upward to position the lower scratcher unit 50 against the lower stop lug 80. As the casing is initially drawn longitudinally upward for this purpose, the engagement of the scratcher elements 52 of the lower scratcher unit 50 with the surface of the surrounding bore hole holds the mov-

able scratcher unit 50 stationary but the adjacent fixed scratcher unit 48 moves with the casing and pulls the clips 56 out of engagement with the movable unit 50. The scratcher unit 50 continues to be stationary until the upward movement of the casing brings the lower stop lug 80 against the scratcher unit. When the casing C then is moved longitudinally downward, the ball 82 binds against the casing to immobilize the lower scratcher unit 50 on the casing adjacent the lower stop. Thereafter the stop keeps the scratcher unit 50 from shifting on the casing in one direction and the detent keeps it from shifting in the opposite direction.

In like manner downward longitudinal movement of the casing C while the upper movable scratcher unit 46 is extended into contact with the surrounding well bore brings the upper stop lug 78 against the scratcher unit and thereafter the ball 85 binds to keep the upper movable scratcher unit 46 from moving away from the upper stop lug. With the two movable scratcher units 46 and 50 positioned against the corresponding stop lugs 78 and 80, longitudinal reciprocation of the casing will cause the two scratcher units to reciprocate with the casing to abrade the bore hole to scour away the deposited mud cake. The longitudinal reciprocation of the casing will also cause the fixed scratcher units 45 and 48 to reciprocate in the same manner.

It is apparent that the four scratcher units 45, 46, 48 and 50 may be arranged to be spaced apart at various distances for this scratcher operation since the distance between the two fixed scratcher units 45 and 48 is a matter of choice and since the positioning of the stop lugs 78 and 80 is a matter of choice. Ordinarily it will be desirable to have the scratcher units more or less uniformly spaced along the casing.

Fig. 9 shows how the structure shown in Figs. 1 to 8 may be modified to cause the scratcher elements of the two lowermost scratcher units to be retracted by upward flexure instead of downward flexure. In this construction the lower fixed scratcher unit 48*a* is integral with the lower fixed cylindrical member 60*a*, as before described, but this portion of the sleeve is lengthened to permit the scratcher elements 52 to extend upward under a relatively short cylindrical skirt 76*a*. The cylindrical skirt 76*a* carries an auxiliary outer cylindrical skirt 76*b* to receive the ends of the upwardly extended scratcher elements of the adjacent lower movable scratcher unit 50.

When both of the scratcher units 48*a* and 50 are in their retracted states the movable scratcher unit 50 is in abutment with the fixed scratcher unit 48*a* and is yieldingly held in this position by the usual spring clips 56 as heretofore described. Thus the construction shown in Fig. 9 provides for all of the spring fingers or scratcher elements 52 to point or extend upward while the scratcher elements are being moved downward through the bore hole. This provision is further insurance against damage to the scratcher elements. It is apparent that in all other respects the construction shown in Fig. 9 operates in the same manner as heretofore described.

The second embodiment of the invention shown in Figs. 10 to 12 includes three scratcher units comprising the previously mentioned upper fixed scratcher unit 45, a lower fixed scratcher unit 48*b* corresponding to the previously described lower fixed scratcher unit 48, and a third still lower scratcher unit 96 which is of the usual collar or ring construction and is fixedly attached to the casing C by welding 98 (Fig. 12). The two scratcher units 45 and 48*b* are controlled by a rotary assembly in the manner heretofore described.

The rotary assembly in this second embodiment of the invention is largely identical as the first described rotary assembly indicated by the use of corresponding numerals to designate corresponding parts. In this instance, however, a relatively narrow cylinder 72*b* is carried by the upper rotary sleeve 32 to form a relatively short cylindrical skirt 74*b* for holding the upper scratcher unit

45 in retracted state and in like manner a relatively short cylinder 75*b* is carried by the lower rotary sleeve 34 to provide a relatively short cylindrical skirt 76*b* for holding the scratcher unit 48*b* in retracted state.

