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WELL BORE CONDITIONING

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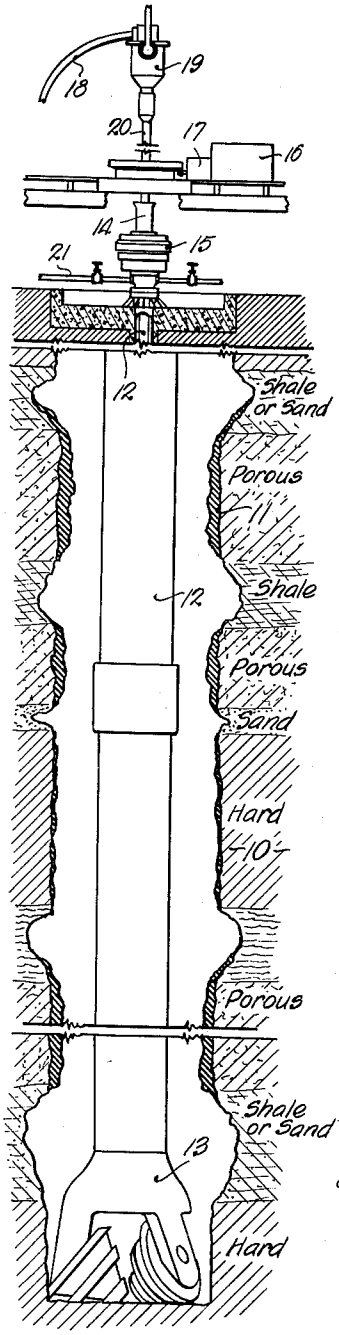


Fig. 1.

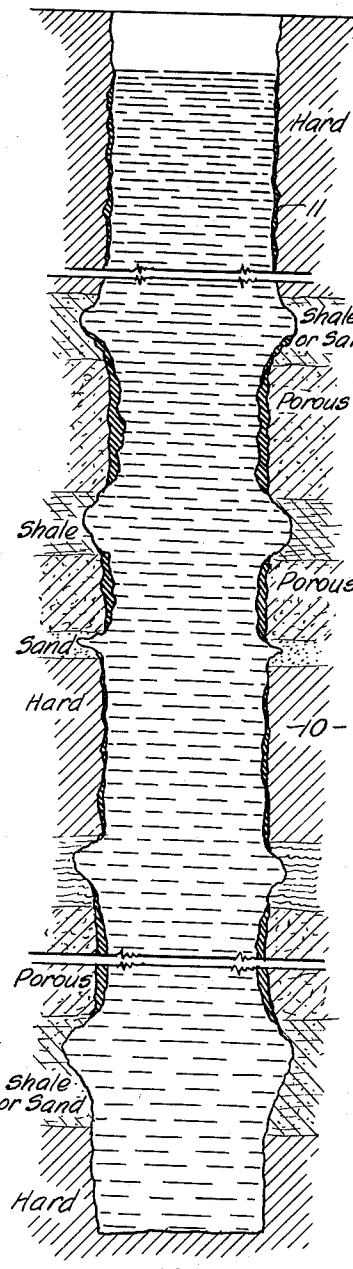


Fig. 2.

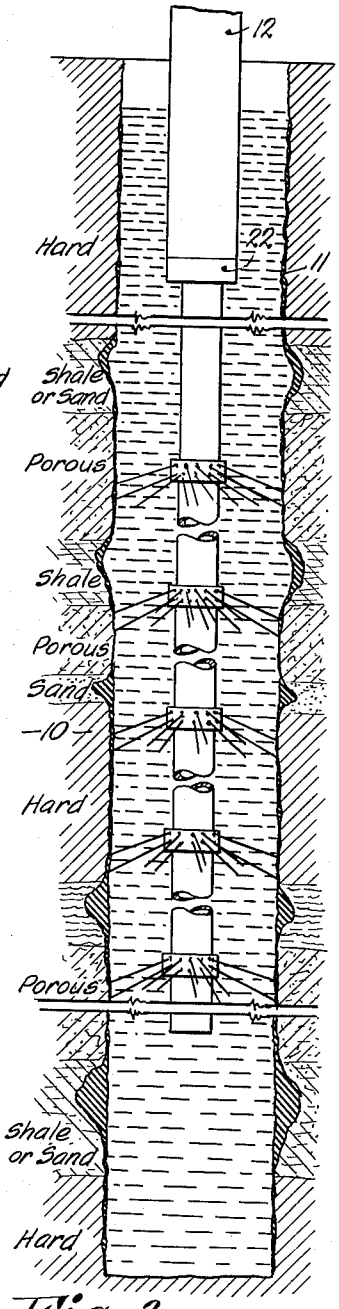


Fig. 3.

