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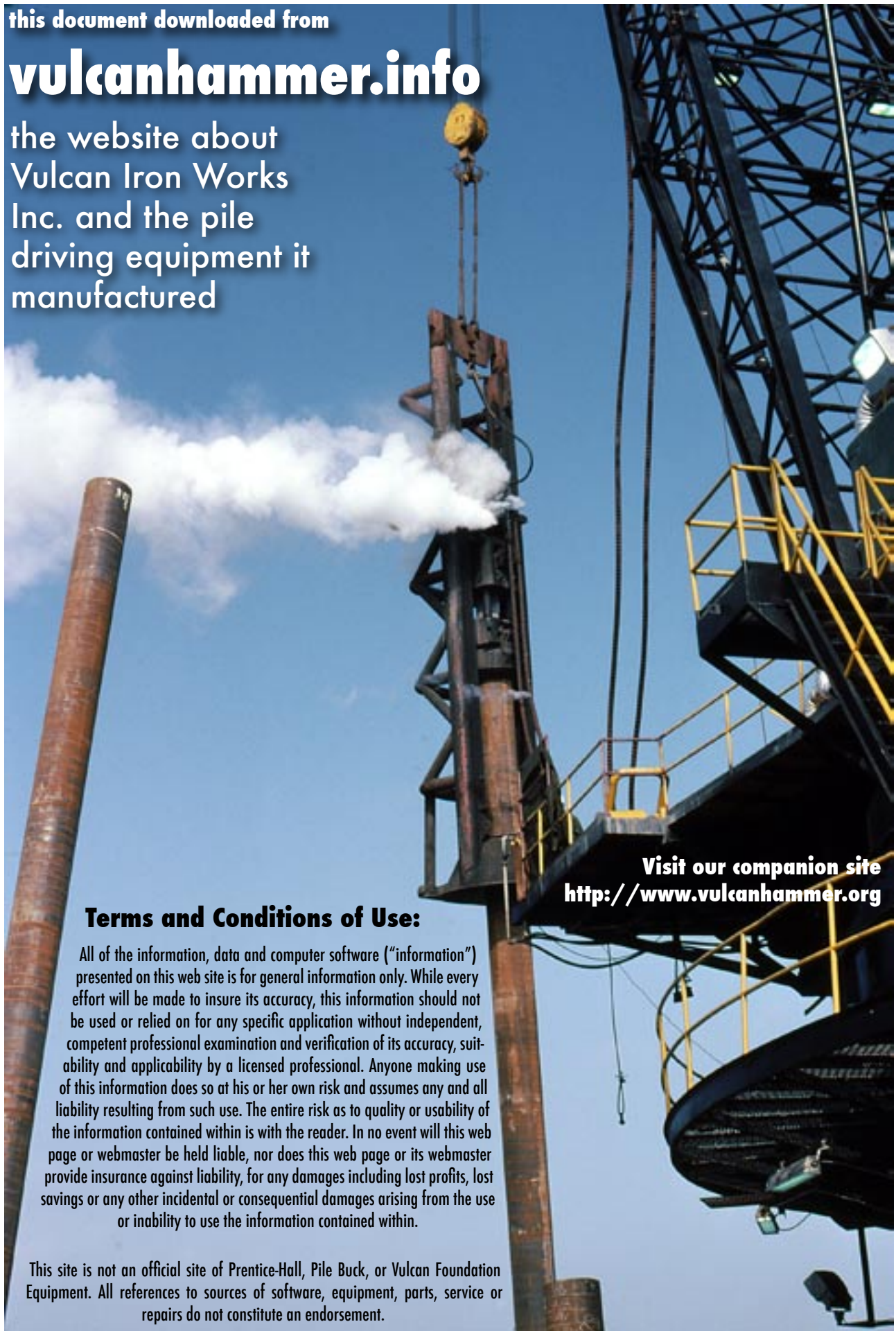
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- [54] VIBRATORY HAMMER/EXTRACTOR
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- [52] U.S. Cl. .... 173/49; 173/162.1
- [58] Field of Search ..... 173/49, 162.1; 175/55,  
175/56; 74/61

