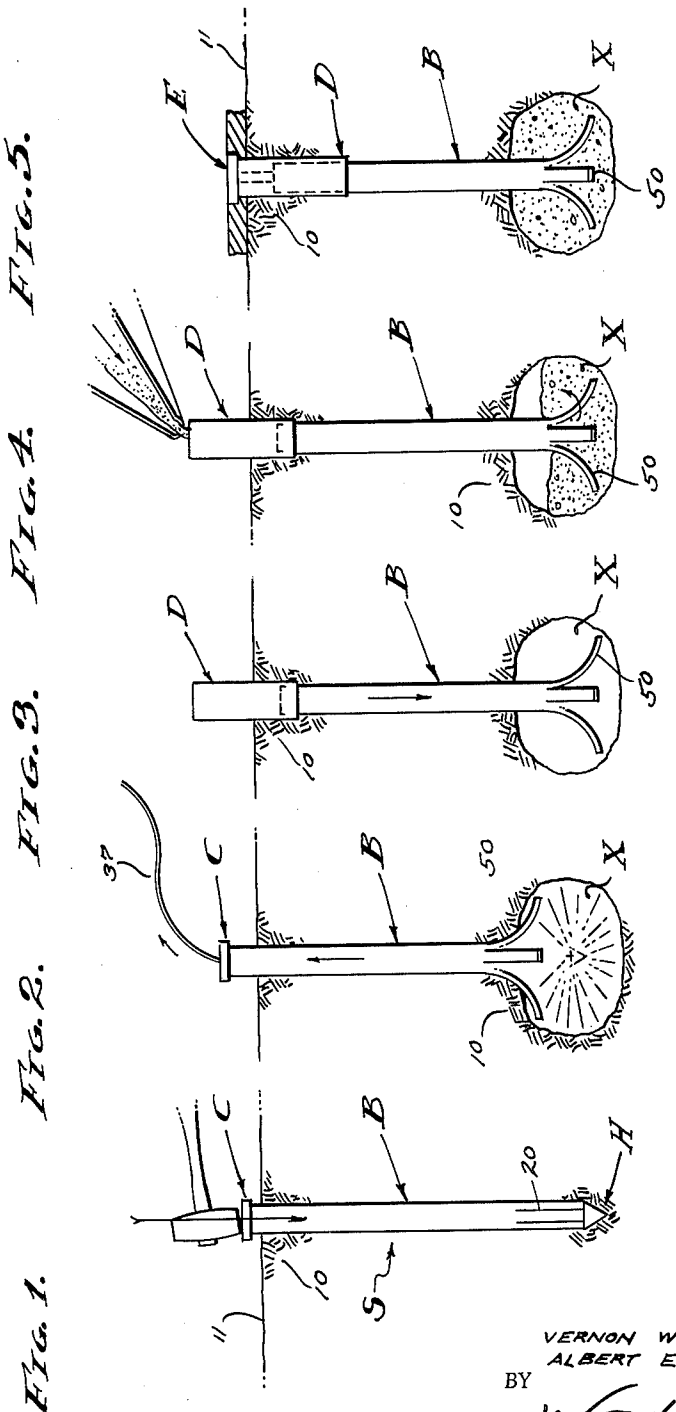
Dec. 14, 1965 V. W. LUEDLOFF ETAL 3,222,842

METHOD FOR INSTALLING CEMENTED ANCHORS

Filed Jan. 15, 1963 2 Sheets-Sheet 1



INVENTORS
VERNON W. LUEDLOFF
ALBERT E. JONEIKIS

BY

W. N. Tunnell

AGENT

Dec. 14, 1965 V. W. LUEDLOFF ETAL 3,222,842

METHOD FOR INSTALLING CEMENTED ANCHORS

Filed Jan. 15, 1963 2 Sheets-Sheet 2

FIG. 6.

