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RECOVERY OF PIPE

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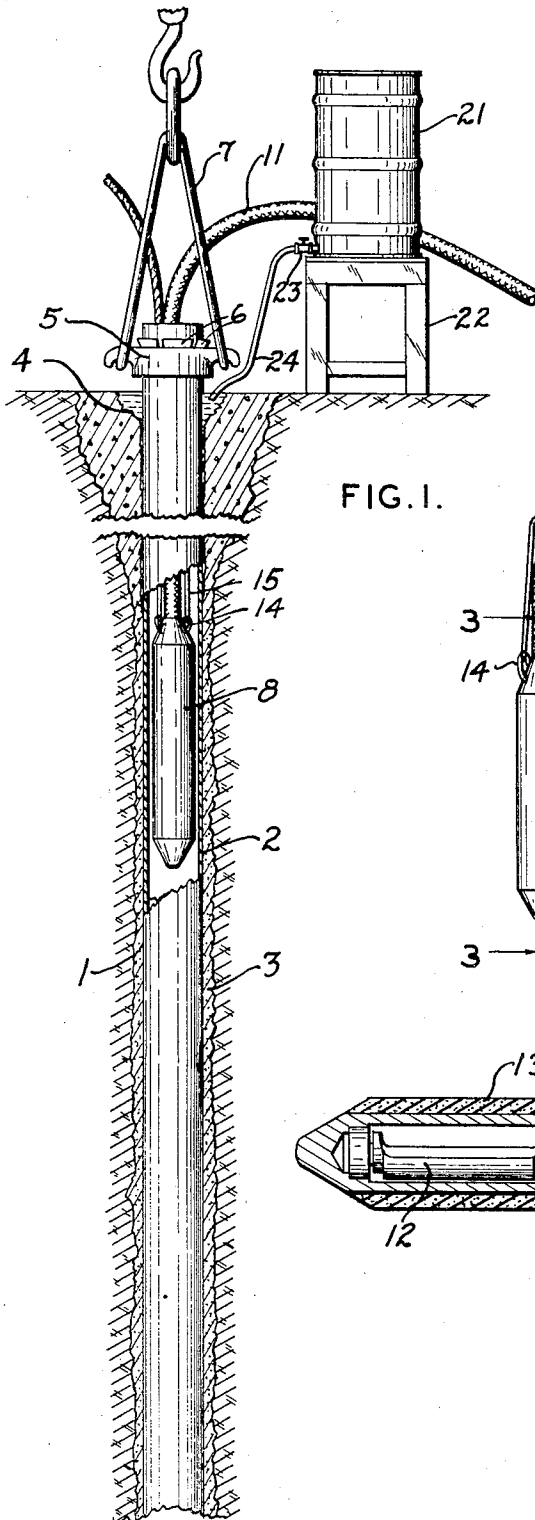


FIG. 1.

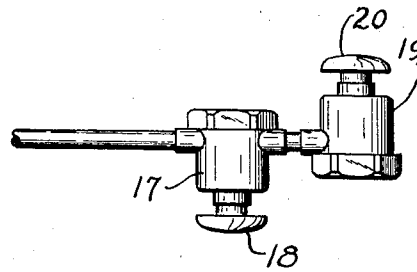


FIG. 4.

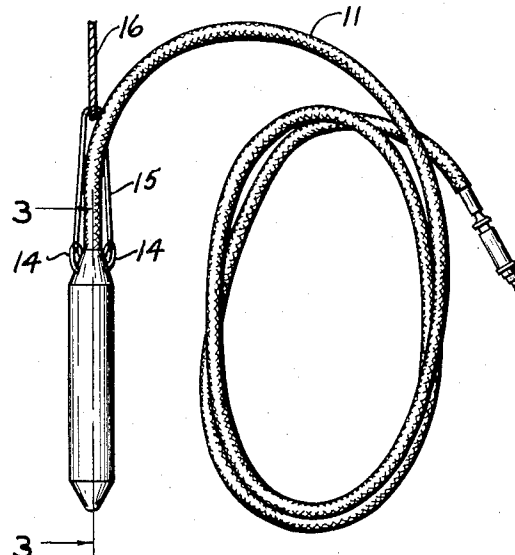


FIG. 2.

