April 6, 1965 H. J. SEAMAN 3,176,597

VIBRATORY COMPACTOR

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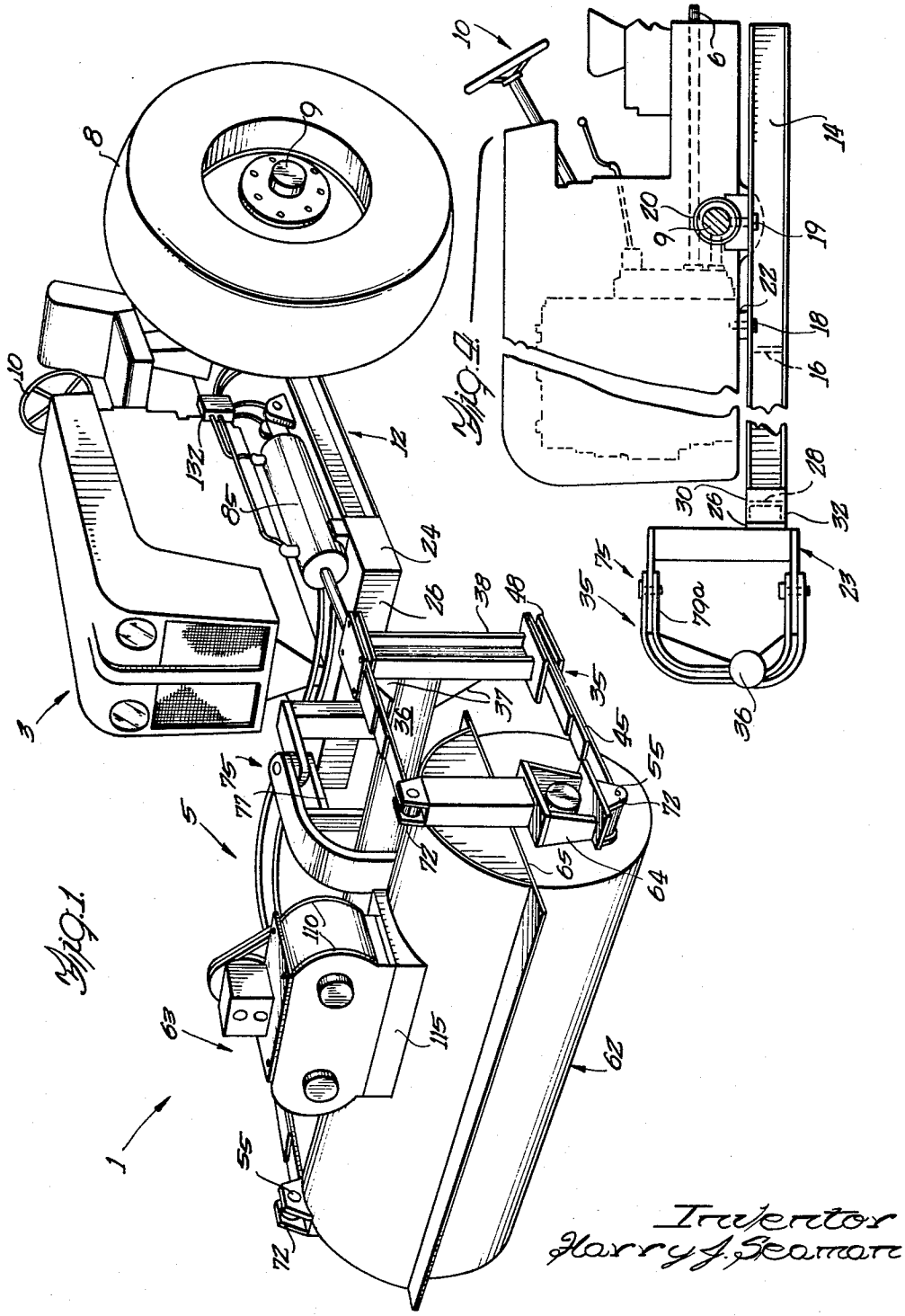


Fig. 1.

Fig. 2.

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Fig. 2.

