

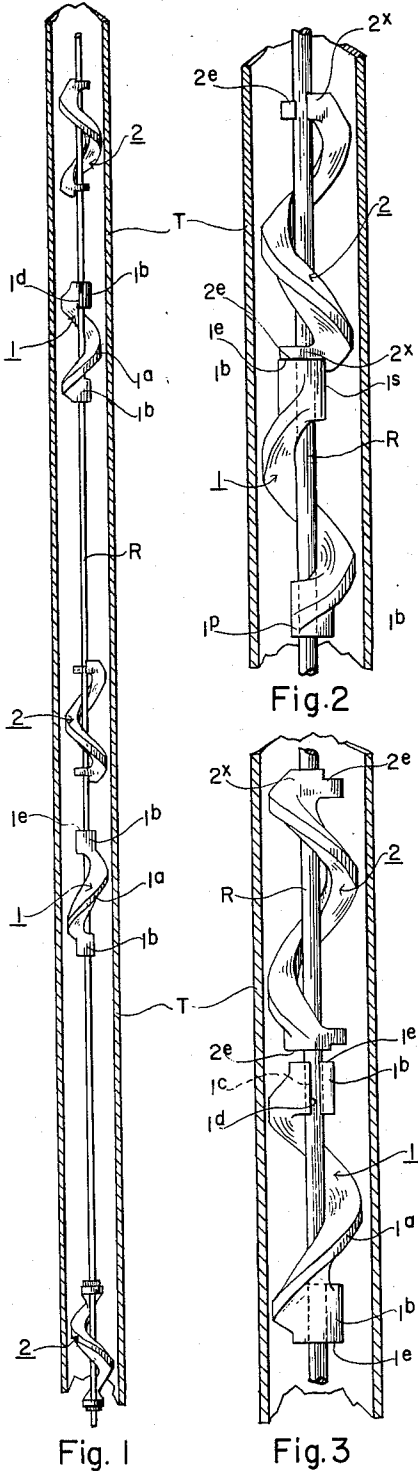
April 2, 1963

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3,083,772

INTERLOCKING FIXED AND AMBULATORY SCRAPERS

Filed Oct. 30, 1958



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INTERLOCKING FIXED AND AMBULATORY SCRAPERS

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Filed Oct. 30, 1958, Ser. No. 770,845
3 Claims. (Cl. 166-176)

This invention relates to paraffin scrapers in novel co-operating combination for use on sucker rods reciprocating inside the tubing string of a well. More particularly, this invention relates to the novel combination of two different types of cooperating paraffin scrapers in such a pumping organization.

It is a principal object of the invention to provide in cooperating combination fixed and ambulatory paraffin scrapers alternately spaced along the sucker rod, the fixed scrapers tightly engaging the sucker rod and traveling therewith and the ambulatory scrapers each loosely engaging the rod between adjacent fixed scrapers, and to provide in this organization mutually interlocking ends on the scrapers such that, when a migratory scraper abuts the end of a fixed scraper, the two interlock for unitary mutual action. The ambulatory scrapers migrate along the rod and serve to scrape both the walls of the tubing and also the outer surfaces of the sucker rod to prevent the building up of paraffin on either, and the fixed scrapers serve to scrape the inner surfaces of the tubing and also serve as abutments for limiting the length of rod over which the ambulatory scrapers may migrate.

Another primary object of the present invention is to provide in combination fixed and ambulatory paraffin scrapers wherein the spiral of the fixed scrapers extends around the rod in one direction, and the ambulatory scrapers spiral around the rod in the opposite direction so that, when the ends of a fixed and an ambulatory scraper are locked together, they will form a composite scraper having a reversed spiral and will remain locked together until the direction of reciprocation of the sucker rod reverses and separates the scrapers.