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WELL BORE CONDITIONING

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2 Claims. (Cl. 166—22)

This invention relates to a process for conditioning the bore of a well and refers more particularly to a process by which the well bore is worked periodically during the drilling to maintain optimum hole conditions and minimize loss of circulating fluid.

It is well known that during the drilling of a well with rotary equipment fluid is pumped from the surface down through the drill pipe to be discharged at the drill bit and circulated to the surface in the annular space surrounding the drill pipe. The principal functions of the fluid are to float out the cuttings produced during drilling and to lubricate the bit. The circulated fluid carries in suspension materials which build up a filter cake or mud layer upon the well bore which is relatively impervious to the passage of liquid and serves as a partial seal against the loss of liquid from the well to the formation and aids in supporting the wall of the hole.

As the well is drilled the hole will penetrate many different types of earth formations, some soft, some hard, some porous and others relatively impervious to the passage of fluids. The type of the earth formation will to a great extent determine and govern the character of the well bore in the different earth structures. If it is soft and porous, there is a tendency for it to cave and slough off and to drain fluid from the well if pressures in the hole exceed those in the structure. If it is hard, solid and relatively impervious, there will be less tendency for the fluid to be lost from the well. Also, depending upon the porosity to a great extent, is the growth of mud or filter cake on the well bore, for in porous soft formations more cake tends to build up than on the harder more pervious structure. A further variable determining the transmigration of fluid from the well to the formation or from the formation to the well is the pressure differential between the well bore and formation at different depths in the well. To alter the well pressures, weight material may be added to the fluid column being circulated and to vary the characteristics of the mud fluid, water-absorbent substances, jell-forming materials as well as oil, animal and vegetable fiber and flakes of different kinds, as well as cork, sawdust, mica and plastics have all been employed. Lightweight aggregate, such as slag or kiln-fired incipiently fused argillaceous clays have been used as addition products to fill caves and indentations where the walls have been broken down during drilling or thereafter or when conditions within the well are not propitious to maintaining of a smooth bore hole with a uniform depth filter cake. By the present process, it is proposed that periodically during the drilling of the well, the frequency depending upon well conditions at the different depths, that the drill string be removed and an abrading extension be applied to the drill pipe in place of the bit. The abrading extension comprises a length of open-ended pipe equipped with an adapter for attachment to the drill pipe and having abrading elements on its outer surface which are of greater diameter than the well bore. With this device connected to the bottom of the drill pipe, the well bore may be worked and abraded to dislodge and remove excessive cakes and redeposit and redistribute the abrasives, cuttings and filter cake constituents in the caves and indentations occurring in the well bore. There will thus be produced a more uniform cake over the entire well wall improving its sealing properties and minimizing loss of circulating fluid from the well.

An object of the invention therefore is to provide a process for working the well bore surface to redistribute accumulations and improve the sealing properties of the filter cake.

Another object is to provide a process for removing accumulations and excessive cakes upon the well bore which would retard and hinder drilling operations and circulation of the well fluid.

A further object is to provide a process for redistributing accumulations and filter cake material in order to fill caving portions of the well bore and redeposit the abrasive and sealing substances of the mud cake upon the exposed porous structures to minimize loss of well fluid and circulation.

Other objects and advantages will be apparent and developed during the course of the explanation and description which follows.

In the accompanying drawings which form a part of the instant specification and are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

Fig. 1 is a vertical section taken through an oil well with the drill string in position for drilling and the apparatus for circulating mud fluid shown diagrammatically on a reduced scale;

Fig. 2 is a vertical section of the same well with the drill string removed;

Fig. 3 is a vertical section of the same well with the well bore reworking equipment in the well.