The upper and lower rotary sleeves 32 and 34 are threaded onto the casing by means of corresponding fixed threaded sleeves as heretofore described. Thus Fig. 12 shows the lower rotary sleeve 34 threaded onto a corresponding cylindrical member 60*b* that is welded onto the casing C. As shown in Fig. 12, the scratcher unit 48*b* need not be integral with the fixed cylindrical member 60*b*. Thus the scratcher unit 48*b* slidingly embraces the casing C but is substantially immobilized relative thereto since it is confined from above by the fixed cylindrical member 60*b* and is confined from below by stop means in the form of circumferential welding beads 100.

The third and lowermost scratcher unit 96 may be held in retracted state by any suitable means that is operatively connected with the lower rotary sleeve 34. In the construction shown, the scratcher unit 96 is held in retracted state by a cylindrical skirt 102 that is formed by a ring 104. The ring 104 slidingly embraces the casing C above the third scratcher unit 96 and is connected with the rotary sleeve 34 by means of a plurality of wires or pull rods 105. The upper end of each of the pull rods 105 extends through an apertured lug 106 on the periphery of the cylinder 75 and the lower end of each of the pull rods extends through an apertured lug 108 on the slidable ring 104. Preferably each end of each pull rod is threaded into a suitable fitting 110 that is enlarged for engagement with the corresponding apertured lug. Thus the fittings 110 may be rotated to adjust the effective length of the pull rods 105.

Figs. 10 and 12 show how the scratcher units of this second embodiment of the invention are held in retracted state when the casing is being lowered through the bore hole to the selected zone or level at which the scratching operation is to be carried out. The upper skirt 74*b* holds the scratcher elements 52 of the upper fixed scratcher unit 45 in retracted or flexed state against the casing C; the lower cylindrical skirt 76*b* holds the scratcher elements 52 of the lower fixed scratcher unit 48*b* flexed against the casing; and the skirt 102 of the ring 104 holds the scratcher elements 52 of the lowermost scratcher unit 96 flexed against the casing. When the three scratcher units reach the selected zone in the well bore 44 the casing C is rotated to cause the scratcher units 45 and 48*b* to be released in the manner heretofore described for extension into abrading contact with the surrounding wall of the bore hole as shown in Fig. 11. In the course of this operation the lower rotary sleeve 34 is shifted longitudinally upward by screw-thread action and since this rotary sleeve is connected to the slidable ring 104 by the pull rods 105 the cylindrical skirt 102 of the ring 104 is also shifted longitudinally upward to release the third scratcher unit 96 for extension into abrading contact with the surrounding wall of the bore hole.

In the third embodiment of the invention shown in Figs. 13 to 15 the rotary assembly is of the usual construction comprising an upper rotary sleeve 114 threaded onto a fixed cylindrical member 115 and a lower rotary sleeve 116 threaded onto a corresponding fixed cylindrical member 118, the two fixed sleeves being welded to the casing C as indicated. The two rotary sleeves 114 and 116 have the usual longitudinal slots 42 therein by means of which corresponding rings 36 and 38, respectively, are slidingly keyed. The rings 36 and 38 carry the usual plurality of bow springs 35 as heretofore described.

An upper scratcher unit 120 comprising a collar or ring fixedly welded onto the casing C carries a plurality of the usual wire-like or rod-like scratcher elements 122. Each of the scratcher elements 122 is positioned between a pair of radial ears 124 of the scratcher unit and is

pivotally mounted on suitable means such as a wire **125**. The pivot wire **125** is mounted in apertures in the radial ears and extends circumferentially around the scratcher unit. Each of the scratcher elements **122** is coiled around the pivot wire **125** and the inner end of each wire forms a control finger **126** by means of which the scratcher element may be rotated between a retracted position and an extended position.