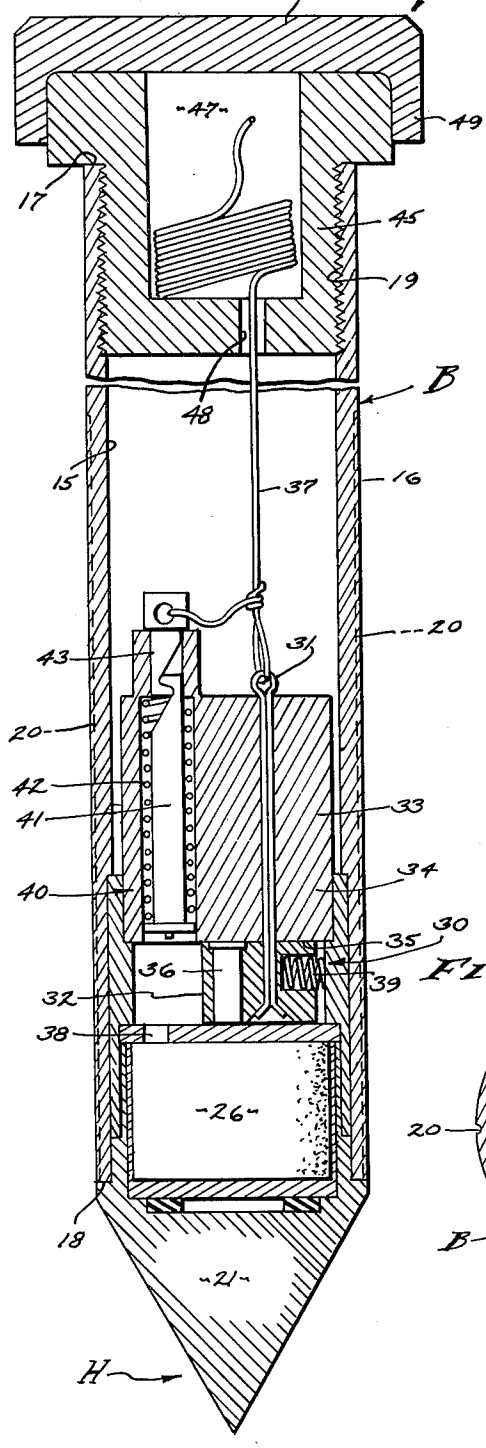


FIG. 7.

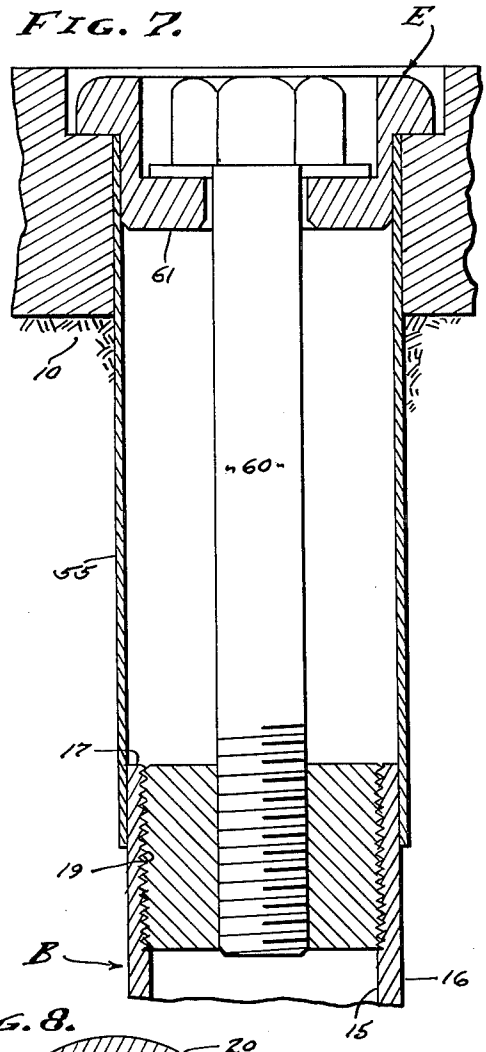
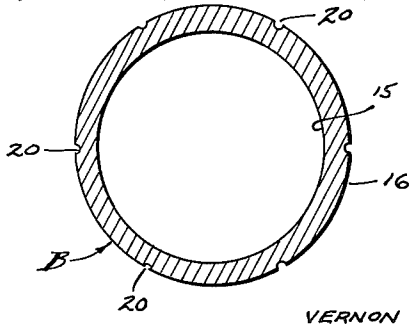


FIG. 8.