Referring to the drawings, at **10** is shown a cross section of the earth's structure with large sections omitted and designations indicating the location of the soft porous layers, the hard impervious horizons and unstable layers of shale and sand or mixtures thereof. Positioned within the well bore **11** is a drill pipe **12** with a drill bit **13** attached to its lower end. At the surface in Fig. 1 is diagrammatically indicated a surface string of pipe **14** at the top of which is a blow-out preventer **15**. During drilling the pipe **12** is rotated by power supplied from the drawwork **16** through a gear and chain transmission indicated diagramatically at **17**. Fluid is supplied to the drill pipe **12** from any convenient source such as a mud pond not shown through the Kelly hose **18**, swivel **19** and hollow Kelly **20**. Upon discharge from the bit **13**, the drilling fluid with the cuttings suspended therein are floated upwardly in the annular space surrounding the drill pipe and discharged at the surface through pipe **21**. After screening to separate the cuttings, the mud is returned to the Kelly hose **18** for recirculation to the drill pipe.

During the drilling operations, a mud or filter cake is built up on the well bore owing to the natural adhesive properties which the mud particles and abrasives have for the well wall and to the differential pressures existing in the well and the earth structure through which the hole is drilled. It is important to keep a somewhat greater pressure in the well than in the formation to promote the deposition of filter cake upon the well bore, and care must be taken that the filter cake forms in an evenly distributed sealing film. A critical function of the cake is to prevent contaminants in the form of liquids, solids and gas from entering the well and loss of fluid from the well which if permitted not only gives trouble with proper mud circulation but hinders efficient drilling operations. Difficulty may arise from many other sources, for example, caving may occur in unstable sand and shale formations which have surfaces exposed to the well bore unsuited

for accumulation of a satisfactory mud cake, then again a porous formation may build up excessive cake into the well bore to the extent that friction is imposed on the drill pipe and circulation retarded by restriction of the annulus through which the mud and cuttings are returned to the surface.

It is helpful therefore during drilling to periodically work or abrade the well bore to redistribute the filter cake which has built up in the form of excessive cakes on the well wall and fill the caved formations thereby obtaining a more even distribution of the filter cake minimizing the possibility of lost circulation. To accomplish this task, it is proposed that the drill pipe be removed from the well at intervals during the drilling of the well, the well bore worked as hereinafter explained, after which drilling is resumed. The time intervals between abradings and the circumstances propitious for requiring the working of the well wall will be readily apparent to the driller by conditions encountered during making the hole. When circulation gets sluggish due to loss of fluid, if the mud becomes excessively loaded with caved material or should frictional resistance develop to rotation of the drill string are a few of the many factors which might give provocation for abrasion of the well bore.

When it has been decided to work the well wall, the drill string is removed from the hole, the drill bit **13** is detached from the lower end of the string and an adapter **22** connected in place of the bit. To this adapter is attached an abrading extension preferably of smaller diameter pipe than the drill pipe although any suitable diameter may be used which can be efficiently handled in the size hole being drilled. As an alternative procedure, the abrading extension may be interposed in the lower portion of the drill pipe and a drill or reamer mounted on the end of the abrading extension during the working cycle. Upon the abrading extension are mounted a plurality of scratchers or abrading elements arranged at intervals throughout its length, the outer diameter of the scratchers being somewhat greater than the diameter of the well bore, so the abrading wires will not only remove excessive cakes and accumulations but will reach into the caves and indentations to work material contained in the mud with that removed from the well wall. In this manner the abrasives and particles which combine to build up the filter cake are redeposited or replastered into the caved sections by the positive action of the scratchers acting upon the well surface and suspensoids contained in the fluid column.

Scratchers particularly adapted to this purpose are those having nonradial wires of the type shown in my application Serial No. 55,619, filed October 20, 1948, now Patent No. 2,671,515, since these scratchers are readily reversible. The scratchers should be mounted between stops or lugs to permit limited longitudinal movement along the stinger and free rotative movement. The spacing of the scratchers upon the stinger should be such that the surface acted upon by the adjacent scratchers will overlap as the pipe is reciprocated in the well bore. The length of the abrading extension is entirely up to the driller or whoever is responsible for the drilling operation. If the abrading extension is short and is to be used in a deep hole, the procedure would be to lower the drill pipe with the abrading extension attached or interposed therein to the bottom of the hole and reciprocate for a period of five to thirty minutes. If a bit or reamer is mounted on the abrading extension, the drill bit also will be rotated. The abrading extension is then raised in the hole to the adjoining unworked section of the well bore immediately above and there reciprocated for a like period until the mud cake and well wall have been satisfactorily worked. This operation is repeated up the hole until the entire well bore has been abraded and worked.

