June 1, 1965 W. C. BRISSE 3,186,523

GROUND ANCHORING SYSTEM

Filed Jan. 3, 1961 2 Sheets-Sheet 1

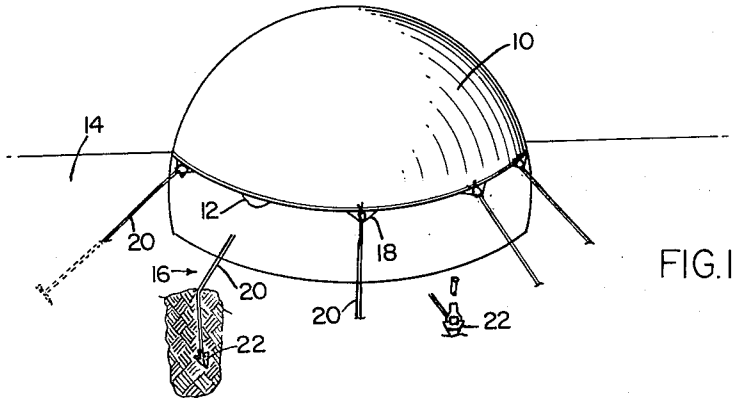

FIG.1

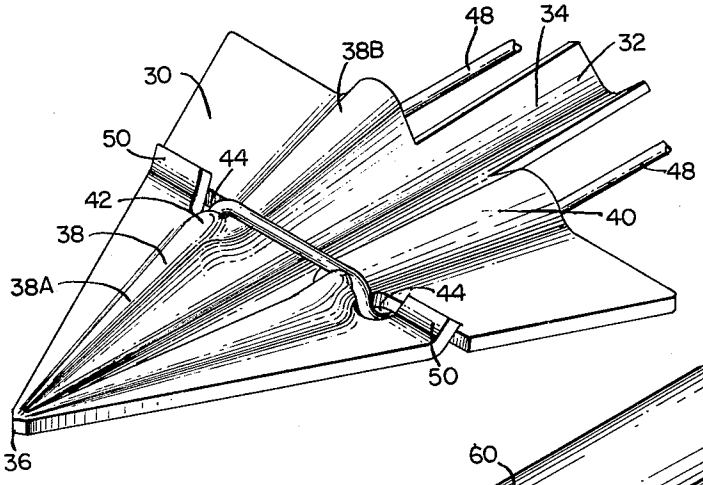

FIG.2

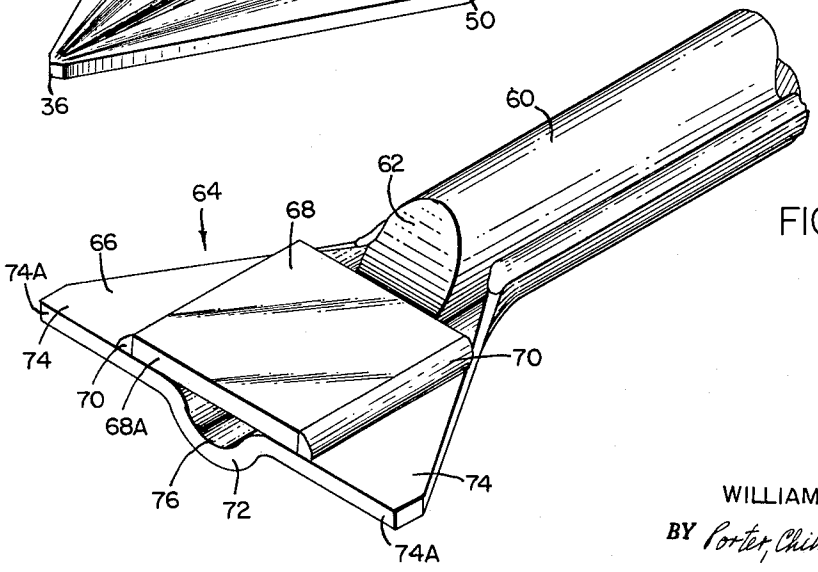

FIG.3

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June 1, 1965 W. C. BRISSE 3,186,523