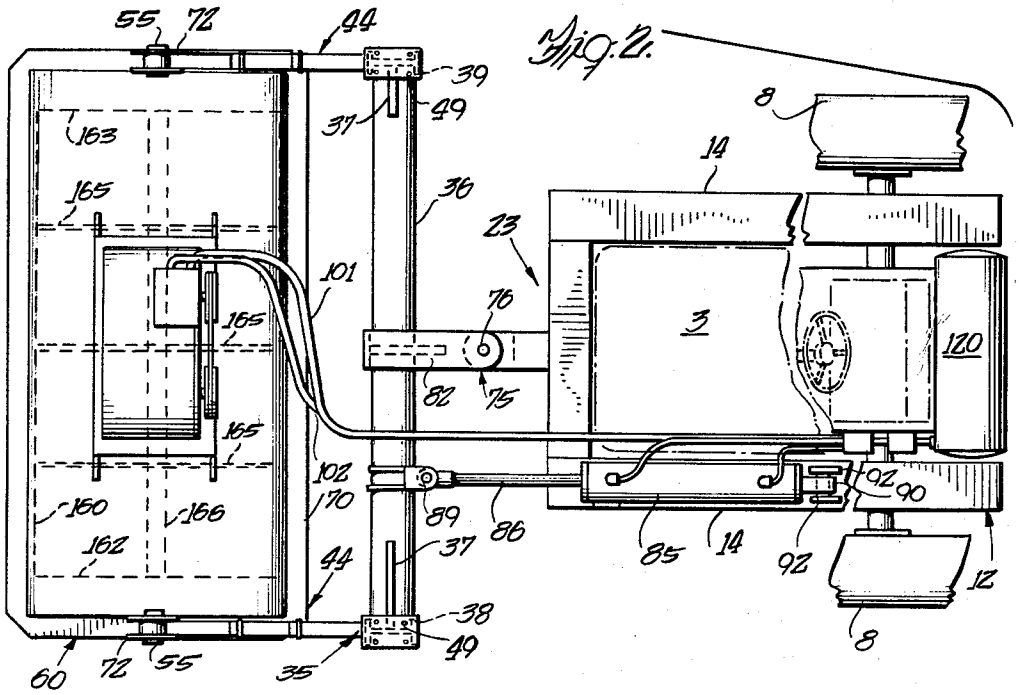
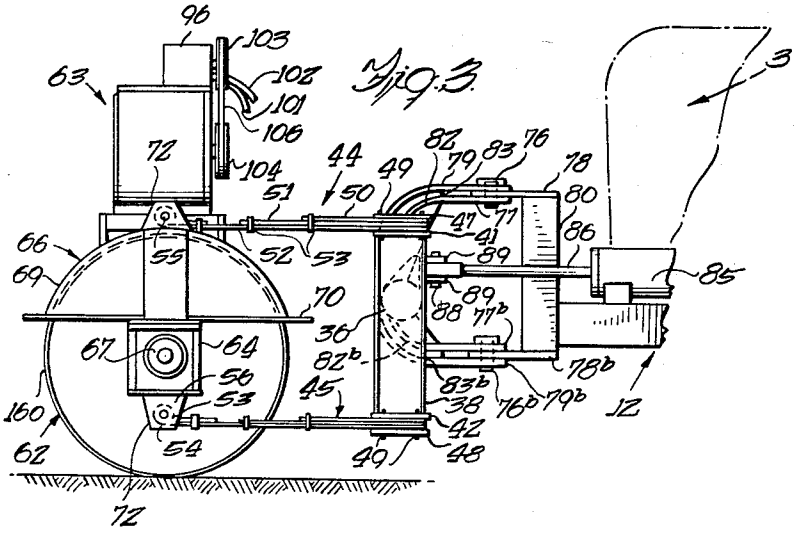


Fig. 3.



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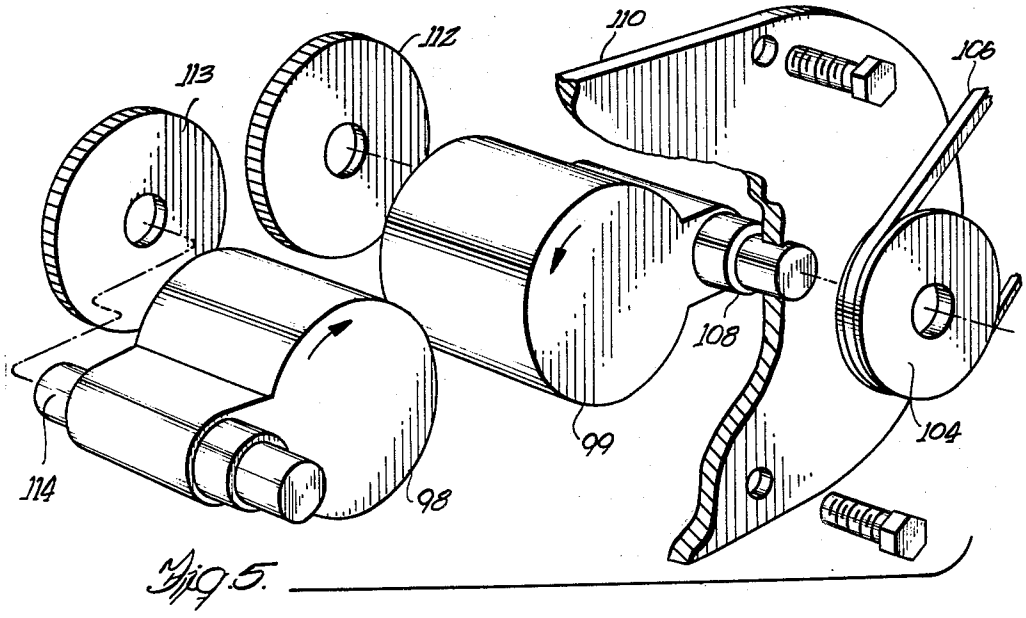


Fig. 5.

Fig. 6.

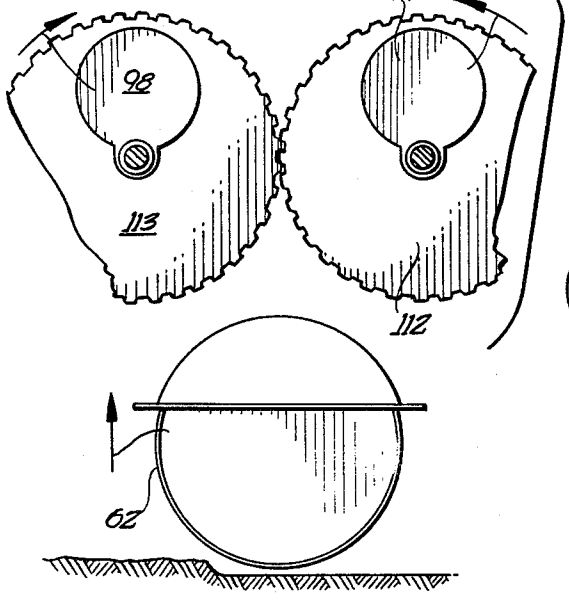
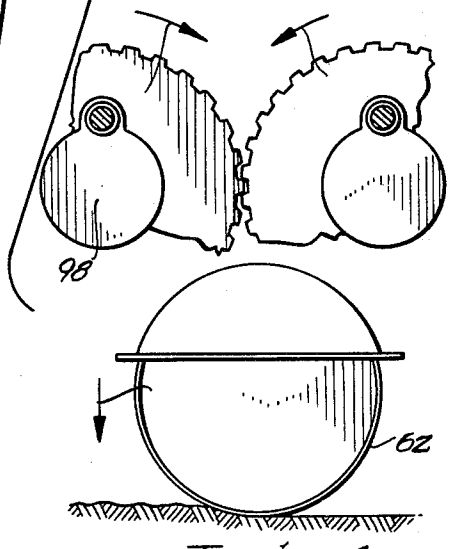


Fig. 7.