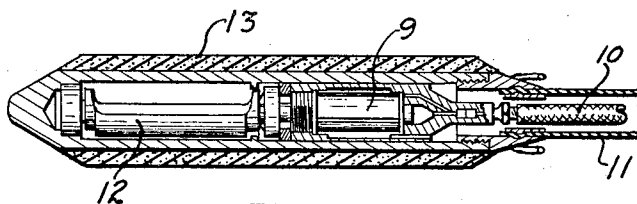


FIG.3.

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RECOVERY OF PIPE

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8 Claims. (Cl. 166—21)

This invention relates, generally, to the recovery of pipe or so-called casing from abandoned oil wells or other holes in the earth.

Throughout the oil fields of the world, thousands of feet of pipe repose in the ground abandoned; and while some efforts have been made to recover such pipe from abandoned oil wells, the recovery thereof has, in most instances, been limited to but a small proportion of the pipe in any particular hole. This result has arisen by reason of the fact that such pipe is commonly anchored in position in the earthen formation by concrete or a cement grout surrounding the pipe. The practice has been heretofore adopted of firing a charge of explosive somewhere below the surface, in an effort to release the pipe from the cementitious material surrounding it. In such cases however, the effect of the explosive charge is not only to loosen the cementitious material, but to rupture and otherwise injure the pipe itself. Frequently in such cases the pipe is torn off at a position intermediate the point of discharge of the explosive and the surface of the ground, with the result that the recovery of the pipe is limited to that portion which is above the torn-off section.

The object of the present invention, generally stated, is to provide a process of recovering pipe from holes in the earth in an economical and efficient manner, and without substantial damage to or loss of pipe.

Another object of the present invention is to provide a process of loosening pipe from the cementitious anchoring formation generally surrounding it.

Another object of the present invention is to provide a process for mechanically vibrating a string of pipe extending vertically in the ground.

Other objects will become apparent to those skilled in the art when the following description is read in connection with the accompanying drawing, in which:

Figure 1 is a view, somewhat diagrammatic in form, showing an abandoned oil well with a string of casing in position, part of the casing being broken away to reveal the relation of the vibrating device employed in connection with one embodiment of the present invention.

Figure 2 is a detail view of the vibrating device shown in Figure 1.

Figure 3 is a sectional view, taken along line 3—3 of Figure 2.

Figure 4 is a view in side elevation of another embodiment of a vibrating mechanism suitable

for employment in connection with the present invention.

In accordance with the present invention, generally stated, pipe such as casing, tubing, or drill pipe is recovered from the earth, as for example, from abandoned oil wells, by applying forces tending to extract the pipe from the earth either concurrently with or subsequent to the application of forces tending to loosen the pipe from the surrounding formations. The loosening forces contemplated by this invention are such as to be effectual without damage or injury to the pipe. As a general rule, the formation surrounding the pipe in abandoned oil wells is cementitious material, which may consist of concrete, but more frequently consists merely of a cement grout. While the features of the present invention may be employed with particular advantage in the recovery of pipe where the anchoring formation is of cementitious material, it is to be distinctly understood that the features of the present invention are likewise operable upon, and useful in connection with, the recovery of pipe from surrounding earthen formations.

The present invention is particularly characterized by the mode of loosening the pipe from the surrounding formations. In general, the present invention contemplates that a rapid succession of blows be struck upon the inside of the pipe at progressively different depths. If the frequency of the blows is appropriate, vibration or waving of the pipe may result. The successive blows, whether or not accompanied by vibrations and/or waves, tend to loosen the surrounding anchoring formations from the exterior surface of the pipe. Such vibration may be accomplished by the insertion of any suitable electrical or mechanical vibrator into the pipe, and so arranged that it may be traversed downwardly substantially throughout the length of the pipe, or to the extent necessary to accomplish a degree of loosening such that the extracting force applied or to be applied is capable of withdrawing the pipe. Such an electrical or mechanical vibrator may be of a character such as to beat the interior of the pipe with a rapid succession of blows, preferably applied at circumferentially displaced points within the pipe. Pneumatic apparatus is particularly adaptable for use in connection with the present invention, and as the disclosure proceeds, two embodiments of such pneumatic vibrators will be described in detail.