- [56] **References Cited**  
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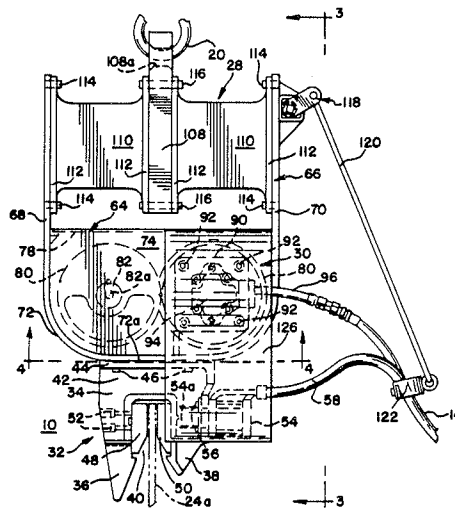
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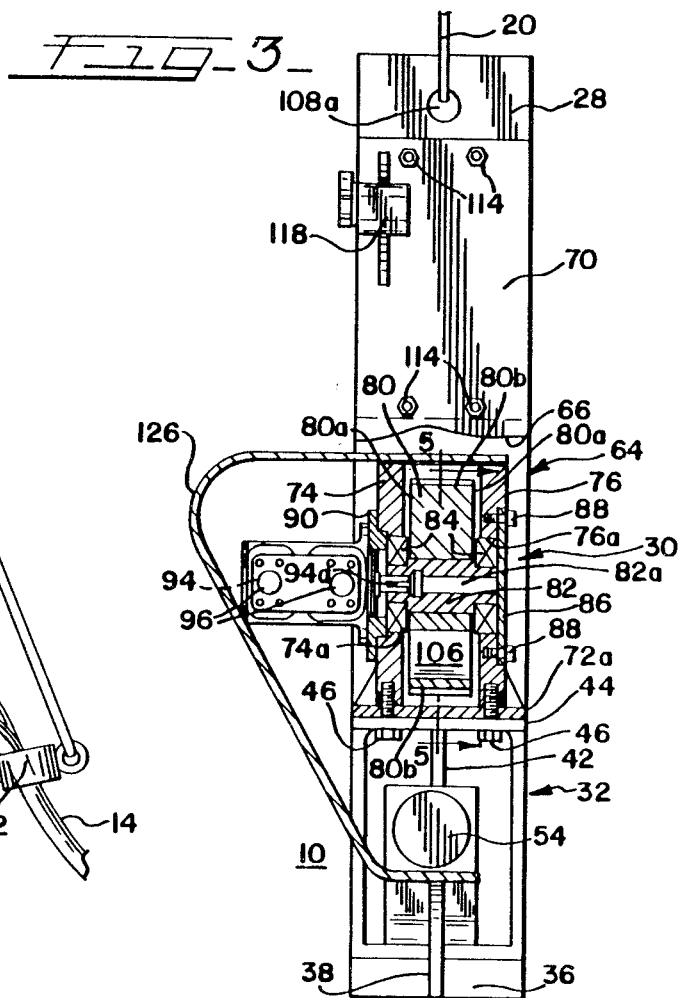
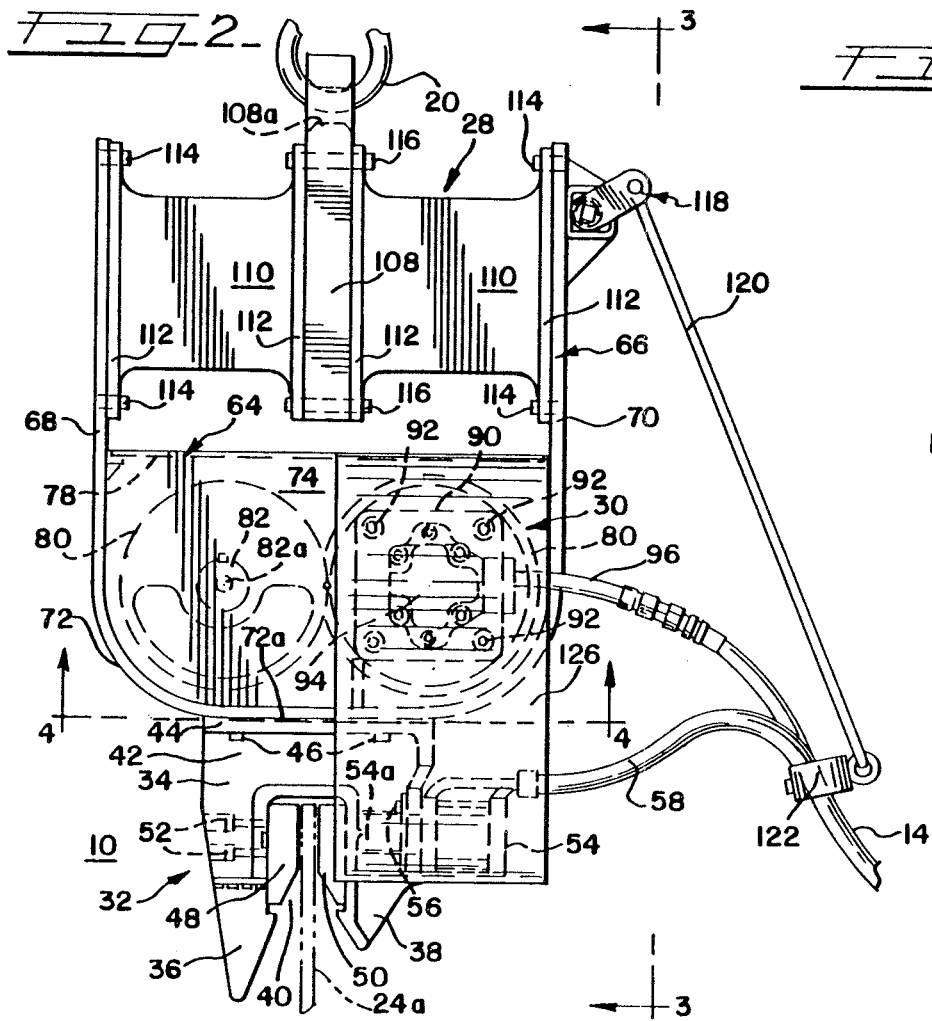
[57] **ABSTRACT**