Paraffin deposits on either the tubing or the sucker rod are highly undesirable since as they build up, they reduce the annular area of the oil passageway between the tubing string and sucker rod and thus reduce the flow of oil to the surface. It is customary to scrape the tubing; but the rod also loads up with deposits which often become so great that the reciprocatory pumping motion is stopped, especially when the rod will no longer drop in the tubing. When an effort is made to pull the rod, the paraffin load therearound drops and dislodges the fixed scrapers, bunching them together in a mass of hard packed paraffin which securely anchors the rod to the tubing walls and makes it necessary to pull both the rod and the tubing together at considerably increased expense. It is therefore an important object of the invention to provide a combination of scrapers which will prevent the building up of paraffin on the sucker rod itself.

It is another object of the invention to provide a combination of paraffin scrapers in which the individual units may be installed anywhere along the length of a sucker rod between the tool joint ends thereof without necessity of altering the standard sucker rod or damaging the same, as for instance by welding.

It is a further very important object of the present invention to provide paraffin scrapers which are made of a plastic which can be economically shaped, and which plastic, at the temperatures encountered in oil wells, is dimensionally stable and resistant to attack by oil and acids. The electrical insulating properties of the plastic are also important since they prevent the attack on other

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adjacent metal parts in the well by electrolysis. A range of suitable plastics includes the following:

- Vinylidene chloride—Rigid compound
- 5 Polyamides—Molding type, Nylon 1001, known as Zytel
- Polytetra-fluoro ethylene
- Polychloro-tri fluoro ethylene
- Polymethyl alpha chloro-acrylate
- 10 Polyester diallyl phthalate
- Poly acetal resin

The use of plastic in connection with such scrapers is important for several reasons. In the first place, manufacturing of the scrapers can be conveniently and economically carried out either by molding or by an extrusion process or by some other plastic handling process in order to produce the desired form. In addition to the multiple advantages which the plastic has over metal, plastics found in the above range also exhibit springlike qualities generally thought of in connection with metals, which springlike qualities permit the scrapers to flex without damage or breakage. Another advantage in the use of the above plastics results from the fact that the very substance to be scraped by the scraper, namely the paraffin, has very little tendency to stick to the plastics since paraffin does not tend to adhere to a smooth non-porous surface. Therefore, the buildup which occurs on metal paraffin scrapers is substantially absent when the above plastics are substituted for the metals.

It is another primary object of this invention to provide a combination of fixed and ambulatory paraffin scrapers wherein at least the ambulatory scrapers have a specific gravity which is not very different from the specific gravity of the liquids found in oil wells. The plastics of the above range have specific gravities not nearly as different from the average of the well fluids as the specific gravity of most springlike metals would be. In addition there are other low-weight materials which would be suitable. This low-weight feature is of considerable importance because of the fact that the paraffin scraper when made of a material having a specific gravity approximating that of the well liquids will migrate through considerable distances during reciprocation of the sucker rod within the well tubing. This action results from the fact that the specific gravity of the scraper is nearly the same as that of the well liquids, so that the scraper will work its way along the tubing from one abutment to the next adjacent abutment even though this distance may be greater than the length of the pump stroke and many times the length of the ambulatory scraper. The latter, of course, does not pass over a length of sucker rod greater than the pump stroke in one or two strokes, but may require a considerable number of strokes to cover the greater length. Tests have shown, however, that it does cover such a length and that such coverage tends to be repeated at regular enough intervals that the ambulatory scraper will satisfactorily prevent the building up of paraffin deposits on both the rod and the tubing. It is well known that well fluids are not homogeneous but contain oil and water, more or less solid objects, lumps of paraffin, and gas pockets. This non-homogeneous character of the fluid which is being pumped upwardly probably accounts for the fact that the spiral scraper is caused to reciprocate over a greater length of rod and tubing than the length of the stroke.

