United States Patent

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[54] **HYDRAULIC VIBRATORY COMPACTER**
7 Claims, 2 Drawing Figs.

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[50] Field of Search 94/48

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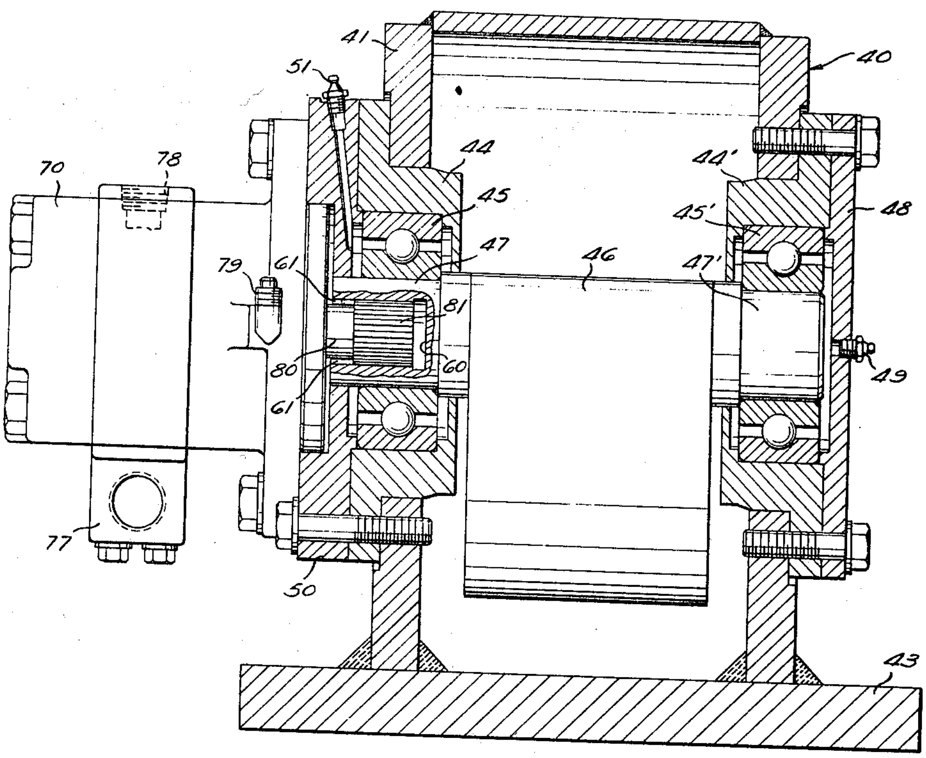
ABSTRACT: Heavy duty vehicle supported soil compacter in which an eccentrically rotated weight is directly driven through a mechanical coupling allowing backlash by a hydraulic motor, thereby permitting high ratio of eccentric weight to total sprung weight, total enclosure of all bearings without use of dust seals, and more efficient utilization of the vehicle's hydraulic system.