The present invention further contemplates

that, as the pipe is vibrated and slightly loosened from the surrounding cementitious material, substances be supplied which have a deleterious action upon the cementitious material. Such a substance may be supplied to the pipe at or near the surface of the ground, and as the loosening process continues downwardly, the substance will migrate downwardly through the fractures in the cementitious material, following slightly behind downward movement of the vibrating mechanism. A great variety of substances are known to those skilled in the art as having a deleterious action upon cementitious materials. In general, acids and oils may be employed for this purpose; but it is particularly advantageous, from the standpoint of both result and economy, to employ a substance known in the art as sludge acid. This substance is a refinery product resulting from the treatment of crude oil with sulphuric acid, and generally comprises sulphuric acid, water, and heavy petroleum fractions in about the following proportions:

	Per cent
Sulphuric acid.....	82 to 93
Petroleum fractions	3 to 7
Water and impurities.....	Balance

The employment of sludge acid of the character just described in the process of the present invention is not only effective to disintegrate or weaken the cementitious material surrounding the pipe, but the presence of the petroleum fractions in the sludge acid protects the pipe itself from the action of the acid. Sludge acid is therefore particularly beneficial in that not only the acid portion of this substance has a deleterious effect upon cementitious material, but in addition, the petroleum fraction protects the pipe from action by the acid and also lubricates the surfaces. If desired, of course, further protection of the pipe from the action of the acid may be accomplished by the addition to the sludge acid or other equivalent substance of a well-known corrosion inhibitor.

While, in the embodiment to be disclosed in detail the sludge acid is supplied only adjacent the surface, it will be understood that by milling or otherwise providing suitable openings in the pipe at points below the surface auxiliary working sources of the substance may be availed of.

While it will be understood that a more expeditious destructive action on the cementitious material may be expected when the sludge acid, or other equivalent substance, is employed in connection with the means for vibrating the pipe in accordance with the present invention, it is to be distinctly understood that some advantage is derived from the employment of the sludge acid without vibrating the pipe, although it is readily apparent that the loosening action in such case progresses with much less rapidity.

Referring now particularly to the drawing for an illustrative embodiment of the present invention, a bore hole 1 in the earth contains a string of pipe 2, secured in position in the bore hole 1 by a cylindrical layer of cementitious material 3, which completely fills the space between the exterior surface of pipe 2 and the interior surface of bore hole 1. While in the embodiment shown, the cementitious material 3 extends from top to bottom of the string of casing, it is to be distinctly understood that the invention is not limited to the recovery of pipe from a situation wherein the cementitious anchoring surface extends continuously from top to bottom, as shown, such arrangement being shown merely for the purpose of illus-

tration, as it represents a more difficult situation than the more common practice in which the cementitious material extends discontinuously throughout the length of the pipe.

In recovering the string of casing 2 from bore hole 1 in accordance with the present invention, a part of the cementitious material 3 is chipped away at the surface of the ground adjacent casing 2, so as to provide a basin 4, the interior wall of which is formed by the exterior surface of pipe 2. Into the basin 4 may be deposited a quantity of suitable substance having a deleterious action upon cementitious material, such for example as the sludge acid, hereinbefore referred to.

Any appropriate means for applying an extracting force to the string of casing 2 may be employed. Such means generally consists of a series of jacks or a series of elevators, or other lifting mechanism, suitably arranged to apply an extracting force to the pipe. In the embodiment shown, a spider 5 is applied over the surface end of string of casing 2, as by means of slips 6; and an extracting force is applied through elevator links 7 in a manner well known to those skilled in the art.