When the sucker rod and fixed scrapers are descending, the column of fluid is standing substantially still in the vertical direction although it is caused to rotate by the scraper blades on the fixed scrapers passing downwardly through the fluid column. For instance, when

the fixed scraper 1 illustrated in FIG. 3 travels downwardly through the fluid column, it provides a propeller action which tends to rotate the fluid column counterclockwise as viewed from above. Still referring to FIG. 3, the ambulatory scraper 2 has rotational inertia which causes it to rotate more slowly than the rate of rotation of the fluid column while the sucker rod is accelerating, and therefore the counterclockwise rotation of the fluid column causes the ambulatory scraper 2 to rise upwardly in the fluid column at the same time that the fixed scraper 1 is traveling downwardly in the fluid column. In other words, there is a screw action between both scrapers and the fluid which causes the scrapers to move rapidly away from each other when the fixed scraper is being moved downwardly. On the other hand, as the sucker rod reaches the foot of its down stroke the rotary motion of the fluid column begins to decelerate, because as the screw action of the fixed scraper on the fluid ceases, the counterclockwise rotation of the fluid column rapidly slows up. At the same time, the rotation of the ambulatory scraper 2, because of its inertia, tends to exceed the rotation rate of the fluid column, the rotation of which is rapidly decelerating, and therefore during said deceleration the ambulatory scraper screws itself downwardly with respect to the column. However, at this moment the fluid column itself is rising because of the upward stroke of the pump, and therefore the ambulatory scraper tends to be carried further upwardly. In a completely homogeneous fluid, the action of the ambulatory scraper might be rather easily predictable, but it must be remembered that the relative rates of rotation in the two directions between the fluid and the ambulatory scrapers vary because of collisions between the scrapers and the above mentioned solid objects, lumps of paraffin, and gas pockets. Although on the upstroke of the pump the ambulatory scrapers are carried upwardly by the fluid flow and perhaps also by abutment against the next-lower fixed scraper, the ambulatory scrapers also tend to sink in the well because of gravity forces, and also because they may be forced downwardly by abutment against the next-higher fixed scraper. Also, the ambulatory scrapers drop very rapidly through gas pockets in the fluid column. Due to the fact that the ambulatory scrapers according to the present invention are made lighter than the usual steel scrapers, the above forces can all play significant roles in providing the desired ambulatory scraper action, without the forces of gravity overriding the weaker forces mentioned above, as would be the case if the ambulatory scrapers were made out of a heavy material, such as steel.

It is another object of the present invention to provide a transverse "land" surface at each end of each ambulatory scraper and at each end of each fixed scraper, which surfaces lie in planes disposed normal to the axis of the scraper the surfaces serving as abutments during contact between ambulatory and fixed scrapers to confine the ambulatory scrapers to the assigned lengths of the sucker rod and the projections preventing mutual rotation between the scrapers when said surfaces are in contact.

Other objects and advantages of the present invention will become apparent in the following discussion of the drawings wherein:

FIGURE 1 is an elevation view showing a sucker rod extending downwardly in the pump tubing, the latter having been broken away to show the sucker rod and also to show the novel combination of paraffin scrapers operatively disposed on the sucker rod.

FIG. 2 is an enlarged view similar to FIG. 1 but showing only two adjacent scrapers in mutually interlocked position.

FIG. 3 is a view similar to FIG. 2 but showing the fixed scraper rotated and out of contact with the ambulatory scraper.

FIG. 4 is an enlarged elevation view of one of the ambulatory scrapers,

FIG. 5 is a view of the scraper shown in FIG. 4 but rotated 180° about its longitudinal axis.

FIG. 6 is a section view taken along line 6—6 of FIG. 4.

FIG. 7 is an end view taken along line 7—7 of FIG. 5.

FIG. 8 is an enlarged perspective view of one end of a fixed scraper particularly showing the boss thereat.

Referring to the drawings, FIGS. 1, 2 and 3 show a length of sucker rod R passing through a length of tubing T in which it reciprocates. Around the rod R and within the tubing T are a series of paraffin scrapers which comprise alternate fixed and ambulatory scrapers forming the novel combination of this invention.