GROUND ANCHORING SYSTEM

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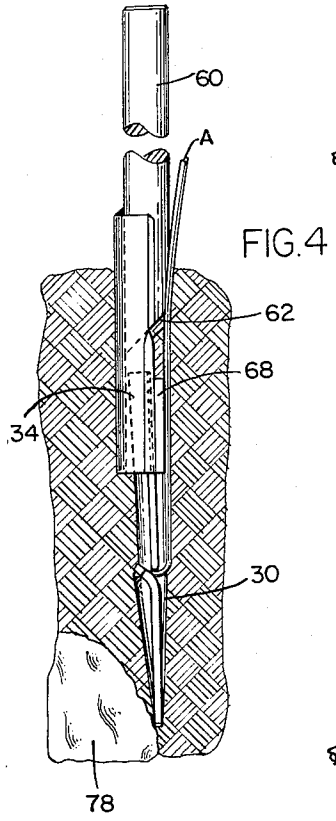

FIG.4

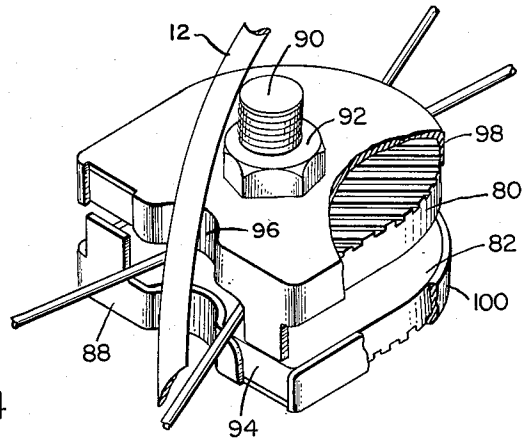

FIG.5

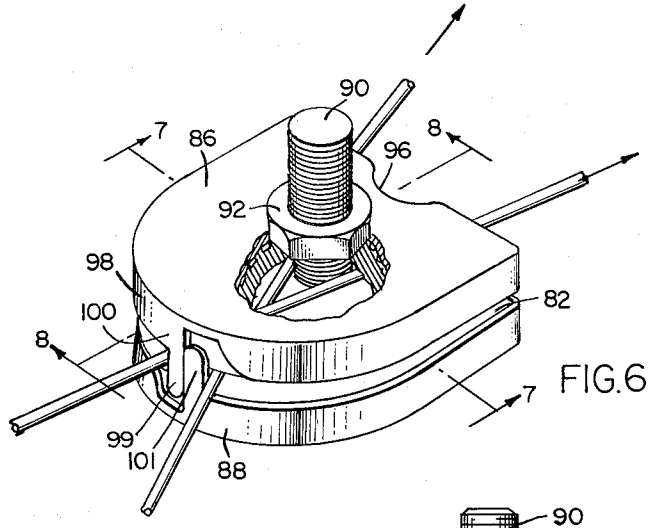

FIG.6

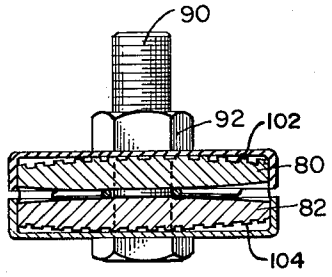

FIG.7

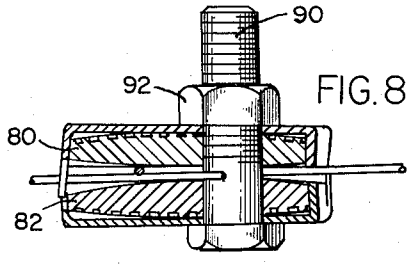

FIG.8

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GROUND ANCHORING SYSTEM

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2 Claims. (Cl. 189—2)

This invention relates generally to supporting and anchoring systems and particularly to ground anchors, embedding tools, and guy clamps appurtenant to portable structures.