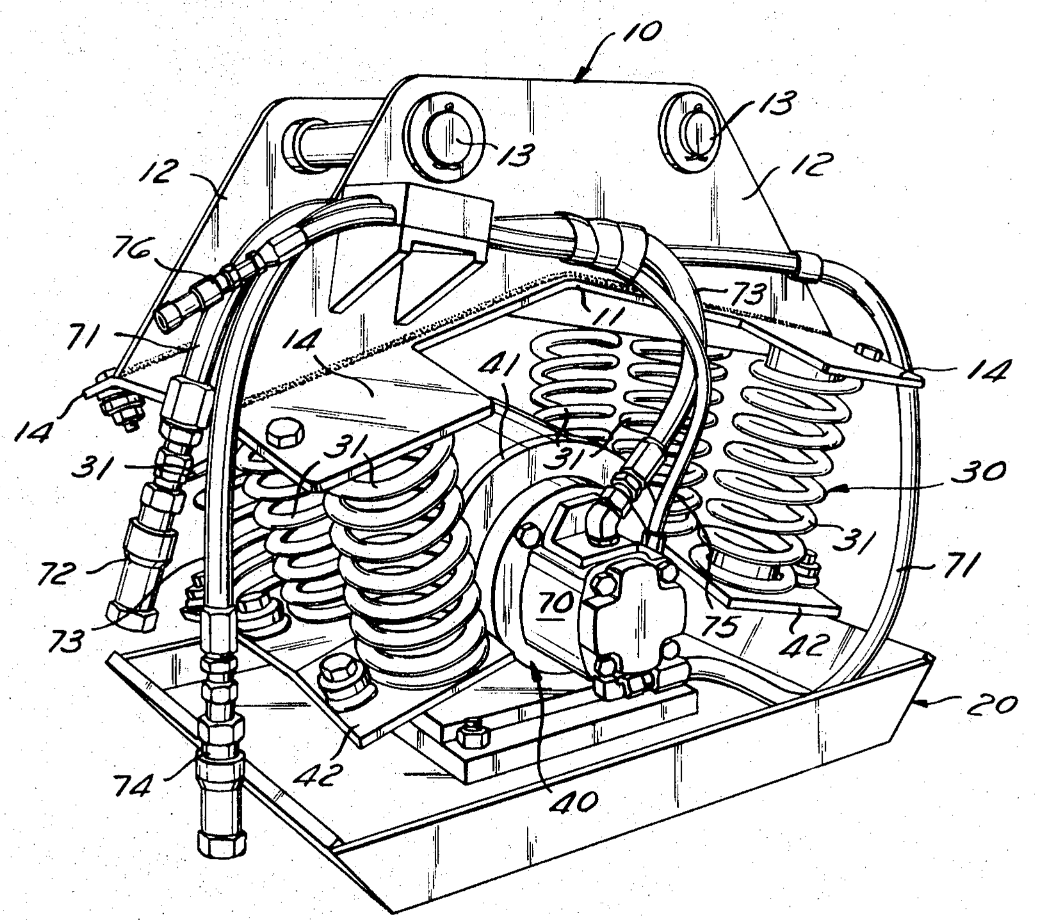


Fig. 1

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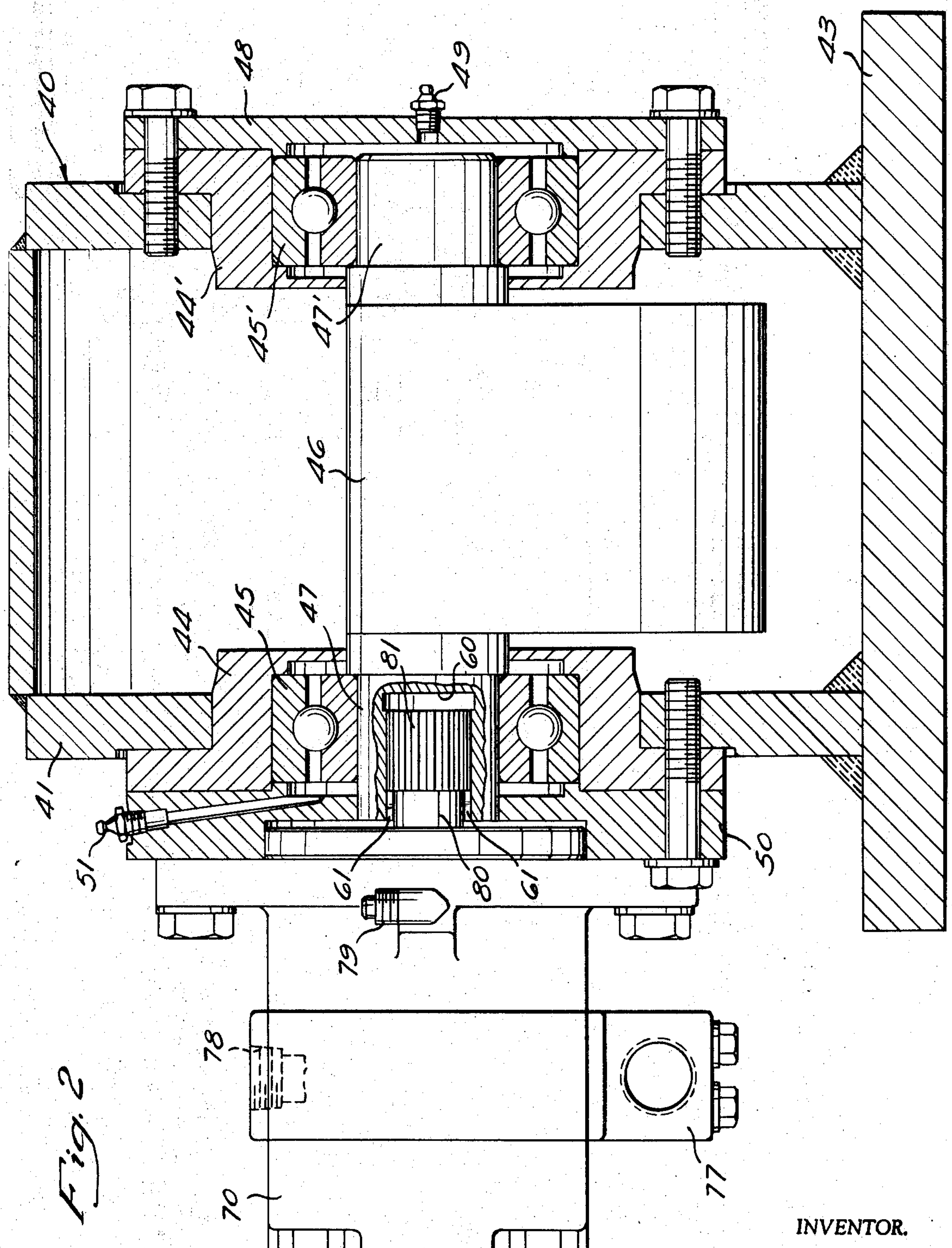