As illustrated in FIGS. 1, 2 and 3, each of the fixed paraffin scrapers 1 is of the type disclosed and claimed in Patent 2,928,473 based on my copending patent application Serial No. 687,161 filed September 30, 1957. This type of fixed scraper includes a spiral blade 1a and a boss 1b at each end. Each boss includes a bore 1c adapted to receive and grip the sucker rod, and in each boss there is a slot 1d which passes through the wall of the boss 1b and opens into said bore. The slots 1d at the opposite ends of the scrapers are opposed to one another both in the sense that they extend away from each other in opposite directions with respect to the longitudinal center of the scraper, and also in the sense that they open in mutually opposite directions radially of the scraper, as can best be seen in FIG. 3. The bores 1c are deliberately made slightly smaller in diameter than the diameter of the sucker rod R on which the scraper is intended to be mounted. By thus making the bore slightly smaller, the scrapers 1 when installed on the rod R will frictionally grip the rod very tightly and thus prevent slipping of the scraper thereon. The slots 1d are tapered outwardly to provide openings which are somewhat wider than the diameter of the rod R so that the rod may be freely received in the outer portion of the slots 1d during the initial step of installing the scraper on the sucker rod.

The scraper 1 is provided with a helical scraping blade 1a which starts at one end and extends through at least one convolution to the other end. In the form shown in the present drawings, the helix passes around the scraper only once, but it is to be understood that it is entirely possible for it to pass around the body through more than a 360° revolution. It will also be noted that the ends of the blades 1a are tapered inwardly and blend smoothly into the rounded ends of the bosses where the latter terminate in the abutment surfaces 1e. The inward tapering of the outer surface of the blade 1a as it approaches the ends 1e serves to prevent snagging of the paraffin scraper on the tubing joints.

Referring now to the ambulatory paraffin scrapers 2 shown in the figures, these scrapers surround the sucker rod R within the tubing T and comprise a plurality of open helical convolutions, the total number of which may be varied to suit particular well conditions and provide adequate scraping coverage therein. The ambulatory scraper 2, as illustrated in the drawing, has a substantially rectangular cross section and includes radially disposed side surface 2a and longitudinally disposed inner surfaces 2b and outer surfaces 2c. The inner longitudinal surface 2b is intended to scrape the sucker rod R and the outer longitudinal surface 2c is intended to scrape the inner surface of the tubing T. It will be noted that clearance is provided between the sucker rod and the inner surface 2b, and between the outer surface 2c and the inner surface of the tubing T so that the scraper 2 will be free to reciprocate with respect to the tubing and the rod, and also free to migrate along the axial lengths of both in either direction until an abutment is struck, the abutment comprising either the land 1e on one end of a fixed scraper 1, or else the end of a tool joint at one end of the sucker rod. With respect to the cross-sectional shape by which the sides 2a, 2b and 2c of the scraper are related, it is to be noted that other non-rectangular

forms would serve satisfactorily. For example, the scraper may be provided with sides 2a which approach each other so as to provide a truncated pyramid shape, or alternatively, the sides 2a could be made concave, or any other satisfactory shape which would serve to leave relatively sharp scraping edges at the intersections of the respective scraper surfaces.

The ends of the scraper terminate in bosses 2x having bores 2y therethrough communicating with mounting slots 2t. The bores 2y are larger in diameter than the diameter of the sucker rod R while the slots 2t are a little smaller. The outer ends of the bosses are preferably cut off in the direction of a plane lying normal to the axis of the scraper so as to provide flat "lands" 2e at each end of the scraper, on which surfaces the scraper will contact the abutments which confine its longitudinal travel.

The outer end of each boss 2x, besides having a "land" surface 2e, also includes a step 2s which is the edge of a locking projection 2p. By reference to FIGS. 2 and 8, it can be seen that the bosses 1b of the fixed scrapers 1 are asymmetrical about the axis of the scraper, i.e. the sides of the bosses are shaved off flat at 1s so that the projection 2p on the ambulatory scraper 2 will overlie the side of the boss 1b with the step 2s in contact with the flat side 1s of the boss, thereby interlocking the scrapers and preventing rotation of the ambulatory scraper 2 with respect to the adjacent fixed scraper 1 with which it is in contact.