In the contracted state of the upper scratcher unit **120** shown in Fig. 13, all of the control fingers **126** of the various scratcher elements **122** extend into a circumferential groove **128** that is formed on the inner surface of a cylindrical member **130**, the cylindrical member being mounted on the upper rotary sleeve **114** in overhanging position as shown. When rotation of the casing C relative to the upper rotary sleeve **114** causes the upper rotary sleeve to retract longitudinally downward by screw-thread action to the position shown in Fig. 14 the downward movement of the cylindrical member **130** swings the control finger **126** of each scratcher element **122** clockwise to cause the scratcher element to swing to its extended or effective position shown in Fig. 14.

A second lower scratcher unit **132** is integral with the lower rotary sleeve **116** and comprises a plurality of scratcher elements **134** pivotally mounted on the rotary sleeve. Here again, the scratcher elements **134** may be spring wires individually mounted between spaced radial ears **135** and may be coiled to pivot on a circumferential pivot wire **136**. Each of the scratcher elements **134** is formed with a control finger **138** that extends into a circumferential groove **140** on the casing C. In this instance the circumferential groove **140** is formed by the lower end of the fixed sleeve **118** in cooperation with a ring **142** spaced therefrom, the ring **142** being welded directly to the casing C.

Fig. 13 shows the lower rotary sleeve **116** at an elevated longitudinal position with the control finger **138** of each scratcher element **134** in engagement with the upper wall of the groove **140** to hold the scratcher element in its upwardly directed contracted position against the casing C. When rotation of the casing C relative to the lower rotary sleeve **116** causes the lower rotary sleeve to unscrew downward, the downward movement causes the control finger **138** to engage the lower side of the groove **140** as shown in Fig. 14 to swing the control finger outward into its extended effective position as shown.

It is apparent that the embodiment of the invention shown in Figs. 13 and 15 may be lowered into the well to any desired level with the scratcher units in retracted state and that the casing C may be rotated in the well bore to cause the scratcher units to extend into abrading contact with the wall of the well bore **44**.

The next embodiment of the invention shown in Figs. 16 to 20 involves the use of scratcher units that are positioned longitudinally of the casing and are intended to be operated primarily by rotation of the casing rather than by longitudinal reciprocation of the casing. In the construction shown there is an upper longitudinal series of spaced scratcher elements **144** constituting an upper scratcher unit designated by the bracket **145** and a similar lower longitudinal series of scratcher elements **144** constituting a second longitudinal scratcher unit designated by the bracket **146**. The scratcher elements **144** of each of the scratcher units may be mounted on a corresponding longitudinal base plate **148** (Figs. 17 and 18) that is transversely curved to fit the periphery of the casing C and is suitably bonded to the peripheral surface of the casing. As best shown in Fig. 18 each base plate **148** may be bonded to the casing by welding **150** along one longitudinal edge and by spaced welds **152** applied through spaced apertures.

The scratcher elements or abrading spring fingers **144** may be made of the usual heavy spring wire. In the construction shown, a single piece of spring wire forms two adjacent spring fingers **144**. Each of the spring fingers **144** is formed with a coil **154** at its base and the coils of two adjacent spring fingers are interconnected by a U-shaped loop **155** of the wire, this U-shaped loop being suitably anchored to the base plate **148** as indicated at **156** in Fig. 18.

The scratcher elements or spring fingers **144** are constructed and arranged to tend resiliently to extend substantially radially outward as shown in Fig. 19 for abrasive action on the surrounding wall of the bore hole. While the casing is being lowered into the bore hole, however, suitable holding means is provided to releasably flex the spring fingers laterally against the periphery of the casing C. In this instance the holding means comprises an upper hinged leaf **158** for the upper scratcher unit **145** and a lower hinged leaf **160** for the lower scratcher unit **146**.

Preferably both of the leaves **158** and **160** are mounted on the casing C by piano-type hinge constructions. For this purpose each base plate **148** is formed with uniformly spaced tongues **162** along one of its longitudinal edges and these tongues are curved to tubular configuration to embrace and hold a long pivot pin **164**. Each of the leaves **158** and **160** is formed with similar spaced tongues **165** along one longitudinal edge for rotatable engagement with the pivot pin **164**. Preferably each of the leaves **158** and **160** is also provided with at least one tongue **167** to serve as a stop to limit the outward swing of the leaf as shown in broken lines in Fig. 18.