A vibratory hammer/extractor for use with elongated pilings and the like extended into the earth includes a clamping assembly for releasing and securing the hammer to an upper end portion of a piling extended into the ground. A vibratory exciter is mounted on the

clamping assembly for generating vibratory forces to be imparted to the piling while clamped tightly, and a suspension device is provided for supporting the exciter and isolating the vibration thereof from a hammer supporting element such as a flexible cable extending downwardly from the boom of a crane. The vibratory exciter includes a hollow gear case having a lower end wall secured to the clamping assembly and at least one pair of eccentric weights mounted on shafts for rotation about an axis transversely of the clamped piling for imparting vibratory forces to the piling as the eccentrics are driven in rotation. Each eccentric comprises a unitary body of dense material such as steel plate having a generally circular periphery and coaxially mounted to rotate with a supporting shaft. Each eccentric body is formed with an enlarged opening or slot on one side of the shaft between a central shaft hub and an outer rim adjacent the periphery. The removal of material to form the slot creates an eccentric center of gravity on the opposite side of the shaft away from the slot. The exciter includes a rotary power unit such as a hydraulic motor mounted on the gear case for rotating a drive shaft carrying one of the eccentrics and the other eccentric is driven by intermeshing toothed engagement with the one eccentric to rotate in an opposite direction.

16 Claims, 3 Drawing Sheets





## VIBRATORY HAMMER/EXTRACTOR

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a new and improved vibratory hammer/extractor for use with elongated pilings and the like which are extended into the earth. More particularly, the invention relates to a vibratory exciter which is mounted on a clamping assembly for generating vibrating forces to be imparted to a piling member while clamped by the assembly and extended into the earth. In theory, vibratory-type hammer/extractors are used for driving or extracting elongated piling members by vibratory forces imparted to the upper portion. These forces are transmitted down the piling into the surrounding earth and the piling can then move downwardly under the weight of the piling and the hammer without requiring an impact blow from a dropping hammer element.

#### 2. Field of the Prior Art

Vibratory-type hammer/extractors have been utilized for driving and extracting elongated pilings, shoring members, etc., and these hammer/extractors differ from conventional impact type devices in that vibratory forces are applied to an upper end portion of the piling which is then able to move up or down in the earth because of the vibrating action imparted to the earth itself surrounding the piling. Such vibratory hammer/extractors are much more desirable for use in congested areas because spike like shock wave patterns are greatly reduced and high level noises are minimized.

### OBJECTS OF THE INVENTION

It is an object of the invention to provide a new and improved vibratory hammer/extractor of the character described and more particularly one which employs a novel vibratory exciter mounted between a clamping assembly and a suspension device thereof.

More particularly, an object of the invention is to provide a new and improved vibratory hammer/extractor which employs a novel vibratory exciter mechanism having at least one pair of gear like eccentrics mounted for rotation within a hollow case so as to generate a selectively controllable amount of vibratory action that is transmitted to an upper end portion of a piling to which the hammer/extractor is clamped.

Yet another object of the present invention is to provide a new and improved vibratory hammer/extractor of the character described which has a simplified construction and thus enables the hammer to achieve improved performance in the coupling of vibratory energy to an elongated piling in the earth.