Before the application of the extracting force, as through elevator links 7 and spider 5, or concurrently therewith, the present invention contemplates a further loosening operation, which consists of striking a rapid succession of blows on the interior of pipe 2. If such blows are struck with a periodicity such as to set up a vibration of the pipe itself, the loosening of the pipe from the surrounding cementitious material will be more rapidly accomplished than in cases where the succession of blows is either not rhythmic, or not of a periodicity resonant with the pipe. In the embodiment illustrated in Figure 1, a pneumatic vibrator 8 is employed for striking the rapid succession of blows on the interior of pipe 2. Such a pneumatic vibrator may be of any of the well-known types, but for the purpose of illustration, Figure 3 of the drawing shows such a vibrator provided with a vaned rotor type air motor 9, operated by compressed air supplied through a hose 10, and delivering its exhaust to the annular space between hose 10 and hose 11. Mechanically connected to the air motor 9, so as to be positively driven thereby, is an eccentric weighted element 12, rotation of which produces a vibration of the entire device, so that blows are struck interiorly of pipe 2 in rapid succession, and at circumferentially spaced points.

Such a vibrator may be arranged to strike the desired number of blows per unit of time on the interior of pipe 2. For example, when operating at a pressure of ninety pounds per square inch, devices of the character shown in Figure 3 rotate at approximately 6,000 R. P. M.; and each rotation represents at least one blow against the interior of pipe 2. The frequency of vibration may however, be regulated by regulating the operating air pressure, and in this way, when it is desired to do so, the frequency of the blows struck by the vibrator 8 may be adjusted to a periodicity such as to set up a vibration in pipe 2; but as hereinbefore pointed out, such vibration of the pipe itself is not essential to the accomplishment of the result.

In order to minimize the possibility of damaging the interior of pipe 2, particularly at the ends of the respective joints, it is frequently desirable to muffle or cushion the blows struck by the vibrator 8; and consequently a cushioning sleeve 13 of rubber or other yieldable or shock-

absorbing material may be applied over the housing of vibrator 8, as clearly shown in Figure 3.

In order to facilitate the manipulation of vibrator 8 within the string of pipe in the bore hole, the vibrator 8 may be provided with a pair of ears 14, arranged to receive a bail 15, which in turn is connected to a cable 16. The arrangement just described permits of manipulation of the vibrator 8 within the string of casing, and the movement of the vibrator 8 up and down therein, without necessitating that the weight of the vibrator be sustained by the hose members 10 or 11. It is understood, of course, that a suitable reeling arrangement is provided at the surface of the ground for handling cable 16.

Any suitable source of compressed air may be employed for supplying air under pressure to hose 10 of vibrator 8.

Any suitable arrangement may be provided for supplying the sludge acid, or equivalent substance having a deleterious action on cementitious material, to the basin 4. For example, in the embodiment illustrated, a drum 21 containing the substance is arranged upon a stand 22, and provided with an outlet 23. A suitable pipe, hose, or other tube 24 extends from outlet 23, and terminates in basin 4. The rate of flow of acid sludge from drum 21 may be regulated by a suitable valve, as shown.

In Figure 4, another type of vibrator is provided, in order to illustrate that the invention is not limited to the particular type of vibrators shown in Figures 1, 2, and 3. The vibrator shown in Figure 4 is the well-known piston type air hammer. Such piston type air hammers are commonly employed with one or a plurality of pistons, but for employment in connection with the present invention, it is desirable that the striking surfaces of the hammer be arranged in circumferential displacement, so that the striking of blows on the interior of pipe 2 will not be confined to one side thereof. Accordingly, the present invention contemplates the provision of such an air hammer having a cylinder 17, with the usual piston on the interior thereof, and having a striking element 18 extending outwardly therefrom for reciprocation axially of cylinder 17. A further cylinder 19, of similar construction and similarly arranged with a piston and a striking element 20, may be arranged so that the striking surface 20 is circumferentially displaced from striking element 18. Any desired number of such cylinders, pistons, and striking elements may be arranged together, preferably arranged in substantially uniform circumferential displacement from each other. Obviously, if desired, each piston may be supplied with two striking elements, one at each end of the piston, and a valve arrangement provided so that a blow is struck at each end, upon reciprocation of the piston, back and forth.