A feature of this embodiment of the invention is the concept of mounting the upper leaf **158** in a manner permitting limited longitudinal movement on its pivot pin **164** so that the upper leaf may be used to control the lower leaf **160**, as will be explained. The desired limited freedom for longitudinal movement is achieved by making the base plate tongues **162** of the upper scratcher unit **145** less in width than the gaps between the tongues **165** of the upper leaf. Thus when the upper leaf **158** is at its lower limit position small gaps **166** (Fig. 17) occur between the tongues **162** and **165**. If there are only two scratcher units under a single control such gaps need not be provided in the second scratcher unit. If there are more than two the gaps will be required in all but the lowermost scratcher unit.

In this embodiment of the invention it is contemplated that suitable means under remote control will hold the upper leaf **158** in its closed position with the leaf at its lower limit position and that the leaf at this lower limit position will cause the lower leaf to be held in closed position. It is further contemplated that when the upper leaf is released to cause the upper scratcher unit **145** to extend into abrasive contact with the surrounding wall of the bore hole, the upper leaf will release the lower leaf to permit the lower scratcher unit **146** to extend into abrasive contact with the wall of the bore hole. Instead of arranging for the upper leaf **158** to overlap the lower leaf **160** for this purpose, I prefer to make the upper leaf longitudinally movable over a limited range as just described and to provide a suitable latch means for the lower leaf under control of the upper leaf.

The required latch means between the leaf **158** and the leaf **160** is generally designated by numeral **170** and may be constructed as best shown in Figs. 19 and 20. A latch housing **172** of hat-shaped cross-sectional configuration is welded onto the surface of the casing C to provide a longitudinal channel in which a suitable latch member **174** is slidingly mounted. To keep the latch member **174** from escaping from the channel the latch member may be provided with a pin **175** that extends through a longitudinal slot **176** in the latch housing.

The lower end of the upper leaf **158** is cut at a slant to provide a tip **178** which extends into the upper end of the latch channel as shown in Fig. 19 when the upper leaf is at its lowermost position. It will be noted in Fig. 19 that the tip **178** abuts the upper end of the latch member **174** and holds the latch member at its lower limit

position. The lower end of the latch member **174** is beveled to form an overhanging lip **180**, which lip may hold the lower leaf **160** in closed position as shown in Fig. 19.

It is apparent that when the two leaves **158** and **160** in their closed positions hold the spring fingers **144** flexed against the casing C as shown in Fig. 18, the spring fingers in their resilient tendency to swing outward create substantial pressure against the two leaves that tends to cause the two leaves to swing outward. A feature of the construction shown in the drawings is that a certain cam action is provided to utilize this force for shifting the upper leaf **158** from its lower limit position to its upper limit position and also for shifting the latch member **174** from its lower limit position to its upper limit position. For this purpose the lower edge **182** of the upper leaf member is curved towards the tip **178** as shown in Fig. 19 and it is for this purpose that the lip **180** at the lower end of the latch member **174** is beveled.

As may be understood by reference to Fig. 19, when the upper leaf **158** is released to swing outward from its normal closed position, the curved lower edge **182** of the leaf slides along the upper end of the latch housing **172** with a cam action that shifts the whole leaf upward and lifts its tip **178** out of the latch channel. This upward retraction of the tip **178** permits the latch member **174** to shift upward and the latch member **174** shifts because the outward movement of the lower leaf **160** against the inclined inner surface of the latch lip **180** lifts the latch member with a cam action.

Any suitable means responsive to rotation of the casing C may be provided to releasably hold the upper leaf **158** in its closed position. For this purpose the present embodiment of the invention employs a rotary assembly as heretofore described comprising a pair of longitudinally spaced rotary sleeves **184** that are threaded onto the casing C by means of corresponding inner cylindrical members **163** and are operatively interconnected by bow springs **185**. In the usual manner the opposite ends of the bow springs are anchored to rings **186** which are slidingly keyed on the corresponding rotary sleeves **184**.