Yet another object of the present invention is to provide a new and improved vibratory hammer/extractor wherein at least one of a pair of rotary eccentrics in the vibratory exciter is formed from a unitary piece of heavy material such as steel plate having an eccentric center of gravity that is found by the removal of material on one side of a rotary shaft supporting the eccentric.

Another object of the invention is to provide a new and improved vibratory hammer/extractor which does not require the use of a separate eccentric weights mounted on a rotating member carried by a shaft.

Still another object of the present invention is to provide a new and improved vibratory exciter of the character described having a relatively lightweight

enclosure or casing surrounding a pair of rotary eccentrics thus providing a lower weight overall so that vibratory energy produced as the eccentrics rotate is more efficiently coupled to the piling to be driven or extracted.

Yet another object of the present invention is to provide a new and improved vibratory hammer/extractor employing an exciter having a plurality of intermeshing rotatively driven eccentrics carried in an enclosed hollow casing and rotatable at a selected speed to impart the desired amount of vibratory force to a piling clamped thereto.

Another object of the present invention is to provide a new and improved vibratory hammer/extractor of the character described which is simple of construction, foolproof in operation and especially effective and efficient in transferring or coupling of vibratory energy to a piling member clamped thereby for driving or extracting the piling to or from the earth.

### BRIEF SUMMARY OF THE INVENTION

In accordance with the present invention, a new and improved vibratory hammer/extractor is provided for use with elongated pilings and the like extending into the earth. The hammer/extractor includes a lower clamping assembly operable for releasing and securing the hammer to an upper end portion of the piling for driving or extracting the same to or from the earth. A vibratory exciter is attached to the clamping assembly for generating vibratory forces of a controlled nature which are imparted to the piling. A suspension and isolation device is provided for supporting the exciter, clamping assembly and the piling in a manner so as to isolate the vibration thereof from a hammer supporting element such as an elongated flexible cable or the like extending downwardly from the boom of a crane. The novel exciter of the vibratory hammer/extractor includes a relatively light in weight, hollow gear case having a lower end wall secured directly to the clamping assembly and the case contains at least one pair of rotating intermeshing eccentrics carried on shafts mounted in the case for rotation about axes extending transversely of a clamped piling. Each eccentric comprises a unitary body of dense material such as steel plate having a generally circular periphery and a hub coaxially mounted on a supporting shaft. The body of each eccentric is formed with a slot on one side of the shaft between the hub and an outer rim portion adjacent the periphery. The removal of body material to form the slot creates an eccentric center of gravity on an opposite side of the shaft away from the slot so that when the shaft is rotated, vibrating forces are generated and coupled to the piling with a minimum of dampening effect. The exciter is provided with a power unit such as a hydraulically powered motor mounted on the case for direct coupling to one of the shafts.

### BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, reference should be had to the following detailed drawings taken in conjunction with the drawings, in which:

FIG. 1 is an elevational view of a new and improved vibratory hammer/extractor constructed in accordance with the features of the present invention;

FIG. 2 is an enlarged side elevational view of the vibratory hammer/extractor;

In accordance with an important feature of the present invention, the hollow gear case 64 is dimensioned to accommodate a pair of horizontally spaced apart rotary eccentrics 80 which are driven by a single hydraulic motor 94. The eccentrics are continuously bathed in a supply of lubricating oil or grease contained within the interior of the case 64. Each eccentric is formed out of a relatively thick, unitary, heavy piece of steel plate and is of a generally cylindrical shape having flat, parallel, opposite sides 80a and a cylindrical ring of teeth 80b provided around the periphery of the cylinder. The teeth of the eccentrics are continuously intermeshing to rotate the eccentrics in opposite directions as indicated by the arrows in FIG. 5.

Each cylindrical eccentric includes an outer rim portion 80c supporting and adjacent to the peripheral ring of teeth and an annular, inner rim or hub 80d keyed to the shaft 82 by means of a key 104. As illustrated in FIG. 3, the opposite side faces 80a of each eccentric 80 are spaced only a short distance away from the adjacent inside surfaces of the side plates 74 and 76 so that the rotary eccentric weights 80 occupy a majority of the internal volume provided within the gear case 64.

In accordance with the present invention, the eccentricity of each rotating member 80 is provided by forming a large slotted out segment 106 or bean-shaped hollow space between the hub and rim on one side of a diametrical radial line extending outwardly from the central shaft 82. The slots 106 are formed by cutting completely through the thickness of the eccentrics 80 from one side face 80a to an opposite side face 80a, and the removal of the material in forming the slot shifts the center of gravity of the rotating body 80 to an opposite side of the central shaft or center line. The amount of material removed determines the amount of the "eccentric moment" that is provided, and when an eccentric 80 is then rotated, a sinusoidal vibrating force is developed and is coupled to the upper end portion of a clamped piling web 24a. The vibratory forces developed by the rotating eccentric 80 are transferred to the piling 24 through the shafts 82, the heavy duty ring bearings 84 and the bottom wall 72a and side plates 74 and 76 of the gear case 64 attached to the clamping assembly 32.