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Fig. 8.

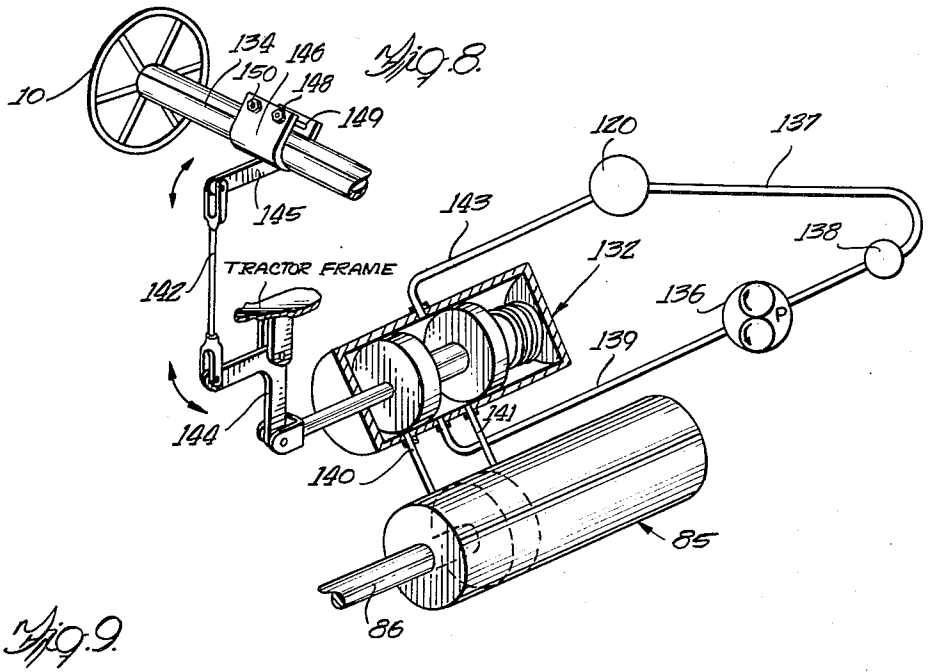


Fig. 9.

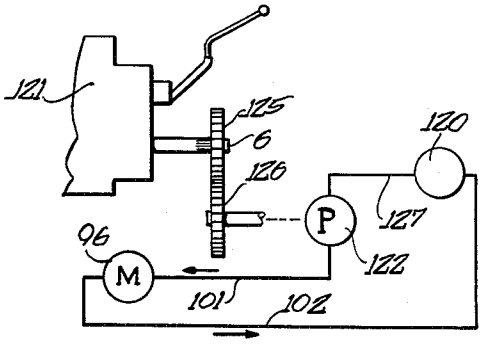
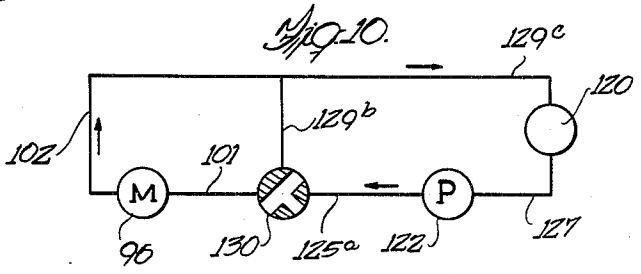


Fig. 10.



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VIBRATORY COMPACTOR

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Filed Oct. 27, 1960, Ser. No. 65,488
5 Claims. (Cl. 94—50)

This invention relates to a vibratory compactor or earth tamping mechanism. One aspect of the invention relates to a vibratory compactor for compacting earth and similar materials with a means that supports part of the tractor or prime mover with which it is associated. In another specific aspect the invention relates to a vibratory compactor that steers the prime mover with the same member that is used for compacting the earth.

The term "earth" as used herein includes various soils, sand, gravel, asphalt, asphalt cement and other compactible materials. It is known to tamp or compact earth by cyclically applying blows to a limited area. Manually positioned tools have been used for compacting in some instances. Other tools that have been provided have been attached to a tractor or other prime mover, ordinarily trailed by the prime mover or suspended therefrom. Frequently the suspended type of vibratory compactor is a special purpose machine and the prime mover for passing it over the earth is not available for other purposes than compacting.

Where large areas are to be compacted, manually positioned tools are inefficient and expensive. The manual tools are ordinarily considered as most effective in repairing or patching the wearing surface of roads, or in tamping in very close quarters such as immediately adjacent foundations, columns, and other structural members.

Where a vibratory compactor is trailed behind a tractor, a fairly large turning radius is required. This makes it difficult to maneuver the prime mover with its associated compactor in close quarters, for example, inside buildings, in underground structures, and similar areas. Additionally, the trailed compactor requires that the operator turn around from his normal position in order to be sure that the compactor is positioned at the place requiring compaction. The difficulty of accurate positioning is thus increased, as well as a safety hazard arising because the operator cannot look where the prime mover is going.

In one suspended type of vibratory compactor, the compactor is suspended between the front and the rear wheels of a prime mover or is mounted on a framework supported in an overhanging position at one end or the other. On occasion, due to differences in elevation between the front and rear wheels, the compactor is elevated sufficiently so that its fuel power is not applied to the earth. In such cases some means should be provided to adjust the length of the stroke in order to achieve effective compaction. In other instances, where the compactor overhangs the end of the machine, an extra-long machine is thereby created and requires a large turning radius with attendant problems in maneuvering within confined quarters. Additionally, the front wheels oftentimes precede the compactor over the area to be compacted and thereby produce uneven tamping, especially in highly compactible materials.