Another type of apparatus which may be employed for vibrating or beating the pipe in accordance with the present invention is the character of apparatus frequently employed and available upon the market for removing scale from the exterior of boiler tubes by setting up a localized vibration. Such apparatus may consist of a pneumatic motor having a knocker element arranged to be rotated and strike a multiplicity of taps against the interior of the pipe. Such device may be driven either by electric motor or a suitable fluid motor.

From the foregoing description it should be apparent that as the vibrating element is trav-

ersed longitudinally of the pipe 2, a rapid succession of blows is struck interiorly of the same. If desired, the periodicity of the blows may be so regulated that the pipe 2 is vibrated throughout its length; but such vibration of the pipe is not essential to the accomplishment of the result. The succession of blows transmitted through the pipe 2 fractures and loosens the cementitious material or other formation anchoring the pipe in position progressively from end to end, and as the loosening of the pipe from the surrounding anchoring formation progresses downwardly, the acid sludge migrates through the fractures, produced by the vibrators, and further disintegrates the cementitious material. When the cementitious material has been sufficiently loosened, the extracting force applied, in the embodiment illustrated, through elevator links 7 and spider 5 withdraws the pipe from the hole. As is obvious, when the pipe has been withdrawn to an extent sufficient to expose one or more "joints" of pipe, the exposed joints are removed, and the spider 5 replaced at a lower position, and the operation repeated.

While in the foregoing description a complete disclosure of the process has been given, and supplemented by a complete disclosure of two types of pneumatically energized vibrators, it is not to be understood that the invention is limited to the particular details of such disclosure, which is given for the purpose of illustration only. Any suitable electrical vibrator may, for example, be employed. It is realized, however, that many modifications and variations of the process herein specifically disclosed will be readily apparent to those skilled in the art, without departing in principle from the process of this invention; and it is therefore to be distinctly understood that such modifications, variations, and adaptations of the features of the present invention as do not depart from the spirit thereof are, although not specifically described herein, contemplated by and within the scope of the appended claims.

Having thus described the invention, what is claimed is:

1. In the art of recovering cementitiously anchored pipe from wells, the process comprising, striking the pipe interiorly with successive blows at a substantial distance below the surface of the ground to loosen the pipe from the surrounding cementitious materials, and forcibly extracting the pipe.

2. In the art of recovering cementitiously anchored pipe from wells, the process comprising, vibrating the pipe by striking it interiorly with successive blows, and forcibly extracting the pipe.

3. In the art of recovering cementitiously anchored pipe from wells, the process comprising, vibrating the pipe by striking it interiorly with successive blows, supplying to the exterior of the pipe a substance having a deleterious action upon cementitious material, and forcibly extracting the pipe.

4. In the art of recovering cementitiously anchored pipe from wells, the process comprising, vibrating the pipe by striking it interiorly with successive blows, supplying to the exterior of the pipe a substance having a deleterious action upon cementitious material, and concurrently applying an extracting force to the pipe.

5. In the art of recovering cementitiously anchored pipe from wells, the process comprising, vibrating the pipe by striking it interiorly with successive blows, and concurrently applying an extracting force to the pipe.

6. In the art of recovering cementitiously anchored pipe from wells, the process comprising, striking rapid periodic blows interiorly of and to the pipe, and concurrently applying an extracting force to the pipe.

7. In the art of recovering pipe from bore holes in which the pipe is anchored in position by a cementitious material, the process comprising, striking the pipe interiorly with a succession of lateral blows to fracture the cementitious ma-

terial on the exterior thereof, and progressively feeding petroleum sludge acid to the fractured regions.

8. In the art of recovering cementitiously anchored pipe from wells, the process comprising, applying rapid periodic lateral blows internally of and to the pipe, and forcibly extracting the pipe.

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