Fig. 2

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HYDRAULIC VIBRATORY COMPACTER

This invention relates to heavy duty, vehicle-boom supported and steered soil compacters. They are particularly adaptable for mounting in a steerable convergent-spring suspension of the type disclosed in the copending application of Joseph A. Braff and Richard A. Fox, Ser. No. 486,968, filed Sept. 13, 1965, now U. S. Pat. No. 3,427,939, whereby they may be advantageously used for more rapidly compacting soil in confined areas (such as in trenches, around building foundations, and the like) as well as in relatively open areas which may be relatively level and/or inclined, as for the foundations, fills, and steep embankments encountered in road building.

Prior to the present invention, it has long been desirable to increase the speed and effectiveness of soil compaction by large units too heavy to be manipulated manually; accordingly, such large and heavy units were supported and steered from booms mounted on tractors, back-hoes, and like vehicles used in operations such as road-building and earthmoving and excavation backfilling. Unfortunately, such soil compactors heretofore were subject to self-limitations, whereby, even for vehicle supported and steered units, further increases in the size of the eccentric weight by which the unit was vibrated to compact the soil, and thus the work which could be performed on the soil, were subject to laws of diminishing returns. That is, due to several factors, the efficiency and flexibility of utilization of the units, beyond an optimum size for each design of unit, decreased as its physical size increased. For example, as the physical size of the unit increased, the power required for the usually employed electrical motors by which the vibratory weight was driven could overtax the generators which could be efficiently supplied, from the point of view of cost, with the vehicles. An increase in the size and weight of such electrical motors, in order to power larger units also adversely decreased the ratio of the eccentric weight to the overall sprung weight of the unit. Likewise, the conventional belt or chain drive by which the eccentric weight has been conventionally driven required increasingly frequent inspection and maintenance in enlarged units. Such inspection and maintenance heretofore required the opening of the housing for the motor and weight and, thus, exposed the contact-type dust seals required for their bearings. Still further, mere increase in physical size of a compacter unit to increase the amount of work it could perform on the soil could exclude its use for compacting soil in confined spaces, such as in the backfilling of soil in trenches and excavation remaining around subsurface building foundations.

This present invention minimizes the above problems of the prior art whereby, for a soil-compacting unit of a given physical size, a greater eccentric weight may be driven and, thus, a greater amount of work may be performed in a given period of time on the soil being compacted.

Another object and advantage of this invention is that it employs a hydraulic motor whereby the unit may be powered by the hydraulic pump customarily constituting the hydraulic power supply required by the vehicle for operating its boom and other accessories; not only is no separate electrical power supply required but the capacity of such available sources of hydraulic power momentarily required by the vehicle for operating its other accessories has, consequently, heretofore been relatively inefficiently utilized. Thus, when also employed for a unit made according to this invention, such a hydraulic power supply is thereby more efficiently used due to its more constant use and, furthermore, the capacity of such conventional hydraulic power supply is usually fully adequate to meet the requirement of the more powerful, heavy-duty compacting units achieved according to this invention.

Another object and advantage of this invention is that its eccentric weight is directly driven through a mechanical coupling, thereby eliminating the relatively frequent inspection and maintenance required by belt and chain drive units and the attendant opening of the housing therefor. Thus, the bearings located within the housing may be used without conventional dust seals, thereby eliminating the initial cost and the expense and downtime attributable to the maintenance inspection and replacement, when necessary, of such seals.

A still further object of this invention is that its use is not necessarily confined to soil compaction; it is also highly adaptable to two other uses each of which heretofore required totally different equipment, namely pile driving and pile removal.

Other objects and advantages of this invention will be apparent from the following specification, claims and drawings, in which:

FIG. **1** is a perspective view of a soil compacter made according to this invention; and

FIG. **2** is a vertical cross section through the vibratory drive employed in the unit shown in FIG. **1**.