The lower rotary sleeve **184** has a cylinder **188** welded thereon to provide a lower cylindrical skirt **190**. A suitable ring **192**, which may be termed an abutment ring, is welded inside the cylindrical skirt.

When the casing is lowered into the well bore, the lower hinged leaf **160** is held in closed position by the latch member **174** as shown in Fig. 17 and the upper leaf **158** is held in closed position by the cylindrical skirt **190** of the rotary assembly. The tip **178** at the lower end of the upper leaf extends into the latch housing **172** to hold the latch member **174** at its lower effective position.

When the scratcher units **145** and **146** reach the level selected for the cementing operation, the casing C is rotated to cause the lower rotary sleeve **184** to retract longitudinally upward until the upper leaf **158** is released. The spring fingers of the upper scratcher unit **145** then swing the upper leaf outward with a cam action that lifts the leaf bodily to its upper limit position. When the tip **178** at the lower end of the upper leaf is free from the latch housing **172**, the latch member **174** is moved upward by the cam action of the upper end of the lower leaf **160** as the lower leaf is swung outward by the spring fingers **144** of the lower scratcher unit **146**.

Fig. 22 indicates how this last embodiment of the invention may be modified by coiling the spring wire of the scratcher fingers around the pivot pin **164**. Each spring finger **144***a* is directly attached to a leaf **158***a* as indicated at **194**.

My description in specific detail of the selected embodiments of the invention, by way of example and to illustrate the principles involved, will suggest various changes, substitutions and other departures from my disclosure within the spirit and scope of the appended claims.

I claim:

1. In oil well production equipment, the combination comprising: a casing to extend into a well bore; a plurality of spring fingers mounted on said casing to swing between outwardly extending effective positions to abrade the surface of the well bore and retracted positions spaced inwardly from the surface of the well bore; yielding means rotatably mounted on said casing for frictional engagement with the well bore; a sleeve rotatably surrounding and axially movable on said casing; means fixed on said sleeve movable axially along said casing to a position holding said fingers in a retracted position; key means to maintain said sleeve in a substantially fixed rotatable but movable axial position relative to said yielding means; and corresponding mating helical screw threads on said casing and on said sleeve to cause axial movement of said sleeve and said finger holding means on said casing to release said fingers by rotation of said casing with respect to said yielding means.

2. The invention as defined in claim 1, wherein said key means includes an axially extending slot in said sleeve and an axially extending spline on said yielding means to fit in said slot.

3. In oil well production equipment, the combination comprising: a casing to extend into a well bore; two sets of spring fingers mounted at two points on said casing to swing between outwardly extending effective positions to abrade the surface of a well bore and retracted positions spaced inwardly from the surface of the well bore; yielding means rotatably mounted on said casing for frictional engagement with the well bore; a sleeve for each of said sets of spring fingers rotatably surrounding and axially movable on said casing; means fixed to each of said sleeves movable axially along said casing to a position holding a corresponding set of said spring fingers in their retracted position; key means to maintain each of said sleeves in a substantially fixed rotatable but movable axial position relative to said yielding means; and corresponding mating helical screw threads on said sleeves and on said casing at two different points, one of the threads on said casing and a corresponding sleeve being opposite the other on said casing and corresponding one on the other of said sleeve, whereby said spring fingers may be released by rotation of said casing to cause said sleeves to move axially and thereby release corresponding sets of said spring fingers.

4. The invention as defined in claim 3, wherein two sets of each of the means specified in claim 3 are provided to abrade the bore of the well and to centralize each set of spring fingers both in an efficient manner.

5. The invention as defined in claim 1, wherein an additional sleeve is fixed to sail holding means at a position spaced from said holding means around said casing; wherein a second set of spring fingers is fixed to said casing at a position approximately the same as said second sleeve; and wherein a linkage is provided between said second sleeve and said holding means, said second sleeve being adapted to retain said second set of spring fingers in their inoperative positions, whereby said second set of spring fingers may be released substantially simultaneously with the release of said first named set of spring fingers.