Because of the relatively large thickness of the side plates 74 and 76, the cap screws 46 which hold the lower clamping assembly 32 in place are extended directly upwardly into threaded apertures provided in the side plates and this results in a firm and secure connection between the case 64 of the exciter 30 and the clamping assembly 32 which is capable of withstanding and transmitting a high value of vibratory force input from the eccentrics 80 to the piling 24. The amount of the eccentric moment provided by a rotating eccentric 80 may be reduced by reducing the slot size of the open slot 106 that is cut from the body of material when fabricating the eccentric. If a greater value of vibratory force is desired, in addition to a single pair of eccentrics as illustrated, additional pairs of eccentrics can be provided spaced upwardly in an upwardly enlarged gear case 64. These additional pairs of eccentrics are drivingly intermeshed with the gear teeth 80b of the lower pair of eccentrics 80. It will also be seen from FIG. 3 that the intermeshing gear teeth 80b extend across substantially the entire width of the interior of the gear case 64 between the faces 80a of the eccentrics 80 to provide a maximum length of driving contact between the teeth

of the intermeshing eccentrics 80. This results in a lower tooth loading and longer gear life.

#### Isolation Support Assembly

In accordance with the present invention, the new and improved vibratory hammer/extractor 10 includes an isolation support assembly 28 for isolating the vibrations generated by the rotating eccentrics 80 from the flexible cable 20 or other supporting device used for supporting the hammer/extractor. The isolation support assembly includes a relatively heavy central support leg 108 formed from a thick heavy metal plate and provided with a circular aperture 108a in an upwardly extending tang portion to accommodate a cable loop of the support cable 20 which is passed through the opening 108a thereby to support the combined weight of the hammer/extractor 10 and the piling 24 clamped thereto when necessary.

The central support element 108 is interconnected to the upstanding leg portions 68 and 70 of the gear case 64 of the vibratory exciter 30 by a pair of shock mount elements 110 or shear fenders, each having a large rectangular body of resilient material such as rubber or synthetic rubber with opposite vertical faces vulcanized or otherwise adhesively secured to metal mounting plates 112. These plates are generally rectangular in shape and are larger than the main body cross-section of the resilient rubber body portion of the shear fenders. The outermost rectangular mounting plates 112 are secured to the inside surfaces of the respective upstanding legs 68 and 70 by cap screws 114 and through bolts 116 are provided to secure the inside mounting plates 112 to the opposite sides of the central element 108. The body of resilient material in each shock mount 110 is operative to dampen force vibrations which would otherwise be transmitted to the cable 20 from the vibratory exciter 30 during rotation of the eccentrics 80 and accordingly, this vibratory energy is available for transmission through the clamping assembly 32 to the piling or shoring element 24 clamped thereby.

As illustrated in FIG. 3, in order to prevent inadvertent disconnection of the hydraulic or electrical lines from the bundle of lines 14 and the operating components of the vibratory hammer/extractor 10 when the hammer is moved or during operation, there is provided a support bracket assembly 118 mounted on the upstanding leg 70 of the U-shaped case member 66. A pivot rod 120 is interconnected to the lever arm of the bracket assembly for supporting a collar 122 at the lower end. The bundle of lines 14 passes through the collar and is restrained thereby. In addition, the motor guard element of relatively heavy plate material 126 protects and partially encloses the hydraulic motor 94 and its supply lines during manipulation of the vibrator hammer/extractor 10 and while the hammer is in operation.

Although the present invention has been described in connection with details of the preferred embodiment, many alterations and modifications may be made without departing from the invention. Accordingly, it is intended that all such alterations and modifications be considered within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A vibratory hammer/extractor for use with elongated pilings and the like, extended into the earth comprising:

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14. The vibratory hammer/extractor of claim 13,  
wherein:  
said top wall extends between said facing inside sur-  
faces of said upper end portion of said U-shaped  
wall member at a level below the upper ends 5  
thereof.  
15. The vibratory hammer/extractor of claim 14,

wherein: said top wall is joined to upper ends of said  
side plates.

16. The vibratory hammer/extractor of claim 15,  
wherein said spaced apart shafts of said eccentrics are  
disposed below said support element and away from  
said opposite faces thereof.

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