INVENTORS
VERNON W. LUEDLOFF
ALBERT E JONEIKIS

BY W. H. Maxwell

AGENT

United States Patent Office 3,222,842 Patented Dec. 14, 1965

3,222,842

METHOD FOR INSTALLING CEMENTED ANCHORS

Vernon W. Luedloff, Torrance, and Albert F. Joneikis, Long Beach, Calif., assignors to Harvey Aluminum (Incorporated), Torrance, Calif., a corporation of California

Filed Jan. 15, 1963, Ser. No. 251,576
3 Claims. (Cl. 52—742)

This invention relates to a method of cementing anchors in the ground and is particularly concerned with an explosively expanded ground anchor that establishes a subterranean cave, or camouflet, which is filled with a material that sets so as to fix said anchor solidly with respect to the surrounding earth formation.

The anchoring and securement of the equipment in a fixed and safe condition is a requirement in many activities and enterprises. For example, the tie-down requirement for aircraft is many times a critical necessity, due to the relatively light weight of the aircraft and due to the high wind forces encountered when the aircraft is grounded. Also, there are many mobile pieces of equipment which require securement under certain circumstances, as for example various types of gun mounts and missile launchers. Further, the erection of buildings, either permanent or temporary, requires tie-down in many situations. Thus, it is apparent that there are many situations where anchors embedded in and beneath the ground are required, such as guy wire anchors used in the erection of poles or towers, and like structures.

A general object of this invention is to provide an anchor structure that is driveable into working position where it is operable to expand and form a cave, or camouflet, which can be filled with a solidfying material in order to fix the said anchor with respect to the surrounding earth formation.

It is also a general object of this invention to provide a method by means of which an anchor is driven into and fixed with respect to the surrounding earth formation.

It is an object of the method and apparatus hereinafter disclosed to provide an anchor which can be driven, as a stake, this being the first step of the method employing an explosively operated anchor that is later fixed in position by means of solidifying material.

It is an object of the method and apparatus hereinafter disclosed to provide an anchor which is explosively operable when positioned by a previous driving step to engage the earth formation by expanding action and simultaneously forming a cave, or camouflet, this being the sec- step of the method.

It is an object of the method and apparatus hereinafter disclosed to provide an anchor which can be properly positioned with respect to the earth formation following the said second explosive step, this being the third and/or intermediate step of the method.

It is an object of the method and apparatus hereinafter disclosed to provide an anchor which can be cemented in a fixed positon relative to the earth formation, establishing a subterranean dead-man with an overlying cone of earth formation, this being the fourth step of the method. The said overlying cone of earth develops a holding power determined by the sum of the weight of earth contained within an overlying inverted cone thereof and of the cohesive resistance or shear strength of the said earth acting on the total peripheral surface area of the said same withdrawal cone.

It is an object of the method and apparatus hereinafter disclosed to provide an anchor which can be utilized to tie down surface equipment and structures by means of studs threaded or otherwise adjustably connected with a subterranean dead-man cemented in a cave or camouflet, this being the fifth step of the method.

It is also an object of this invention to provide an anchor structure wherein the body serves a multiplicity of functions, as a stake, as an explosive carrier, as an expanding "spider," as a pouring conduit, and as a tie-down element.

It is still another object of this invention to provide an explosive head adapted to be driven into the ground as by hammering and then operated to create a subterranean cave or camouflet, and means to safety the same during the driving or said hammering.

The various objects and features of this invention will be fully understood from the following detailed description of the typical preferred forms and applications thereof, throughout which description reference is made to the accompanying drawings, in which:

FIGS. 1 through 5 are sequential views that show the progressive steps involved in the installation of the anchor of the present invention, FIG. 1 showing the first step of driving the stake-like anchor, FIG. 2 showing the second step of detonation and ignition of the explosive element of the anchor, FIG. 3 showing the third step or intermediate step of relocating the anchor, FIG. 4 showing the fourth step and cementing operation involved in setting the anchor, and FIG. 5 showing the final dispositon of parts and wherein the anchor is used to tie down equipment.