6. The invention as defined in claim 1, wherein said sleeve is provided with a plurality of axial grooves having pins extending across corresponding grooves through a body portion of said sleeve; wherein said sleeve is also provided with a circumferential groove, and wherein said spring fingers include wire scratching elements having inner ends looped around corresponding pins and extending into said circumferential groove to retain them in their operative abrading positions on said casing.

7. In oil well production equipment, the combination of: a casing to extend into a well bore; rotary means mounted on said casing for rotation relative thereto and also for longitudinal movement relative thereto between a first position and a second position; means including

screw threads on the rotary means and on the casing to retain said rotary means against longitudinal movement relative to the casing at its first position on the casing, said retaining means being releasable in response to relative rotation between the rotary means and the casing; a scratcher unit mounted on said casing for longitudinal movement thereon between a first position and a second position in response to longitudinal movement of said rotary means from its first position to its second position, said scratcher unit having scratcher fingers to abrade the well bore wall; means to hold said scratcher fingers retracted from the bore hole wall at said first position of the scratcher unit; means on said rotary means for yielding engagement with the bore hole wall to resist both rotary and longitudinal movement of the rotary means in the well bore, whereby with said rotary means retained at its first position and said scratcher unit at its first position with the scratcher fingers retracted, the casing may be lowered into the bore hole to place the scratcher unit at a desired level and then the casing may be rotated to release the rotary means from said retaining means and then the casing may be moved longitudinally to cause longitudinal movement of the rotary means from its first position to its second position thereby to place the scratcher unit at its second position with said scratcher fingers extending into contact with the surrounding well bore wall; and detent means to prevent movement of said scratcher unit relative to said casing in a direction from the second position of the scratcher means towards its first position.

8. The invention as defined in claim 7, whereby stop means are additionally provided on said casing to limit relative longitudinal movement of said scratcher unit at its second position whereby said detent means may cooperate with said stop means to immobilize the scratcher unit relative to the casing at the second position of the scratcher unit.

9. In oil well production equipment, the combination of: a casing to extend into a well bore; rotary means mounted on said casing for rotation relative thereto and also for longitudinal movement relative thereto between a first position and a second position; means including screw threads on the rotary means and on the casing to retain said rotary means against longitudinal movement relative to the casing at its first position on the said casing, said retaining means being releasable in response to relative rotation between the rotary means and the casing; a scratcher unit mounted on said casing for longitudinal movement thereon between a first position and a second position in response to longitudinal movement of said rotary means from its first position to its second position, said scratcher unit having scratcher fingers to abrade the well bore wall; means to hold said scratcher fingers retracted from the bore hole wall at said first position of the scratcher unit; means on said rotary means for yielding engagement with the bore hole wall to resist both rotary and longitudinal movement of the rotary means in the well bore, whereby with said rotary means retained at its first position and said scratcher unit at its first position with the scratcher fingers retracted, the casing may be lowered into the bore hole to place the scratcher unit at a desired level and then the casing may be rotated to release the rotary means from said retaining means and then the casing may be moved longitudinally to cause longitudinal movement of the rotary means from its first position to its second position with said scratcher fingers extending into contact with the surrounding well bore wall; and detent means to prevent longitudinal movement of the scratcher unit relative to the casing in the direction from the second position of the scratcher unit towards its first position.

10. In oil well equipment, the combination comprising: a casing to extend into a well bore; a first set of spring fingers mounted on said casing to swing between outwardly extending effective positions to abrade the surface of a well bore and retracted positions spaced inwardly from the surface of the well bore; a ring slidable on said casing; a second set of spring fingers mounted on said ring to swing between outwardly extending effective positions substantially parallel with said first set of spring fingers to abrade the surface of a well bore and retracted positions spaced inwardly from the surface of a well bore; yielding means surrounding said casing for frictional engagement with the well bore; a sleeve mounted in a position to surround both of said sets of spring fingers and in a position firstly to release said second set of spring fingers and secondly to release said first set of spring fingers successively in response to manipulation of said casing in a manner to move it relative to said yielding means and said sleeve; a radial projection on said casing spaced from said first set of spring fingers to prevent relative movement of said ring on said casing beyond a predetermined distance from said first set of spring fingers; and detent means to prevent movement of said ring along said casing in a direction opposite the direction of said projection from said first set of spring fingers.