The unit as shown in FIG. **1** is ready for attachment to the boom and control rod of a suitable vehicle, such as the "dipstick" of a back-hoe, and for connection of the unit's flexible hydraulic lines to flexible lines running to the vehicle. As such it comprises a head or mounting bracket **10** from which a compacting shoe **20** is connected by a spring assembly **30** to flange plates **42** on the housing **41** of a hydraulically driven vibratory drive **40** bolted or otherwise directly connected to the shoe **20**, whereby the overall sprung portion of the unit is comprised of the shoe **20** and the vibratory drive **40** and its appurtenances.

The top mounting bracket **10** is comprised of an angular plate **11** having spaced upstanding longitudinal webs **12** between which extend the heavy pins **13** by which the unit may be connected to the conventional boom and extensible control rod of a back-hoe or tractor. The unit is positioned and relatively static pressure is applied thereto by coaction of the boom and control rod; depending upon the relative length of the control rod (usually actuated by a hydraulic cylinder) with respect to the boom, the relative angle of the shoe to the soil being compacted may be controlled.

As shown, the spring assembly **30** is comprised of two sets of three heavy springs **31**, each set being connected between an outer end of the angular bracket plate **11** and a corresponding fore and aft flange plate **42**. It is to be noted that each end of the bracket plate is essentially T-shaped to provide ears **14** which, so as to correspond with the outer marginal portions of the flange plates, are bent inwardly as well as downwardly so that all springs **31** in each set are downwardly convergent in a fore and aft direction and the outer springs in each set are also downwardly and inwardly convergent. In accordance with the teaching of the above Braff et al. patent, the centers of effort of the lower ends of these convergently mounted springs **31** lie in a plane which is substantially parallel to the bottom of the compacting shoe **20** and which also passes through the axis of rotation of the eccentrically mounted weight in the vibratory unit **40**. This springing arrangement not only allows a substantial static load to be put on the bracket **10** by the "dipstick" while the vibratory unit is being driven, but at the same time, also allows the unit to be steered and positioned under such pressure, all without causing the sprung portion of the unit to "popout" from beneath the mounting bracket **10**.

As also shown in FIG. **1**, the housing **41** carries a compact hydraulic motor **70**, which is preferably of stock "off-the-shelf" construction, selected to have an adequate power capacity to drive the vibratory unit at the operating pressure available for the hydraulic power supply on the vehicle on which the unit is mounted. Although but one hydraulic motor is shown in the disclosed embodiment and, thus, is carried at one end of the vibratory unit **40**, it is to be understood that two motors **70** may be mounted at each end of the unit **40**. A flexible input line **71**, provided with a suitable fluid coupling **72**, and a flexible exhaust line **73**, provided with a suitable coupling **74**, are connected to the motor **70** to connect it to the available hydraulic power supply. The particular motor **70** shown in FIG. **1** is also provided with a motor drain line **75**, having its coupling **76**, for conducting leakage from the motor back to the power supply. If a stock motor having internal ducting leading the motor leakage into the exhaust line is employed, the line **75** is not, of course, employed. As shown, all flexible lines **71, 73,** and **75** are preferably harnessed together and held out of the way of the vibratory shoe **20** and the flexing springs of the assembly **30** during operation by means of a hose bracket **15** on the top bracket **10**.

As shown in FIG. 2, the housing **41** of the vibratory unit **40** is preferably of welded plate construction having a base plate **43** by which the unit is secured to the shoe **20**. The sides of the housing are bored concentrically to receive bearing retainer plates **44** and **44'** in which the eccentric weight bearings **45** and **45'** are received. The eccentric weight **46** is provided with integral offcenter shaft ends **47** and **47'**, the shaft end **47'** being mounted in the bearing **45'**, which, in turn, is retained in its retainer plate **44'** by means of a hub plate **48** bolted through the plate **44'** to the side of the housing **41**. This provides, through the machined mating surfaces of the side of the housing **41**, retainer plate **44'**, and hub plate **48**, a dusttight enclosure for the shaft end **47'**. The bearing **45'** is lubricated through a grease fitting **49** carried by the hub plate **48**.

The bearing **45**, in which the shaft end **47** is journaled is retained in its retainer plate **44** by means of the motor base plate **50**, on which the hydraulic motor **70** is mounted, the motor base plate **50** being bolted through the retainer plate **44** to its side of the housing **41**. This likewise provides, through the machined mating surfaces of the base of the motor **70**, the motor base plate **50**, bearing retainer plate **44**, and its side of the housing **41**, a dusttight enclosure for the shaft end **47**. The bearing **45** is lubricated by means of a grease fitting **51** on the motor base plate **50** and leading to its cavity for the bearing **45**.