FIG. 6 is an enlarged detailed sectional view of the structure as it is used in FIG. 1 of the drawings above described.

FIG. 7 is an enlarged detailed sectional view of a portion of the structure as it is used in FIG. 5 of the drawings above described.

FIG. 8 is a sectional view taken as indicated by line 8—8 on FIG. 6.

It is well known that different earth formations possess different densities and different cohesive properties and weights and strengths. Therefore, experience and factual information can be used in order to determine exactly the holding power of a given anchor design beneath or within a certain body of earth formation. As expressed in the one foregoing objective, the holding power of the anchor hereinafter disclosed is the sum of the weight of effective overlying earth, the earth in an overlying inverted cone, and of the shear strength or cohesive resistance of the surface area of said effective earth or cone thereof. Thus, it is apparent that an exacting science is involved in determining said holding power, taking into account different types of earth and how they affect variations as for example in the overlying cone angle, etc.

The anchor of the present invention has utility in all angular dispositions, providing there is sufficient lateral supporting earth formation 10. Also, the anchor can be embedded in the earth formation 10 at any desired depth. In the drawings I have shown a vertically disposed installation of the anchor and at an angle normal to the ground surface 11. In accordance with the invention the method and apparatus involves, generally, the driving of a tubular body B into the ground, said body being provided with a sharpened earth piercing head H carrying an explosive charge that simultaneously destroys said head, opens the lower end of the body, and forms a cave or camouflet X. The structure is preferably of round cross-section with the head H at the lower end and with replaceable means at the upper end in order to convert the structure from a driving stake into a fixed anchor with tie-down capabilities. In carrying out the method and in making a suitable anchor structure there are three basic functions and related means provided for at the top end of the structure, a

driving cap C, a pouring conduit D, and a tie-down adapter E. These means C, D and E are structural parts utilized separately in carrying out the method of installation, and the head H above referred to is destroyed in the process.

Primarily, the anchor involves the body B which is a tubular part of cylindrical form. Thus, the body has inner and outer walls **15** and **16**, and it has top and bottom ends **17** and **18** in planes normal to a central axis. The body is made, for example, of steel tubing having substantial wall thickness and is characterized by internal threads **19** or other coupling means at the upper end portion and by longitudinal striations **20** at the lower end portion. The said striations are of substantial length and are a plurality in number, there being six striations as shown, and preferably cut into or suitably indented in the exterior wall **16**. The striations **20** are straight and they terminate in a common transverse plane whereby circumferentially spaced lines of weakening are established for the deformation or reforming of the body B as and when internal pressures are applied. However, columnar strength of the body B is maintained and not materially affected by the presence of said striations.

The head H is pressed into and/or suitably secured to the lower end portion of the body, and for the most part it occupies the body B within the portion thereof weakened by the striations **20**. The head H comprises an earth-piercing nose **21**, an explosive charge **26**, safety means **30** normally retained by a safety pin **31**, and a firing means **40** operable when the safety means **30** is released. The explosive charge **26** is significantly located at the lower end portion of the body B within the striations **20** and above the bottom end **18**.

The head H is composed of a sectional body fabricated of several or more parts, the nose section **21** of which is hard metal shaped as shown. The safety means **30** involves a fuze housing **34** with a transverse guideway **35** therethrough that slidably supports a slider block **32**. The fuze housing **34** is closed by a fuze block **33** which captures the slider block **32** in the guideway **35**. The slider block **32** carries a detonator cap **36** which is normally held positioned at the center axis of the structure by means of the retaining safety pin **31** which enters longitudinally through the fuze block **33** and through the slider block **32**. The safety pin **31** is a cotter which has its ends deflected below the slider block **32** and has its loop end exposed and joined to a lanyard **37** extending upwardly through the body B and adapted to be pulled at the exterior of the structure.