Normally it will be unnecessary to alter the consistency of the drilling fluid unless it becomes excessively loaded with abrasives or caved materials. If it is too thin or needs weight, solids may be supplied and bentonite or other well known additives may be introduced to furnish jelling and added sealing action.

Circulation of the drilling fluid will usually be unnecessary during the working of the well bore, but it is contemplated in the event the mud becomes sluggish and unwieldy during the working cycle that circulation may be employed. The longer the abrading extension the more surface of the well bore can be covered at each level or stage of cultivation.

Fig. 2 shows a cross section of the well shown in Fig. 1 with the drill string removed and before abrasion. Fig. 3 shows the abrading extension attached to the lower end of the drill pipe **12** and lowered into the well. In this figure the lower portion of the well bore has already been worked, the portion in which the stinger is located is undergoing abrasion and the upper portion of the hole above the abrading extension is yet to be abraded. Note that in the lower portion of the hole the excessive cakes and accumulations have been removed and the caves and indentations have been filled with abrasives held in place with the adhesive constituents of the mud. This result has been obtained by the abrading, mixing, and plastering effect of the wire scratchers. In the zone where the abrading extension is located, the well bore is undergoing a like change while above the abrading extension the hole is still in a relatively unworked state.

It has also been found that the process is particularly efficacious in reducing difficulties arising from the surging produced in running in or removing the drill pipe from the well. This surging action produces an increased pressure differential between the well and in the earth foundations and is sometimes responsible for disruption and failures of the filter cake. When the hole is kept at a more uniform diameter throughout the drilling operation, this surging action is reduced to a minimum.

A further advantage which the process offers is the displacement circulation that is set up as the abrading extension is lowered into the well. As material is removed from the well wall and is incorporated in the column of fluid in the annular space surrounding the abrading extension, the column becomes heavier while the column within the abrading extension and drill pipe made up of fluid entering at its lower end is lighter in weight. The columns will continually equalize and in doing so will set up reverse circulation which moves the fluid from the annular column into the pipe and causing excess to overflow at the surface. In the event it becomes desirable to enhance the rapidity of this natural circulation caused by the different weights of the two columns, positive and more rapid flow may be created in either direction by pumping at the surface. The advantage obtained from either the natural flow set up by the difference in weights of the columns or by positive circulations created by pumping is readily apparent, since it removes the abraded material from the locations where excess materials is objectionable and transports it to places where additional material is desired.

After the well wall has been worked or abraded in the manner described, the abrading extension is removed from the drill pipe and the drill bit replaced and drilling continued until hole conditions develop requiring further conditioning when the above procedure is repeated. By employing the above process periodically during the drilling of a well, many of the difficulties now encountered such as lost circulation, crooked hole, fishing jobs due to broken drill strings and other expensive and time-consuming occurrences may be avoided.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcom-

binations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. A method of periodically conditioning a limited portion of the bore of a well during drilling operations to minimize loss of circulating fluid, comprising the steps of stopping circulation of fluids in the well bore, removing the drill pipe from the well, attaching an abrading extension to the lower end of the drill pipe with abrading elements on the exterior surface of greater diameter than the diameter of the well bore, lowering the drill pipe and extension into the fluid filled well bore, moving the drill pipe and extension longitudinally of the well bore to work a portion of the exposed surface thereof whereby filter

cake and accumulations on the well wall are abraded and worked and mud and abrasives from the well fluids and well walls are redeposited in caves, indentations and upon the porous formations formed and exposed in the drilling process, removing the drill pipe and extension from the hole bore and the extension from the drill pipe, returning the drill pipe with drilling elements thereon to the hole bore, reestablishing circulation of fluids in the well bore and proceeding with the drilling operation.

2. A method as in claim 1 wherein circulation of the well bore fluids is reestablished during the abrading operation should the fluids in the hole bore become sluggish and unwieldy.

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