It is an object of the present invention to provide a vibratory compactor that forms a highly maneuverable combination when in association with a prime mover. An object is to provide a vibratory compactor of simple construction. A further object is the provision of a vibratory compactor that is removably connected to the prime mover. Another object is to provide a vibratory compactor that is mounted at the front end of the prime mover where the operator can view operations from his

normal position. It is also an object to provide a vibratory compactor where the vibrated member or tamping member also serves as a steering member for the prime mover associated with the vibratory compactor.

By way of example, in the preferred embodiment an ordinary four-wheeled tractor is employed as a prime mover. The front wheels of the tractor are removed and the vibratory compactor, according to the invention, is connected to the prime mover. An appropriate means is provided so that the cylinder for tamping and steering is positioned by the steering wheel of the tractor. Preferably, a hydraulic system to control the steering and the tamping is provided. The hydraulic pump is driven from the power take-off shaft that commonly extends out through the rear end of most commercially available tractors today.

The preferred embodiment of the invention provides a tamping member comprising a roller or cylinder that is resiliently mounted at the front end of a tractor for rolling contact with the earth. The weight of the tractor is partly supported by the roller. Appropriate vibrating mechanism, such as two unbalanced, rotatably mounted masses which rotate synchronously in opposite directions, is provided for compacting the earth beneath the roller or cylinder by cyclically moving the cylinder on its resilient mounts. The organization is such that the cylinder can be vibrated even though it is apparently supporting a part of the weight of the tractor.

The cylindrical member is so associated with the tractor that it serves as a steering member as well as an earth-contacting member for the compaction. Mounting at the front of the prime mover allows the operator to see where he is going and eliminates the need for his turning around in order to position the compactor; and provides greater ease and precision in spotting and more even compaction by advancement of the cylinder over the area to be treated prior to contacting with what would ordinarily be wheels of the prime mover. The cylindrical member and its associated apparatus is removably mounted on the prime mover, thereby eliminating the requirement for a special purpose machine to compact the earth by vibratory means. Thus, when compaction is completed, the prime mover may be used for other work, e.g. towing other equipment. Additionally, means are provided to selectively operate the vibrating means.

By combining the tamping and steering into a single apparatus that is closely associated with the prime mover, a highly maneuverable combination is achieved. This is particularly advantageous when working in close quarters such as enclosed areas in underground installations, inside large buildings, and in other places where turning on a short radius is a distinct advantage. Additionally, by mounting the compactor to support some of the weight of the prime mover, any necessity for providing adjusting means to compensate for changes in level between the rear and front wheel is eliminated. Similarly, any problems of stroke adjustments are eliminated. Moreover, by employing a particular kind of vibration-inducing means, forces longitudinal of the prime mover and compactor are eliminated and thereby the steering and handling is facilitated. The invention is further described by the following description when read in conjunction with the drawings wherein:

FIGURE 1 is a perspective view of a front end attachment for a prime mover in combination with the prime mover which is illustrated to be a tractor of the class that is steered by front wheels, but with the front wheels removed.

FIGURE 2 is a partial plan view showing some elements of the attachment which is combined with the tractor in FIGURE 1.

FIGURE 3 is a side view of the elements as seen in FIGURE 2.

FIGURE 4 is another side view illustrating the body frame attaching means whereby the front end vibratory compacting combination of the invention is attached to the structural body members of a tractor.

FIGURE 5 is a perspective schematic view of the vibrating means showing the essential components for cyclically moving the tamping means or cylinder relative to the tractor.

FIGURES 6 and 7 are operating positions of the apparatus of FIGURE 5 shown in conjunction with the respective operating positions of the compacting means that are induced thereby.

FIGURE 8 is a schematic drawing of a steering system, including the linkage between the steering column and the hydraulic control valve, as well as the interconnection of the various flexible hydraulic lines with the other elements.

FIGURE 9 is one embodiment of a hydraulic system for selectively controlling the motor that drives the vibrating means, and

FIGURE 10 is another embodiment of a system for selectively controlling the motor for operating the means for vibrating.

Referring now to FIGURES 1 through 4, the general organization of the invention comprises the combination **1** of a prime mover **3** and a front end vibratory compactor assembly **5**. The construction of these elements will be discussed below in further detail but for the present it should be noted that the prime mover comprises a tractor characterized by having a rearwardly-extending drive shaft **6** (FIGURE 4) which can be used for the driving of accessories connected to or towed by the tractor, a pair of rear wheels **8** mounted on axles **9** which in turn drivingly engage the ground and receive their power from the tractor engine, and normally includes a front wheel or wheels for the purpose of supporting part of the weight and for steering the tractor plus any attached implements by the manipulation of the steering wheel **10**. In the embodiment shown, the front wheels have been removed and replaced by the front end vibratory compactor assembly **5**. The outstanding features of the assembly are that it includes a cylinder or roller **62** that rollably engages the ground and which is positionable with relation to the tractor by the steering hydraulic cylinder **85**, whereby the tractor is steered. Appropriate means are provided for connecting the cylinder to the steering wheel. In addition, means **63** are provided for vibrating the cylinder either as it advances over the ground ahead of the driving wheels **8**, or as the entire machine stands still.

In referring to the cylinder or roller **62**, it is intended to include in such terms other shapes than a pure cylinder, for example rollers of elliptical cross section, or with corrugated peripheries, or with interrupted peripheries such as sheepsfoot-type rollers, and the like, all to the end that a steerable weight-supporting, ground-engaging member capable of being vibrated is provided.

Normally, prime movers such as tractor **3** include means for attaching implements to tow them behind the tractor, such as a rearwardly-extending hook, a bracket with a pintle to match, and the like. With the present invention, however, attachment to the front-end is preferred and is accomplished by attachment frame means **12** for enabling the front-end connection and support of the vibratory compactor assembly to the prime mover or tractor **3**.