It is well known that, in recent years, new types of large portable structures, as "radomes," have been developed for many diverse purposes. As a result, persons in the art have become increasingly aware of the necessity for providing means which are especially adapted to supporting and anchoring portable structures, the problem being emphasized by the increased size of practical portable structures and the use of such structures under more and more difficult conditions. A most satisfactory solution to the problem may be attained only when it is recognized that a ground anchoring system designed specifically to support and anchor modern portable structures must be provided.

Insofar as a supporting and anchoring system per se is concerned, there are many criteria which must be met if the full advantages of modern portable structures are to be realized. Among the criteria are the following: The system must be adapted to use with many different types of structures; no special provisions must be required to use the system in different environments; and the system must be economical to produce and use.

A satisfactory ground anchor, first of all must be capable of insertion to any desired depth in different kinds of soil, ranging from soft dirt, or loess, to hard-pan, or rock-bestudded ground. It is even desirable that ground anchors be adapted also to use in compacted snow or ice. Such widely differing conditions make it mandatory that the ground anchor be extremely strong, yet somewhat flexible, so as to be operable under any condition encountered. In addition, it is highly desirable that a ground anchor be compact and easily transported, since numbers of anchors often are used in almost inaccessible sites. This last stricture requires that satisfactory ground anchors be nestable, so that transportation problems attendant upon bringing anchors to their place of use may be minimized. It is evident that ground anchors which have been fabricated from a flat piece, or a sheet, of material will best meet this last-mentioned requirement, but that special provision must be made if an anchor fabricated from a sheet of material is to have sufficient strength satisfactorily to perform its intended function.

The prior art relating to single piece ground anchors is exemplified by anchors such as are described in Burns et al., U.S. Patent No. 1,014,806, Saunders, Patent No. 1,244,133, Eggleston, Patent No. 1,308,940, and Clevett, Patent No. 2,712,864. Both Burns et al. and Saunders disclose curved ground anchors particularly suited for use with relatively light structures, as fences. Such anchors may not be driven straight down into any kind of soil, but must of necessity follow an arcuate path. Therefore, neither may be driven deeply into any type of ground so as to be effective in anchoring large portable structures. Eggleston shows a removable ground stake which also may not be fully inserted into any type of ground. Clevett shows a ground anchor which, although it may very well be used to anchor a portable structure, is not adapted to use in all kinds of soil. The disclosed triangular ground anchor, which has a cone-shaped rib running longitudinally thereof may be used

to advantage in soft dirt, or loess. However, since it is relatively inflexible, it may not be used to maximum advantage in hard-pan or rock-bestudded soil.

It is common practice in the art to use guys, either wire or cable, running from a number of ground anchors to spaced points on a portable structure. The tension of each guy must be adjusted so that the load is equally distributed between the guys, regardless of the number of guys used or the contour of the terrain on which the structure is being erected. Therefore, any means used to attach guys to a portable structure are critical in a satisfactory anchoring system, since such attaching means must be positive in action under all conditions, easily adjusted and must not weaken the guy.

The prior art relating to clamps used in anchoring systems is exemplified by clamps such as are described in Kiemzle, U.S. Patent No. 1,315,969, Webb, U.S. Patent No. 862,298, and the co-pending application of Clevett, Ser. No. 782,597, filed December 23, 1958, now Patent Number 2,986,242. Kiemzle describes a clamp for a cable in which means are provided to ensure rupture of a coupling before the elastic limits of the cable are reached. Such a device is particularly suited for applications in which sudden strains are experienced and does not provide any easy way of adjusting tension on a cable. Webb describes a clamp for wire used to connect a guy between a fence and a ground anchor. In view of the relatively small strains experienced in such a use, no provision is made to ensure holding by the clamp when large strains are placed on it. Clevett describes a clamp which holds a cable by deforming such cable between two jaws. While such a clamp may be satisfactory for some applications, the weakening of the cable which may be experienced under certain conditions and the fact that the clamp may not be used with a wire guy limits its use.