11. In oil well equipment, the combination comprising: a casing to extend into a well bore; first sets of upper and lower spring fingers mounted on said casing at two points to swing between outwardly extending effective positions to abrade the surface of a well bore and retracted positions spaced inwardly from the surface of the well bore; an upper ring slidable on said casing in a direction upwardly from said first set of upper spring fingers; a lower ring slidable on said casing in a direction downwardly from said first set of lower spring fingers; a second set of upper spring fingers mounted on said upper ring to swing between outwardly extending effective positions to abrade the surface of a well bore in the same direction as said first set of upper spring fingers and to retracted positions spaced inwardly from the surface of the well bore; a second set of lower spring fingers mounted on said lower ring to swing between outwardly extending effective positions to abrade the surface of a well bore and retracted positions spaced inwardly from the surface of the well bore; yielding means extending around said casing for frictional engagement with the well bore; an upper sleeve threaded to said casing and surrounding both of said upper sets of spring fingers to move downwardly and release said second set of upper spring fingers firstly and to release said first set of upper spring fingers secondly upon movement downwardly along said casing, said upper sleeve having a longitudinal keyed connection with said yielding means to move downwardly in response to rotational movement of said casing in a predetermined direction relative to said well bore, said yielding means maintaining said upper sleeve in a fixed circumferential position with respect to said well bore; a lower sleeve threaded to said casing and surrounding both of said lower sets of spring fingers to release said second set of lower spring fingers firstly and to release said first set of lower spring fingers secondly upon movement upwardly along said casing, said lower sleeve having a longitudinal keyed connection with said yielding means to move upwardly in response to rotational movement of said casing in said predetermined direction relative to said well bore, said yielding means maintaining said lower sleeve in a fixed circumferential position with respect to said well bore; an upper radial projection on said casing above said upper ring to prevent movement thereof beyond a predetermined distance above said first set of upper spring fingers; a lower radial projection on said casing below said lower ring to prevent movement thereof below a predetermined distance below said first set of lower spring fingers; detent means carried by said upper ring to prevent movement thereof in a downward direction on said casing; and detent means carried by said lower ring to prevent movement thereof in a direction upwardly on said casing.

12. An oil well tool comprising: a casing to extend into

a well bore; a plurality of spring fingers mounted on said casing to swing between outwardly extending effective positions to abrade the surface of the well bore and retracted positions spaced inwardly from the surface of the well bore; means on said casing for frictional engagement with the well bore; means connected to said frictional engagement means in a fixed rotatable position and movable axially along said casing from a position holding said fingers in a retracted position to a position releasing said fingers; and corresponding mating helical-type screw threads on said casing and on said finger holding means to cause axial movement of said finger holding means on said casing to release said fingers by rotation of said casing relative to said frictional engagement means.

13. An oil well tool comprising: a casing to extend into a well bore; first and second sets of spring fingers mounted at two points on said casing to swing between outwardly extending effective positions to abrade the surface of the well bore and retracted positions spaced inwardly from the surface of the well bore; and means to hold each of said sets of spring fingers in their retracted positions, said holding means including corresponding first and second cylindrical means to confine each of said sets of

spring fingers and means connected to said cylindrical means for frictional engagement with the well bore to prevent rotational movement of said cylindrical means with respect thereto, said casing and each of said cylindrical means being provided with corresponding mating helical-type screw threads, the screw threads of said first cylindrical means being of a reverse pitch of the screw threads of said second cylindrical means, whereby both said first and second cylindrical means may be moved in opposite directions to return said first and second sets of fingers to their effective positions simultaneously in response to rotation of said casing relative to said frictional engagement means.

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