As best presented in FIGURES 1 through 4, the frame means **12** includes a pair of parallel stringers **14** extending longitudinally of the tractor frame and having at least one cross bar **16** extending laterally of the tractor between the stringers and secured at each end to the stringers. Preferably, the stringers and the cross bar and I-beams are welded together in the positions shown. Bolting and

riveting can also be employed, bolting being advantageous in those situations where disassembly may be required for ease of shipping to construction sites. A plurality of frame bolts **18**, **19** extend through holes in the I-beam flange and threadedly engage corresponding tapped holes in structural portions of the tractor body. For example, bolt **18** extends into the axle housing **20**. Shims such as **22** are positioned between the stringers and the body proper, when necessary, in order to maintain the body in a normal, horizontal position. At times, of course, the shims can be eliminated where appropriate alignment of the frame means **12** and the tractor body can be accomplished without them. In other circumstances, the shims must be provided at all points of contact between the frame means and the tractor body or tractor body frame. Also, the shims may have to be shaped to provide a proper mating contour between the tractor frame and the attachment frame **12**.

The front end of the attachment frame means **12** includes a box frame structure **23** in order to accommodate the greater forces resulting from vibration, thrust and weight which are imposed upon it at this portion. The box frame includes outer side plates **24** extending rearwardly from the front of the box frame and for a distance along the I-beams. Front and rear plates **26**, **28** respectively extend laterally of the frame between the front side of the side plates and an intermediate portion of the side plates determined by the front end of the stringers **14**. Of course, the front and rear plates extend laterally completely between the two stringers **14**. This presents a sort of rectangular structure as seen in FIGURE 2, for example. Top and bottom plates **30**, **32** complete the box frame structure.

A cylinder anchor frame assembly **35** provides a support base for the tamping cylinder **62** so that the latter can be vibrated, i.e. cyclically moved in a harmonic fashion in a substantially vertical direction and so that it can be turned in order to steer the combination of the tractor and the compactor assembly. The anchor frame assembly comprises a torque tube **36** which is conveniently formed of pipe or tubing. A spring support strut **38**, **39** (FIGURE 2) is supported on each end of the torque tube (support bar), being affixed thereto by welding and further secured by the gusset plates **37** which are advantageously formed from triangular pieces of metal and welded in place as most conveniently seen in FIGURES 1 and 2. The support struts are formed from I-beam sections. There is one support strut on each end of the tube **36**, each of which is constructed alike, hence only one (**38**) will be described, it being understood the other is constructed in similar fashion.

To the top and bottom of each strut is secured, as by welding, a fixed spring plate **41**, **42**, respectively. Top and bottom cantilever leaf spring assemblies **44**, **45**, are secured respectively to the top and bottom plates **41**, **42** by the top and bottom removable cap plates **47**, **48**, respectively. The cap plates are removably mounted by a plurality of nuts and bolts **49** whereby the spring assemblies are clamped between the cap plates and the fixed plates. Advantageously, lock washers, lock nuts, cotter keys or other such means can be used to secure the nuts and bolts **49** in such fashion that vibration and other conditions of use will not shake them loose.

The four leaf spring assemblies are preferably constructed alike, thereby reducing the number of different parts required. Each assembly comprises a plurality of individual leaves **50**, **51**, **52** of respectively different lengths which are bound together by closed bands or links **53** (FIGURE 3). The foremost end of the longest leaf **52** is shaped by being bent in a generally circular form to provide an attaching means **54** to a wrist pin **55**. A short wrist pin leaf **56** is bent in a generally similar fashion and secured to the foremost end of the leaf **52** with an additional closed ring **53**.

In this fashion, the springs are pivotally secured to the

cylinder support means 60 which is connected between each of said top and bottom leaf springs, extends laterally between the right and left-hand ones of springs 44 and 45 to rotatably support the tamping roller 62 from the leaf spring in a ground-contacting position. The cylinder support means, in addition to providing rotatable supports for the cylinder or roller 62, also provides a means for supporting the vibrating means 63. A description of the means for vibrating is set forth below with relation to FIGURES 6, 7 and 8. However, by the manner of construction shown, the forces from the vibrating means 63 are transmitted directly to the cylinder, thereby to lift the roller 62, the roller support means 60, and the vibrating means itself, along with any additional equipment, into and out of ground-contacting position.

The cylinder support means includes, on each side, a pillow block bracket 64 depending from each side plate 65 of the fender assembly 66. The pillow block brackets each carries a bearing 67, preferably a roller bearing mounted on conical races. In addition to side plates 65, the fender assembly includes a hollow elongated partially-cylindrical fender cap 69 which is welded to provide a side plate and pillow block bracket on each end. If desired, flanges 70 can be provided around the edge of the fender assembly.

Wrist pin brackets 72 are mounted on top of the fender cap and underneath the pillow block. The brackets 72 each comprise a pair of lugs spaced apart to receive a corresponding one of the leaf springs 44, 45 therebetween. The wrist pin 55 is driven through a hole in one lug, the rounded aperture in the foremost end of the long leaf 52 of the spring, and the other lug. The wrist pin is secured as by cotter pins or the like at each end.