Laterally of the central axis and parallel thereto there is a firing pin **41** on its axis. The said firing pin axis extends through the guideway **35** and aligns with an ignition port **38** entering into the charge **26**. As is indicated, the slider block **32** is shiftable to an armed position by a spring **39**, whereby the detonating cap **36** aligns with the ignition port **38**. Said armed position is permitted by pulling of the lanyard **37** thereby removing the safety pin **31** from the slider block **32**. Having thus armed the head H, the firing pin **41** is operated by the continued pulling of the lanyard **37** and cocking of said pin **41** against a spring **42**, and by withdrawal of a sear **43** from the fuze block **33**. The sear **43** and pin **41** are normally coupled for pulling by means of a slip joint that is released by withdraw of the sear from the confinement within an opening that slidably contains these two parts. Upon release of the biased firing pin **41** the detonating cap **36** is struck and the charge **26** is ignited thereby.

The driving cap C is provided in accordance with the first step of the method and is essentially a protective closure for the upper end **17** and which is suited to receive repeated hammer blows. The cap C also protects the threads **19** which are used for later purposes and is preferably a sectional cap comprising a plug **45** threaded into the body B and a pad **46** overlying the plug. The plug **45** is provided with an upwardly opening recess **47** that accommodates a length of lanyard **37** and an opening **48** in the plug passes the lanyard from within the tubular body B. The pad per se is a disc that closes the recess **47**, having a depending protective lip **49**.

In accordance with the first step of the method the stake S composed of the body B, head H and cap C hereinabove disclosed is placed in or driven into the earth and to a suitable depth as by hammering or the like, as shown in FIG. 1.

In accordance with the second step of the method the lanyard **37** is pulled and the charge **26** ignited as hereinabove described. Having buried the head H surrounded by the weakened body portion, said weakened portion is deformed from its initially preformed condition by splitting and dividing into the radial fingers that reform into a spider **50**, as shown in FIG. 2. The fingers of the spider **50** curve gently outward substantially as shown, due to a ripping action initiated at the lower end of the body B and progressing upwardly.

The pouring conduit D is in the nature of a shield **55** that telescopes over the body B. Upon detonation and ignition of charge **26** the stake S is expanded at its lower end and a cave or camouflet X is simultaneously formed. With this action, and in actual practice, the stake S is raised or lifted upwardly as shown in FIG. 2. Therefore, the cap C is removed and the shield **55** is telescoped onto the body B and the body is lowered or properly repositioned by manipulation, this being the third and intermediate step of the method. Further, it is to be understood that the intermediate step can be performed after the next and fourth step to be described.

In accordance with the fourth step of the method the cave or camouflet is filled via the tubular body B and through the shield **55** which prevents earth formation from tumbling into the same. Any suitable solidifying fluid material can be employed for filling the cave or camouflet X, and preferably a cement Y or the like which hardens rapidly around the spider **50**.

The tie-down adapter E replaces the plug **45** and comprises a stud **60** threadedly engaged in the threads **19** so as to project axially from the body B. In practice there is a bushing **61** that adjustably receives the stud **60**, and said stud can be secured to an object or equipment Z as circumstances require, a typical securement being shown. From the foregoing it will be apparent that the steps hereinabove described together with this last and fifth step result in an anchor installation characterized by an enlarged dead-man that is buried in the earth formation substantially below the surface **11** thereof. A characteristic feature of the method and apparatus herein disclosed is the retention of one body part which serves the many purposes involved in the five steps enumerated and described. The original head H disintegrates upon ignition thereof and simultaneously opens the body B for passage of fluid or cement therethrough and into the cave or camouflet which is simultaneously established and formed by explosion of said head. It is a simple matter to relocate and properly position the body B after the said detonation and ignition of the explosive charge, following which the tubular body conducts a solidfying fluid, a cement, to occupy the cave or camouflet thus formed. As pointed out at the outset of this specification the holding power of such an installation can be readily determined through analysis of the particular earth formation involved taken in consideration with the effect of the overlying inverted cone of earth and of the cohesive resistance or shear strength thereof.