The means for embedding a ground anchor into any type of substratum is critical to a satisfactory anchoring system. The requirements for driving means for ground anchors are the ability to drive a ground anchor into any type of soil to any desired depth and the ability to withstand repeated shocks in such use. To meet the latter requirement, satisfactory driving means must be highly resistant to fatigue. Consequently, concentration of strain points, whether such points occur in either the ground anchor being driven or in the driving means itself, must be avoided. To meet the former requirement, satisfactory driving means must lock positively to a ground anchor during the driving operation and automatically compensate for small differences in the relative positions of the two elements, should the ground anchor strike some obstruction. In addition, satisfactory driving means should not interfere with the soil displaced by the ground anchor during the driving operation. Finally, the driving means must be capable of easy withdrawal after a ground anchor has been driven to a desired depth.

The prior art relating to driving rods for ground anchors is exemplified in the patent to Foulke, U.S. Patent No. 1,311,335, in which a device for inserting a fence anchor is described. The lower end of the disclosed driving rod is formed so as to accommodate a particular ground anchor along the side of a rod near the lower end thereof. In operation, an anchor, with a guy attached thereto, is placed on the rod and the rod is driven into the ground to a desired depth. The guy is then pulley upwardly to remove the ground anchor from the rod. While such construction is satisfactory when the anchor is being driven into rockless soil, it is obvious that, if the anchor is being driven into rocky soil, it is quite likely then a rock will dislodge from the flat face before the anchor reaches its desired depth.

Therefore, a primary object of my invention is to provide an improved ground anchoring system adapted to use with many types of portable structures.

Another object of my invention is to provide an improved ground anchor, clamp, and driving rod which, when used together permit anchoring of portable structures in many types of substrata, using either solid wire or cable as guys.

Still another object of my invention is to provide a ground anchor that may be embedded into many kinds of substrata to any desired depth.

Another object of my invention is to provide clamping means which will allow adjustment of the tension among a plurality of guys, without danger of deforming any one of the guys.

A still further object of my invention is to provide a ground anchor and a driving rod which, when used together, will allow the anchor to be driven into soil containing a large number of rocks.

A still further object of my invention is to provide a driving rod and a ground anchor which, when used togeaher, minimize chances of damage to either the driving rod or the ground anchor by distributing forces between the two over a large area.

In the accomplishment of these and other objects of my invention, I provide an anchoring system having a plurality of similar adjustable guy assemblies. Each guy assembly consists of a unitary ground anchor embedded in the substratum over which a portable structure is to be erected, a guy doubled on itself to form a bight, the bight being secured to the ground anchor and the free ends of the guy being led out of the substratum and secured to a self-locking adjustable clamp. The clamp, in turn, is attached to or joined with the portable structure in any convenient way. Thus, after the ground anchor has been driven to any desired depth, the tension on each guy may be equalized. In addition, I provide a novel driving rod operative with my ground anchor to embed such an anchor in any type of substratum which may be penetrated by a ground anchor. The details of my invention will become apparent from the following description of a preferred embodiment, wherein:

FIG. 1 is an isometric view, greatly simplified, showing the anchoring system contemplated by this invention in use;

FIG. 2 is an isometric view of a preferred embodiment of the ground anchor used in FIG. 1;

FIG. 3 is an isometric view of a preferred embodiment of a driving tool, showing particularly the end of such tool which mates with the ground anchor shown in FIG. 2;

FIG. 4 is a side view of ground anchor shown in FIG. 2 and the driving tool shown in FIG. 3 mated together in a substratum during typical driving process;

FIG. 5 and FIG. 6 are isometric views, partially broken away, showing in detail the clamp used in FIG. 1;

FIG. 7 and FIG. 8 are cross-sectional views taken respectively by passing the planes 7—7 and 8—8 through the clamp as shown in FIG. 6 to illustrate the action of the clamp when it is taken up to secure a guy.