The anchor frame assembly 35 and the attachment frame 12 are connected together by a hinge-like joint 75 (FIGURES 1, 2 and 3). The joint has upper and lower sections, the lower section parts being denoted by the postscript "*b*" and being constructed in the same fashion as the upper joint. With the joint 75, steering can be accomplished by turning the cylinder 62 and its associated equipment, including the anchor frame assembly, about the turning pins 76, 76*b*. The turning pins are aligned on a vertical axis and are driven through aligned holes in horizontally extending hinge plates 77, 78, 79 and 77*b*–79*b*. The hinge plates 78, 78*b* are welded atop a vertical box frame assembly 80 which is in turn welded so that it is secured centrally of the front plate 26 in the attachment frame. The hinge plates 77, 77*b*, 79*b* and 79 are curved at the forward end thereof to where they extend vertically down to the torque tube 36 to which it is welded. Vertical support is given to the hinge plates by gusset plates 82, 82*b* which are welded thereto and extend from the support bar upwardly to a region adjacent the turniing pin 76. Spacer plates 83, 83*b* space plates 77 and 79 and plates 77*b*, 79*b*, respectively to receive hinge plates 78, 78*b*.

The turning moment for causing the positioning of the anchor frame assembly 35, the tamping cylinder 62, and the like is provided by a hydraulic cylinder 85 that is pivotally mounted on the attachment frame means 12, the plunger of which is pivotally mounted to the anchor frame assembly on one side of the hinge-like joint 75. The pivotal mounting is arranged so that a sort of universal joint type action takes place, whereby changes in the vertical (in the plane of FIGURE 3) and horizontal (in the plane of FIGURE 2) relationship or alignment between the cylinder and tractor are allowed for without impeding the turning effort. The horizontal alignment means is connected to the plunger 86 which extends forwardly from the cylinder 85 and is pivotally secured by a vertical pin 88 between the vertically spaced-apart pair of lugs 89. Cotter pins or the like are used at the ends of the pin to secure the same in place. The vertical alignment means is connected to the mounting lug 90 of the cylinder and is pivotally secured by horizontal pin 91 between the horizontally spaced-apart pair of lugs 92. Flexible hydraulic connections are provided whereby changes in horizontal and vertical alignment may occur without permanently distorting and damaging the hydraulic lines connected to the cylinder.

Referring now to FIGURES 1, 3 and 6 through 8, the vibrating means 63 comprises a hydraulic motor 96 that drives two unbalanced rotatably mounted masses 98, 99 in a fashion such that they rotate synchronously in opposite directions, thereby to provide vertical forces sufficient for lifting the cylinder 62 out of contact from the earth while the cylinder is apparently supporting a portion of the tractor weight, and returning the cylinder into ground-contacting postion with an additional kinetic force derived from the rotating masses that is sufficient to compact the earth. Hydraulic fluid is provided to the motor through lines 101 and 102. The motor rotates a pulley 103 which drives a second pulley 104 through a belt 106. The pulley 104 is keyed to one end of a shaft 108 upon which the rotating mass 99 is mounted. The shaft is journaled in the plates 110 comprising the housing for the masses, only one such plate being shown in FIGURE 6, for the sake of convenience. On the other end of shaft 108 is mounted a timing gear 112 that meshes with a second timing gear 113 which is in turn mounted on the corresponding end of shaft 114 upon which the second rotating mass 98 is mounted. As an alternative to using the timing gears 112, 113 enmeshed, it is also permissable to use a chain drive to connect the two where center spacing is too great to permit the use of a toothed gear driving connection. The gears are of the same diameters, whereby a one-to-one ratio of rotation is obtained. The timing mechanism 112, 113; the rotating masses 98, 99; and most of the shafts 108, 114 are mounted inside the housing, i.e. between the two plates 110 defining the front and back sides of the housing.

The rotating masses 98, 99 each comprise the same known weight rotating at the same radius, whereby when both of them reach their top dead center, FIGURE 6, a lifting force sufficient to lift the cylinder and any attached mechanism off the ground while supporting the front end of the tractor. Conversely, when the rotating masses reach bottom dead center, they drive the cylinder into the ground with a compacting force. The latter is shown in FIGURE 7. The weights rotate at the same speed and are, of course, eccentric to their respective centers of rotation. They rotate in opposite directions. The arrangement shown eliminates side forces, and provides only vertical forces. The vibrating means 63, just described, is mounted centrally of the cylinder support means cap 69 on a platform 115. The latter can be welded to the cap in a central position. The vibrating means 63 is not novel per se, and does not, in and of itself, comprise a portion of the invention, except insofar as it is a part of the combination of elements involved in the invention. The mechanism of the vibrating means is shown in various prior art references, one of which is United States Patent 2,938,438, issued to William Hamilton on May 31, 1960.

The roller or cylinder 62 comprises a means for tamping and is constructed with a hollow cylindrical shell 160 that is made as light as possible to reduce inertia forces in the course of vibrating. Circular end plates 162, 163 are welded to respective ends of the shell, thereby to close the ends. A plurality of circular intermediate supporting plates 165 (three being shown in FIGURE 2) are disposed along the longitudinal axis of the cylinder between the end plates. A shaft 166 extends centrally through all of the plates and past the end plates on each side to engage the bearings 67. The shaft is of one-piece construction, welded to the respective plates 162, 165, and 143. A central hole is provided in each of the plates whereby the shaft can pass therethrough.

FIGURE 9 illustrates one embodiment of a means for selectively operating the means for vibrating. In this

figure there is shown a clutch-driven pump, driven from the rear-drive shaft **6**. Selective control is obtained by engaging and disengaging a clutch. This embodiment is constructed to take advantage of a rear-shaft clutch **121** which is provided with some types of tractors and other prime movers. In the present embodiment with the clutch **121** engaged, a pump **122** is driven from the shaft **6** by means of a pair of gears **124**, **125**, which are mounted respectively on the pump drive shaft and on the shaft **6**. The pump **122** is preferably a gear-type pump. Hydraulic fluid is supplied from a reservoir **120** through a line **127** to the inlet of the pump which, after pressurizing the fluid, directs it through a discharge line **101** to the hydraulic motor **96**. After the fluid gives up its energy to the motor, thereby driving the vibrating means, it leaves the discharge port of the motor and is directed back to the reservoir through return line **102**.