Having described only a typical preferred form and application of our invention, we do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to ourselves any modifications

or variations that may appear to those skilled in the art and fall within the scope of the following claims.

Having described our invention, we claim:

1. Method for establishing a subterranean anchor and ground level tie-down comprising the steps of

driving an elongated metallic tubular stake below ground level, the tubular stake including a ground-piercing head at one end and a driving head at the opposite end with an explosive charge and detonating means located intermediate the ends of the tubular stake and confined in close proximity to the piercing head within a portion of the tubular stake which has been weakened with a pluraltiy of longitudinally extending wall surface demarcations, the piercing head and weakened portion of the tubular stake being driven a substantial distance below ground level, then

detonating the explosive charge located within the driven tubular stake to expand the weakened portion of the tubular stake so that the plurality of stake wall sections between wall surface demarcations extend radially from the tubular stake in angled relationship to the longitudinal axis of the tubular stake into a hollow subsurface chamber formed by the explosion, the piercing head being separated from the tubular stake opening a passageway at that end of the tubular stake,

moving the radially extended sections of the tubular stake downwardly into the hollow subsurface chamber formed by the explosion,

delivering a semi-fluid, settable material through the tubular body into the hollow subsurface chamber in surrounding and covering relationship to the radially extended sections of the tubular stake, and

securing tie-down means to the tubular stake contiguous with ground level.

2. Method for installing and securing a subterranean ground anchor comprising the steps of

driving an elongated metallic tubular stake below ground level, the tubular stake including a ground-piercing head at one end and a driving head at the opposite end with an explosive charge and detonating means located intermediate the ends of the tubular stake and confined in close proximity to the piercing head within a weakened wall portion of the tubular stake, the piercing head and weakened wall portion of the tubular stake being driven a substantial distance below ground level, then

detonating the explosive charge located within the driven tubular stake to expand the weakened wall portion of the tubular stake radially into a subsurface chamber formed by the explosion, with the explosion opening a passageway through the tubular stake and into the subsurface chamber,

attaching a longitudinally extended, tubular pouring conduit to the tubular stake to extend the length of the tubular stake a substantial distance above ground level, then

moving the tubular stake downwardly to dispose the opposite end of the tubular stake, as extended by the pouring conduit, contiguous wtih ground level, and

delivering a semi-fluid, settable material through the tubular body into the hollow subsurface chamber in surrounding and covering relationship to the expanded portion of the tubular stake within the subsurface chamber.

3. Method for establishing a subterranean anchor and ground level tie-down comprising the steps of

driving an elongated metallic tubular stake below ground level, the tubular stake including a ground-piercing head at one end and a driving head at the opposite end with an explosive charge and detonating means located intermediate the ends of the tubular stake and confined in close proximity to the piercing head within a weakened wall portion of the tubular stake, the piercing head and weakened wall portion of the tubular stake being driven a substantial distance below ground level, then

detonating the explosive charge located within the driven tubular stake to expand the weakened wall portion of the tubular stake radially into a hollow subsurface chamber formed by the explosion and open a passageway through the tubular stake into the hollow subsurface chamber, then

attaching a pouring conduit to the tubular stake to extend the length of the tubular stake a substantial distance above ground level,

moving the expanded portion of the tubular stake downwardly within the hollow subsurface chamber formed by the explosion,

delivering a semi-fluid, settable material through the tubular body into the hollow subsurface chamber in surrounding and covering relationship to the expanded portion of the tubular stake, and then

securing tie-down means to the metallic tubular stake contiguous with ground level.

References Cited by the Examiner

UNITED STATES PATENTS

1,106,606	8/1914	Wilhelmi	61—53.54
1,249,200	12/1917	Rivinoja	182—92
1,273,890	7/1918	Loseth	182—92
1,449,236	3/1923	Malone	61—53.54
1,461,451	7/1923	Powell	61—53.54
1,746,848	2/1930	Bates	61—53.6 XR
2,269,646	1/1942	Burke	189—92 X
3,115,226	12/1963	Thompson	189—92

HARRISON R. MOSELEY, *Primary Examiner.*