In FIG. 1, my ground-anchoring system is shown securing a radome, although other types of portable structures are equally well adapted to the system. In the figure, the numeral **10** designates a radome. Peripherally attached to the radome is a so-called "catenary" line **12**. The manner in which the catenary line **12** is attached to the radome is not critical to the invention, it being sufficient only that a number of depending loops be provided. The radome **10** is secured to a substratum **14** by means of a plurality of my anchoring assemblies **16**, one of the anchoring assemblies **16** being attached to each one of the loops of the catenary line **12**. Each one of the anchoring assemblies **16** consists of a clamp **18**, a guy **20**, and a ground anchor **22**. As illustrated, the guy **20** consists of a wire folded approximately at its center and doubled back on itself to provide two leads. The bight of the wire is attached to the ground anchor **22** as shown in detail in FIG. 2. The individual ground anchors are driven into the substratum **14** to a desired depth, using the driving tool illustrated in FIG. 3, leaving the free ends of the two leads projecting up from the substratum as shown at A in FIG. 4. After all the ground anchors have been embedded in the substratum **14**, the clamp **18** (shown in detail in FIGS. 5 and 6) is placed on each of the loops of the catenary line **12**, and the free ends of the guys **20** are inserted in their respective clamps. The clamps are then adjusted so that the tension on the guys is equalized.

The preferred embodiment of the ground anchor **22** is shown in FIG. 2 to consist of a triangular head section **30** and a driver guide **32** integrally formed with the head section **30** and projecting therefrom. I prefer to use a semi-hard steel sheet, say ⅛" thick, for my ground anchor, although other materials and other thicknesses may be used without departing from the concepts of my invention. With the preferred material, I have found that a ground anchor made in a shape of an isosceles triangle having a base of 4" and an altitude of 4" may be fabricated to withstand a pull of 2,000 pounds when embedded in soil. In order to render such a relatively light anchor capable of withstanding such a force, the head section **30** and the driver guide **32** are stiffened by a longitudinal rib **34** running from near the apex **36** of the head section **30** through the entire length of the driver guide **32**. In addition, I have found it highly desirable to stiffen the body section **30** still further and to provide structure to protect a guy wire adjacent the anchor from undue abrasion during the embedding process. Such stiffening and protection are attained by providing a pair of complex ribs **38**, **40**. As may be seen, ribs **38** and **40** are mirror images of each other, so only one will be described in detail. Rib **38** consists of a leading portion **38A** running from the apex **36** of the head portion **30** adjacent the rib **34**, diverging slightly therefrom and being curved oppositely thereto and deepening with distance from the apex **36**. Trailing portion **38B** consists of a rib generally similar to leading portion **38A**, but commencing adjacent rib **34** at the end of the leading portion **38A**. Thus, a protuberance **42** is formed at the junction between the leading portion **38A** and the trailing portion **38B**. An aperture **44** is formed through the head section **30** behind protuberance **42** to receive a guy, shown here as a wire **48** although a cable may also be used. Insertion of the wire **48** in the aperture **44** may be facilitated by slotting the body section **30** inwardly from the edge thereof to the aperture **44** and rolling back a flap **50**. After the wire **48** is inserted in the aperture **44**, flap **50** is forced downwardly again into the plane of the head section **30** so as to hold the wire securely in place on the end section **30**. It will be noted that the ribs **34**, **38**, and **40** stiffen the head section **34** materially between the apertures **44**, thus rendering the head section **30** capable of withstanding the strains encountered when tension is applied to the wire **48**. Further, it will be noted that the wire **48** at the points where it is bent sharply is protected by the protuberances **42** against abrasion during insertion into a substratum. It will further be noted that the position of the apertures **44** in the head section **30** need not be below the centroid of such head section **30**, in order to prevent slippage of the ground anchor in the substratum when tension is applied to the guys.

The preferred embodiment of a driving tool is shown in FIG. 3 as consisting generally of a shaft **60** having a beveled end **62** secured to an adapter **64**. Adapter **64** consists of a base **66** and a plate **68** rigidly attached to each other, as by a bead weld **70**. Base **66** is preferably formed from a sheet material, say of ⅛" steel, formed so as to have a substantially semicircular element **72** joining a pair of wing-like elements **74**, plate **68** being

disposed between wing-like elements 74 over a semicircular element 72 whereby a non-circular opening 76 results.