The sealed hydraulic motor **70**, having a pressure line inlet fitting **77**, a tapped outlet opening **78** for the exhaust line **71**, and a fitting **79** for the motor drain line **75**, is provided with an output shaft **80** having external splines **81**. This splined shaft **80** is received in a socket **60** provided in the shaft end **47** and having internal splines **61**, whereby, through the mating splines **61** and **81**, a direct-drive mechanical coupling is provided between the motor **70** and eccentric weight **46**.

It has been found that for optimum trouble-free performance, it is desirable that the mechanical coupling between the motor **70** and weight **46**, allow ample backlash and play, both axially and rotationally. In the particular coupling provided by the splines **61** and **81**, this is obtained by allowing substantial clearance between them. This loose mechanical coupling not only allows for normal nonconcentricity in assembly but prevents preloading the internal bearings of the motor and the eccentric bearings **45** and **45'** due to such nonconcentric assembly and also due to the nonconcentric wear on the bearings which the eccentric weight **46** eventually causes as it is driven to vibrate the unit.

The unit as described is rugged and exceptionally compact for its vibratory power capacity. If employed as a pile-driver, the shoe **20** may be replaced by a suitable pile cap, though due to the ability of the unit as shown to withstand considerable offcenter loading on the shoe while substantial static load is imposed by the vehicle "dipstick," in practice the unit is usually employed for pile-driving without changing the shoe **20**. For pile extraction, the shoe **20** is replaced by a cap which may be bolted or otherwise secured to the head of the pile being removed and, instead of static pressure being applied, static tension is applied to the unit by lifting it with the vehicle's "dipstick." In soil compaction and pile-driving, the operator is made aware of the appropriate amount of static pressure to apply through the "bottoming" of the springs **31**, which cause the boom to vibrate when the springs are overloaded. In pile extraction, it is advisable to employ tension-limiting bolts extending between the ears **14** and flanges **42** so that similar warning shaking of the boom will occur if the unit is subjected to an excessive lifting tension as it is vibrated.

This invention is not limited to the specific embodiment disclosed but may be modified and altered by those skilled in the art without departing from the scope of the following claims.

I claim:

1. A unit for applying combined static and dynamic vibratory loads for soil compaction and for pile driving and extraction comprising a top bracket for connection to the boom of a vehicle whereby a relatively static load is applied, a spring assembly connecting the top bracket to a sprung portion comprising a vibrating unit and a member having a force-transmitting face, said member and vibrator unit being rigidly connected, said vibrating unit comprising a housing a hydraulic motor mounted thereon and an output shaft extending into said housing from said motor, a rotatable eccentric weight journaled in bearings carried by the walls of said housing, the axis of said weight and said shaft being in substantial alignment, and a loosely engaged mechanical coupling between said shaft and said weight whereby direct drive of said weight by said motor is obtained.

2. A unit as defined in claim **1** in which said bearings are sealed within said housing, said motor is sealed and including a motor-mounting plate having a close mechanical fit between the base of said motor and the side of the housing in which an adjacent bearing is mounted to provide a dusttight entrance of said shaft into said housing.

3. A unit as defined in claim **2**, including a hub plate over the end of the axis for said eccentric weight at an end which is nonadjacent said motor, a bearing retainer plate and a bearing mounted therein in which said end of the weight is journaled, and a close mechanical fit between said hub plate, said retainer plate, and the mating side of said housing whereby a dusttight closure of said bearing is obtained.

4. A unit as defined in claim **3** including a bearing retainer plate carrying said adjacent bearing and mounted with a close mechanical fit between said motor-mounting plate and the side of the housing in which said retainer plate is carried.

5. A unit as defined in claim **4** in which said eccentric weight is provided integral shaft ends mounted in said bearings and, except for movement in said mechanical coupling, the only movement of surfaces with respect to each other within said housing while said weight is rotated occurs within said bearings.

6. A unit as defined in claim **5** in which said top mounting bracket connects a spring assembly to external flanges extending at an angle to a plane parallel to the work face of said unit whereby said springs extend, downwardly and inwardly toward each other from said bracket.

7. A unit as defined in claim **6** in which said spring assembly is comprised of sets of springs containing more than two springs per set and the said flanges and the end portions of said bracket are angled to position the outboard springs in each set so that they extend downwardly and inwardly toward each other from said bracket.