A feature of the system of FIGURE 9 is that the pump is only operated when it is desired to vibrate the roller **62**. At other times the pump is not operated. In contrast, FIGURE 10 features a continuously operating pump and a means for returning to the reservoir the fluid discharged by the pump during those times that it is not desired to vibrate the roller. Both systems thus provide means for selectively operating the motor **96**, hence for selectively operating the vibrating means.

The preferred means for FIGURE 10 is a three-way valve **130**. The system of FIGURE 10 is arranged for incorporation into those tractors and prime motors which do not have a clutch on the rear-drive shaft, or which do not have a rear-drive shaft at all. In this fashion, the continuously running pump can be directly driven by any suitable means, as gears, chain-and-sprocket, or belts and pulleys, from the engine that operates the prime mover, and selective operation of the motor **96** is attained by appropriate manipulation of the three-way valve.

Other structural features of FIGURE 10 are generally similar to those of FIGURE 9, similar reference numerals being used where appropriate. The pump discharge conduit **128***a* connects to the inlet of the three-way valve **130**, the two outlet conduits from the valve being line **101** to connect to the inlet of the motor and **129***b* which is a portion of the return to the reservoir. The motor discharge line **102** connects to **129***b*, forming the conduit **129***c* which directs the fluid from either conduit back into the reservoir.

FIGURE 8 schematically represents the steering system and features a hydraulic control valve **85** having suitable linkage that connects it to the steering column **134** as well as the hydraulic system for connecting the control valve to the steering cylinder **85**. As with the systems of FIGURES 9 and 10, all the hydraulic lines are of suitable, flexible material. Where possible, the steering system is designed to utilize the hydraulic pump which is part of many tractors and prime movers which are designed for towing and/or operating other construction equipment such as scrapers, towed vibrators, and the like. Such pumps are continuously running, that is, they operate as long as the prime mover engine is operating, and are usually gear pumps. In the present embodiment, the continuously running gear pump **136** draws hydraulic fluid from reservoir **120** through a conduit **137**. A strainer **138** is disposed in line **137**. The gear pump discharges the pressurized hydraulic fluid through conduit **139** to the steering control valve **132**. The latter is of a type called a "spool valve" because of the spool-like configuration presented by its plunger. Such valves are commercially available from a wide number of sources.

The gear pump **136** discharges into a conduit **139** that is connected to the inlet of the control valve **132**. The control valve has two directional control lines **140** and **141** which are connected to respectively opposite sides of the piston within the hydraulic cylinder assembly **85**. A reservoir return line **143** connects the discharge port of the control valve to the reservoir **120**.

The control valve has a reciprocating plunger which is connected to bell crank **144** which is in turn pivotally connected to some point on the frame of the tractor. The connection is of the pin-in-slot type or other suitable means whereby differences in pivoting radius and pivot-to-pivot distance are accommodated. The other arm of the bell crank is pivotally connected to one end of rod **142** which is pivotally connected at its opposite end to an arm **145** which is welded or otherwise secured to a flexible U-shaped steering column bracket **146**. The bracket **146** is resiliently secured on the steering column **134** by the clamping action brought about by drawing up extremely tight the nuts **147**, **148** which threadedly engage the securing bolts **149**, **150** which pass through holes in the opposed legs of the bracket. The construction of bracket **146** is such that by loosening the nuts, the bracket is disengaged from the steering column and thus the vibratory compactor of the present invention can be readily disconnected from the tractor steering system when it is desired to remove the compactor from the tractor. As should now be evident, the steering column **134** is connected to the steering wheel **10**. It is to be realized that other suitable linkages can be employed; the linkage used, in any event, ought to be compatible with the existing tractor steering system and with the vibratory compactor.

In operation, the tractor is driven in a fashion generally similar to normal operation. The wheels **8** drivingly engage the ground and advance the entire apparatus as best seen in FIGURE 1 over the ground with the cylinder **62** preceding the tractor **3**. The pump **136** commences to operate and pressurized hydraulic fluid is provided at the outlet thereof. When driving in a straight line, the hydraulic fluid passes through the valve **132** and returns to the reservoir **120**, the pump operating continuously. When it is desired to turn, the operator rotates the wheel **10** in the proper direction whereupon the valve **132** responds by directing the fluid into the appropriate end of the hydraulic cylinder **85**. This either pushes the plunger **86** out or retracts it, whereupon the anchor frame assembly turns about the turning pin **76** and the combination **1** then follows in the course designated by the operator. When it is desired to operate the vibrating means, then the clutch **121** (FIGURE 1) is engaged or valve **130** of FIGURE 10 is opened, thereby directing hydraulic fluid to the inlet of hydraulic motor **96**, whereupon the eccentrically mounted rotating masses **98**, **99** rotate and produce vibration in a vertical direction in such a fashion that the tractor continues to be supported at the front end although the supporting means is moving relative to the ground at a cyclic harmonic rate. When it is desired to remove the compactor from the tractor, the frame bolts **18**, **19** are removed, the front wheels of the tractor replaced, bracket bolts **147**, **148** loosened. The hydraulic lines are, of course, disconnected when necessary in order to complete the removal of the front end tamping attachment.