The operation of the driving tool may best be seen by referring to FIGS. 3 and 4, wherein the driving tool is shown driving a ground anchor past an obstruction, as a rock 78, in the substratum 14. The driver guide 34 of the ground anchor is inserted in the noncircular aperture 76 until surfaces 68A, and 74A of the driver tool come in contact with the base of the head section 30. Thus, rotation of the ground anchor with respect to the driving tool is prevented and driving forces transmitted through the driving rod 60 are passed through the wing-like elements 74 and the plate 68 to the ground anchor. However, since the noncircular opening 76 in the driving tool is slightly larger than the driver guide 34, it is possible for the ground anchor to move slightly out of alignment with the longitudinal axis of the rod 60. This means then that, should the anchor strike an obstruction, as the rock 78, it may move slightly with respect to the driving rod 60 so as to find the easiest path around the obstruction thereby minimizing danger of breakage of the anchor. It should be noted also that there is a space between the plate 68 and the beveled end 62 of the driving rod 60. This space provides a relief opening for dirt or small stones which pass through the noncircular opening 76 between the plate 68 and the driver guide 32 during the embedding operation. After the ground anchor has been driven into the substratum 14 to a desired depth, the driving tool may be withdrawn by simply pulling on its upper end.

Referring now to FIGS. 5 through 8, the details of construction and operation of a preferred embodiment of the clamp 18 particularly suited for use in my anchoring system is shown. As illustrated, the clamp is adapted to be used with a wire guy, but as will be shown hereinafter, the clamp may be easily modified for use with a cable guy. The clamp 18 consists of a pair of opposing clamping jaws 80, 82 oriented with respect to each other by a pair of complementary cover plates 86, 88 and linked by a threaded stud 90 and a nut 92 as shown in FIG. 8. The faces of the clamping jaws 80, 82 are crowned, again as shown in FIG. 8, and the stud 90 is disposed adjacent the base 94 of the clamping jaws 80, 82. A rounded depression 96 is centrally formed in each of the complementary cover plates 86, 88 and the clamping jaws 80, 82 to accommodate the catenary line 12 during use. The complementary cover plates 86, 88 are folded so as to form walls 98, 100 having a number of extensions, as for example extensions 99, 101, to match a corresponding number of cooperating depressions in the opposite cover element to prevent the two cover plates 86, 88 and the clamping jaws 80, 82 from rotating with respect to each other. The stud 90 passes through the cover plates 86, 88 and the jaws 80, 82 being led through aligned openings in each of the elements. The sizes of the aligned openings are not critical to the invention, it being sufficient only that they be somewhat larger than the diameter of the stud 90.