The scrapers are thus automatically locked together when a fixed scraper 1 overtakes an ambulatory scraper 2 as shown in FIG. 2, and are separated and thus unlocked when the fixed scraper reverses and retreats from the ambulatory scraper as shown in FIG. 3. It should also be noted that alternate scrapers are preferably reversed as to the directions in which they spiral about the sucker rod so that, when the interlocking ends are engaged, the opposite spirals will cooperate in a novel manner to cancel any tendency to rotate the sucker rod which the mutually engaged scrapers would otherwise have.

In order to prevent snagging, the ends of the scraper, FIGS. 4, 5 and 7, should be somewhat rounded as at 2f. It is to be clearly understood that the total number of helical convolutions of the scrapers 1 and 2 is not to be limited to any particular number so long as there are sufficient convolutions to prevent cocking of the spiral scrapers on the sucker rod.

As illustrated in FIG. 1, the fixed and ambulatory scrapers are alternately spaced along the length of the sucker rod R, the ambulatory scrapers 2 being free to migrate along the length of the rod R which is located between two fixed scrapers 1. As the rod R is reciprocated within the tubing T, the scrapers 1 travel with the rod, their positions being fixed with respect thereto and the fixed scrapers 1 being retained on the rods at the selected positions by a tight frictional grip. The ambulatory scrapers 2, comprising a plurality of open convolutions, are free to travel on the rod between the fixed scrapers, and since their specific gravity is very similar to that of the well fluids being pumped upwardly between the sucker rod and the tubing T, these ambulatory scrapers 2 migrate axially during the pumping operation. These scrapers, according to actual tests in oil wells, work their way along the sucker rod sometimes upwardly and sometimes downwardly, but over an interval of time cover a

length of rod which is actually greater than the stroke of the pump. If, however, in the case of a particularly difficult well it appears that the scrapers are not migrating the full distance between the fixed scrapers, then the fixed scrapers may be placed closer together and/or the ambulatory scrapers made longer so that the distances over which they must travel to cover the entire sucker rod are equivalent to the length of stroke of the pump, or less.

It should also be pointed out that other types of fixed scrapers may be employed so long as they are capable of maintaining their selected position on the rod R and so long as they permit comparatively free passage of oil therepast. A satisfactory alternative type of fixed scraper is disclosed and claimed in Patent 2,928,472 based on my copending patent application Serial No. 672,267 filed July 16, 1957. Both fixed and ambulatory scrapers in the present organization also perform the function of guiding the rod within the tubing T.

The present invention is not to be limited to the exact form shown in the drawings, for obviously changes may be made therein within the scope of the claims.

I claim:

1. For use on a sucker rod to be reciprocated in well fluids within a string of tubing and through a predetermined stroke, the combination of more than two paraffin scrapers of two different types including fixed scrapers clamped to the rod and spaced apart by substantially the length of said stroke and alternating with ambulatory scrapers surrounding the rod and freely slidable thereon, said scrapers each having a helical scraping blade extending around the rod and terminating at each end in a substantially annular boss having a transverse end surface, the bosses on one type of scraper having a projection offset from the sucker rod and extending beyond said transverse surface and the bosses on the other type of scraper being cut away on one side to receive the projection of the adjacent scraper, whereby the scrapers interlock to prevent mutual relative rotation when the transverse surfaces of different types of scrapers are brought together.

2. In a combination as set forth in claim 1, the blade on one type of scraper spiraling around the sucker rod in the opposite direction from the blade on the other type of scraper.

3. In a combination as set forth in claim 1, the ambulatory scrapers having specific gravities approximating the specific gravity of the well fluids, whereby the forces acting on the ambulatory scrapers due to buoyancy effects are small as compared with the forces acting thereon due to motion of the rod and due to the flow of said well fluids.

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