In review, it is seen that the attachment for a prime mover includes a cylindrical ground-contacting member for tamping and for supporting a portion of the weight of the tractor. A frame means is provided for supporting said cylindrical member to rollably contact the ground and for steeringly connecting the same to the prime mover while transmitting a portion of the weight of the prime mover through the frame means to the cylindrical member. The frame means also includes means for supporting the cylinder for vibratory motion relative to said prime mover. Thus, it is seen that the frame means just described includes what has heretofore been denoted as the attachment frame assembly, the anchor frame assembly, the steering joint **75**, and the cylinder support means **60** as well as the resilient means connecting the anchor frame to the cylinder support, such as the leaf spring

assemblies 44 and 45. Mounted on such frame means, and preferably mounted—as shown—on the cylinder support means, is a means for vibrating the cylindrical member which exerts on the system a force sufficient to cause the cylinder to lift out of contact with the earth while the cylinder is supporting a portion of the prime mover weight, all in such fashion that the prime mover is maintained in a supported position. The means for vibrating also is selectively controllable, whereby it can be turned on and off, e.g., valve 128, when open causes vibration and when closed no vibration of the cylinder takes place. Additionally, appropriate means are connected between the prime mover and the cylinder for selectively positioning the cylinder relative to the prime mover, thereby to steer the entire assembly of prime mover and vibratory compacting apparatus. The coaction between the steering means and portions of the frame means is such that the cylinder is restrained to move in a predetermined path responsive to positioning signals. The hinge-like joint 75, inter alia, connects the anchor frame to the attachment frame assembly and operates to restrain the relative motion therebetween in a substantially horizontal arc while at the same time transmitting a portion of the prime mover weight to the cylindrical member. Where required in the hydraulic system, it is preferred to use flexible hydraulic lines whereby turning and vibration will not cause permanent distortion or fracturing of the lines.

It is thus seen that the invention comprises several different aspects. One of these is a combination with a prime mover such as a tractor, of a front end mounted vibratory compactor. Another one of these is a vibratory compactor that is so built that it comprises an attachment for the front end of a prime mover such as a tractor. Another feature is that the vibratory compactor can be used both as a means for supporting the weight of the front end of the prime mover and also as a means for compacting and steering, all at the same time.

Another feature is a combination with a prime mover of a vibratory compactor which is so connected to the prime mover that it supports a portion of the weight thereof during both normal movement of the combination and during the time when compaction is to take place through vibrating one of the compactor elements.

While a leaf spring has been shown as the example of providing the yieldable suspension for the rolling cylinder, it will be appreciated that coil springs and torsion springs, so proportioned and selected to furnish the equivalent results are within the contemplation of the invention. Also, while a rear end power takeoff has been disclosed, the hydraulic fluid pressurizing source is not limited thereto. For example, a front end power takeoff could be used for driving the hydraulic pump or otherwise furnishing power to steer and/or vibrate the various portions of the invention. It is also to be understood that other variations in the mechanisms and means for accomplishing the respective functions are possible. For example, mechanical linkages could be employed for steering.

While the invention has been disclosed with reference to a specific embodiment, it is to be recognized that various alternative constructions obvious to those skilled in the art are included within the spirit of the invention.

While particular probable theories of operation have been presented (e.g., FIGURES 5–7), to facilitate the description of the present embodiment, it is not intended that the invention be limited to constructions operating in accordance with such theories, but that the invention include all constructions as fall within the spirit of the invention.

I claim:

1. The combination comprising a prime mover having driving means for drivingly engaging the earth, and apparatus for supporting a portion of the prime mover weight while vibratorily compacting earth, such apparatus further comprising

a cylinder for rollably contacting the earth,

selectively controllable vibrating means for vibrating said cylinder into and out of contact with the earth,

a support connecting said vibrating means to said cylinder, and

a frame connecting said support to said prime mover for restraining said cylinder to vibratorily compact and to rollably engage the earth while the combination advances thereover responsive to said driving means and while supporting at least a portion of the prime mover weight;

said frame including an anchor frame assembly resiliently connected to said support and connected to said prime mover about a vertical pivot,

steering means connected between said prime mover and said anchor frame assembly for selectively positioning said cylinder about said pivot to move in a predetermined path,

said selectively controllable vibrating means exerting a force, causing said cylinder to lift from a position where it supports a portion of prime mover weight, to thereby maintain said combination in a supported position while said cylinder is out of contact with the earth.

2. The combination with a prime mover having front and rear wheels and wherein said front wheels are removed,

of a front end combination vibratory compactor and steering means, comprising,

a ground-contacting cylinder,

first means resiliently supporting said cylinder to rollably contact the ground,

vibrating means supported on said first means for vibrating said cylinder, said first means having a portion extending across the front of said prime mover,

vertically positioned pivot means connected to the midpoint of said portion and to the midpoint of the front end of said prime mover whereby said cylinder may be steered by turning said cylinder relative to said prime mover;

steering means for controllably and selectively positioning said cylinder relative to said prime mover about said pivot; said steering means including a force applying means having one end connected to said prime mover and the other end to said support means at a point spaced from the midpoint of said portion,

and control means for selectively operating said vibrating means in any position of the roller,

the whole in such combination that steering and vibratory compacting are accomplished while supporting a portion of the weight of said prime mover.

3. The combination according to claim 2 wherein said resilient support means includes a pair of leaf springs operatively connected to each end of said cylinder to thereby isolate the vibrations of said cylinders from said prime mover.

4. For use as an attachment to the front end of a prime mover having drive wheels at the back end thereof, the combination comprising a hollow cylinder for contacting the ground; an anchor frame assembly including first and second leaf springs extending respectively from ends of said anchor frame assembly to corresponding ends of said cylinder; support means connected between each of said leaf springs and the corresponding ends of said cylinder for rotatably supporting said cylinder from said leaf springs in ground-contacting position; vibrating means connected to said support means to cyclically move said cylinder relative to said prime mover by flexing said springs, thereby to move the cylinder into and out of contact with the ground; an attachment frame assembly for attachment to the front end of a prime mover; and a hinge-like joint means connected between said anchor frame and attachment frame assemblies for restraining relative motion therebetween in a horizontal arc and for

transmitting part of the weight of the prime mover to said cylinder; the whole in such combination when connected to a prime mover that said cylinder advances ahead of a prime mover, supports a portion of the weight thereof, and vibrates responsive to said vibrating means.

5. A combination according to claim 4 and further including steering means connected between said anchor frame assembly and said attachment frame assembly for selectively rotating said cylinder to a preselected position by turning about said joint.

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