During operation, the clamp is placed over the catenary line 12 with the depression 96 resting on top of the catenary line. The free ends of the wire 48 to be clamped are passed through the base of the clamp, one free end lying on one side of the catenary line 12 and the other free end lying on the opposite side of the catenary line 12. Upon entering the clamp, the leads are passed on different sides of the stud 90, crossed, and let out of the clamp on different sides of the extensions 99, 101. When the screw 92 is made hand-tight and tension is applied to the wire 48 in the direction shown by the arrows in FIG. 6, the wire moves slightly in the direction of the arrows, frictionally engaging the surfaces of the jaws 80, 82. This frictional engagement causes the jaws 80, 82 to rock slightly on the stud 90, bringing the opposing faces of the jaws together adjacent the base of the clamp as shown in FIG. 8. At the same time, each of the free ends of the wire 48 bears upon one side of the stud 90 and one of the extensions 99, 101, thereby maintaining the overlap of the free ends of the wire 48 in the clamp, even though the wire 48 slides a short distance within the clamp. As the rocking motion of the jaws 80, 82 continues, the frictional engagement between the wire and the faces of the jaws 80, 82 increases and the cross-over point between the free ends of the wire moves toward the stud 90 until the wire is jammed in the clamp. The advantages attained by crowning the faces of the jaws 80, 82 may now be seen. Obviously, the minimum spacing between the faces of the clamping jaws 80, 82 is dependent upon the thickness of the wire therebetween. At the cross-over point of the free ends of the wire, this minimum spacing is equal to twice the thickness of the wire, if there is no deformation of the wire, while at other points within the clamp the minimum spacing is less, approaching the thickness of the wire as a limit (again, if there is no deformation of the wire). If the faces of the clamping jaws 80, 82 are uncrowned, that is, if the faces are flat, there would be a tendency for holding engagement between the wire and the clamping jaws to be restricted to the area of the clamping jaws adjacent the base of the clamp, or at the very edge of such base. This latter condition, when it exists, is not desirable in that the wires may be held only when the jaws of the clamp dig into the wire. On the other hand, when the faces of the jaws are crowned, the holding engagement between the jaws and the wire is maintained over a relatively long length of the wire, thus ensuring a more secure clamping action without danger of deforming the wire. As a matter of fact, I have found that, the faces of the clamping jaws are crowned, a 2" clamp (that is, a clamp having clamping jaw faces 2" wide) may withstand more than 2,000 pounds tension on a guy without slippage or damage to the guy.

If it is desired to clamp cables rather than wires, the illustrated clamp may easily be adapted to such a purpose as previously mentioned. Thus the jaws 80, 82 may be reversed within the clamp so that two serrated surfaces 102, 104 are oppositely disposed. During operation, a cable is inserted in the clamp in exactly the same manner as previously described and tension is applied to the leads of the cable. The clamp itself operates in basically the same manner as when a wire is to be held, except that the serrations 102, 104 provide additional frictional forces between the cable and the jaws 80, 82 so that the relatively rough surface of the cable may be firmly held.

There are modifications to my clamp which may be made without departing from the original concepts thereof. For example, the cover plates 86, 88 may be dispensed with, their function being assumed by forming a noncircular hole through the clamping jaws 80, 82 to receive a stud 90 having a noncircular section. Thus, when the screw 92 is taken up, the clamping jaws 80, 82 are prevented from rotating with respect to each other. Another obvious modification to the invention is to provide separate clamping jaws for holding wire and cable rather than the reversible clamping jaws illustrated.

Having thus described and disclosed a preferred embodiment of my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. A ground anchoring system to secure a portable structure to a substratum, comprising, a line affixed to the outside of said portable structure at a plurality of equally spaced points initially to form a plurality of catenary sections of line depending from said portable structure, a similar plurality of guy assemblies, a separate one of said guy assemblies cooperating with a separate one of said catenary sections of line, each said separate one of said guy assemblies consisting of a clamp having opposed convex guy wedging and clamping surfaces, a guy, and a ground anchor, said ground anchor being embedded in said substratum, said guy being looped around said ground anchor to form a first and a second lead of said

guy, said first and said second lead running from said ground anchor through said substratum to said clamp, the free ends of said first and said second lead extending beyond said clamp, the points of contact between said clamp and said first and second leads being adjustable along the length thereof, said first and said second lead being frictionally engaged in said clamp, a separate clamp of each said plurality of guy assemblies being disposed on a separate one of said catenary sections whereby the tension on each said guy assembly may be equalized by adjusting the points of contact between each said clamp and the leads of said guy corresponding thereto.

2. A variable tension adjustable ground anchoring system adapted to secure a portable structure to a substratum, said system including, a peripheral line secured to the exterior of said structure, having a plurality of circumferentially spaced dependent caternary sections, clamping means removably attached to each of said caternary sections, doubled stranded guy members having one end formed into looped engagement with ground anchors embedded in the substrata, said guy members passing in crossed relationship to each other through said clamp having the free ends disposed on either side of said caternary section, said guy members being retained in frictional engagement between opposed convex guy wedging and clamping surfaces of said clamp and the points of contact therewith adjustable along the length thereof whereby uniformity of tension may be maintained on each of said guy members.

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