

Aug. 27, 1968

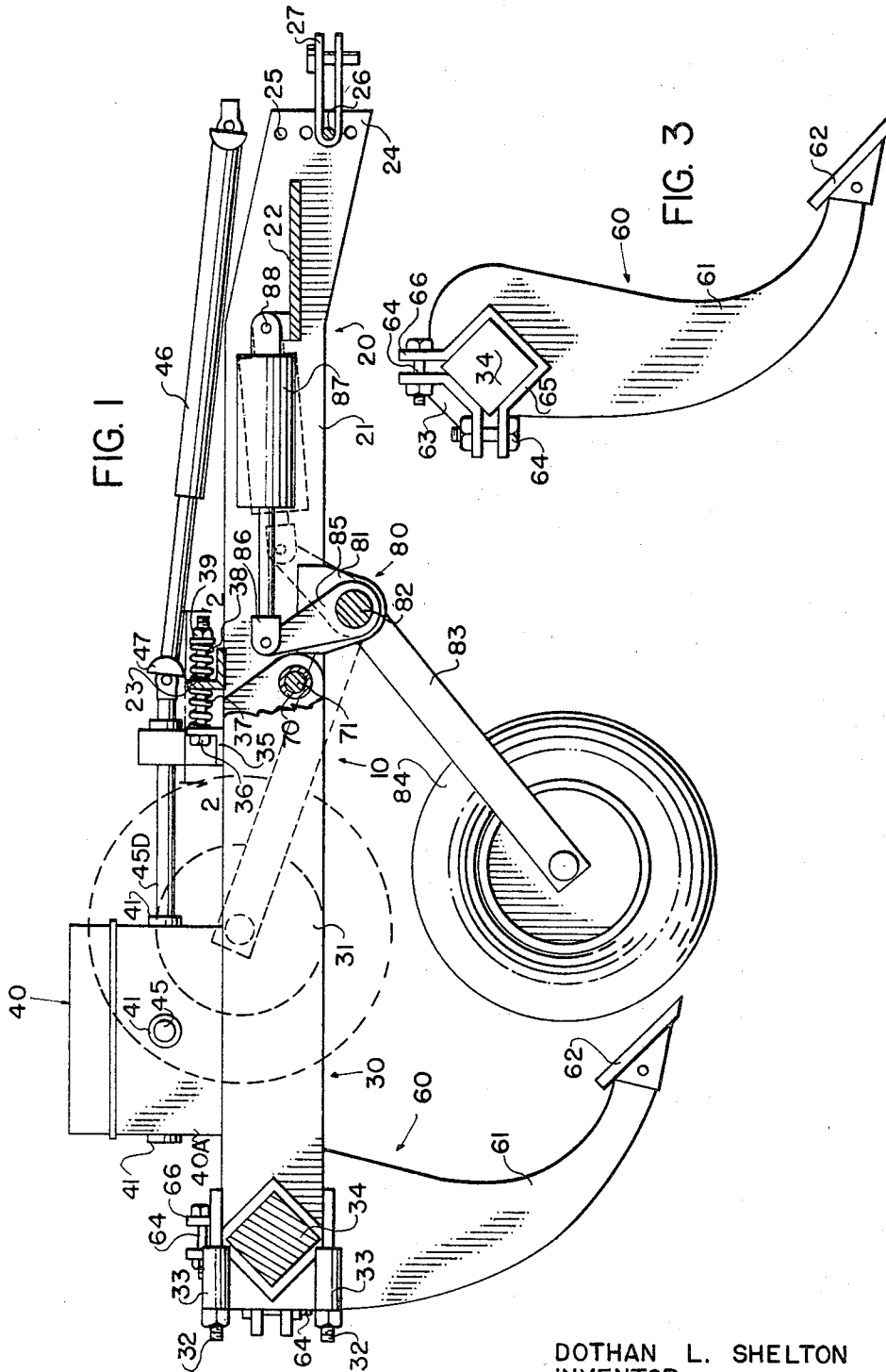
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3,398,798

VIBRATING EARTH WORKING APPARATUS

Filed Sept. 10, 1964

6 Sheets-Sheet 1



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6 Sheets-Sheet 2

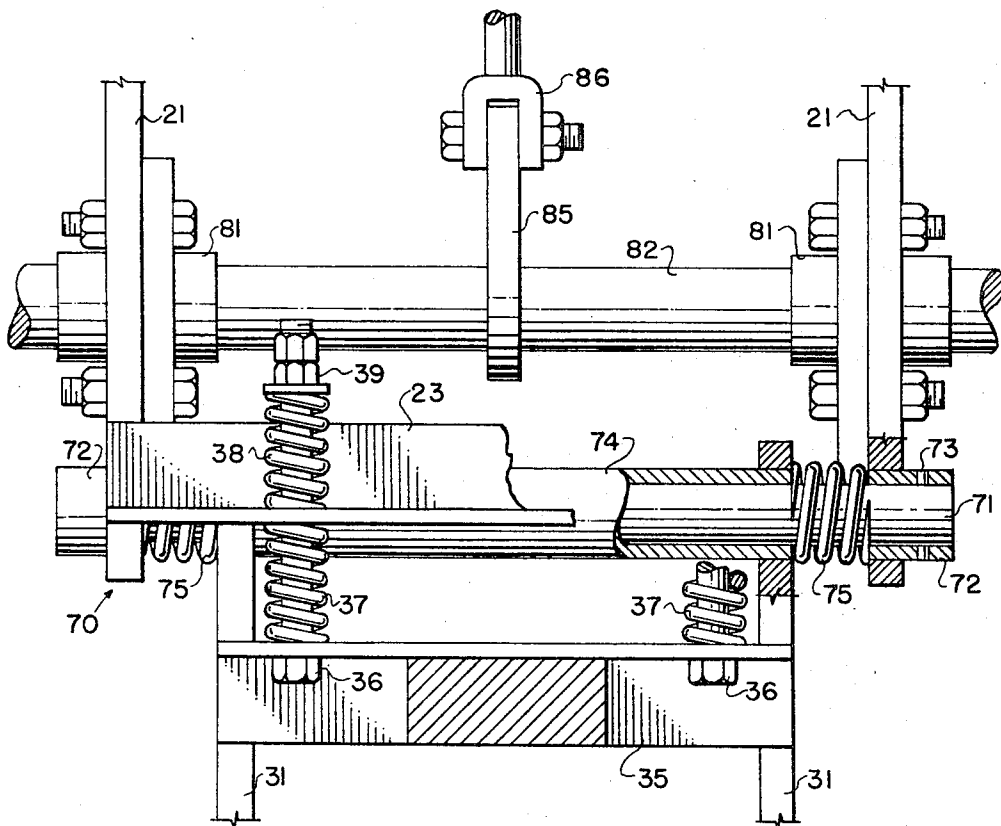


FIG. 2

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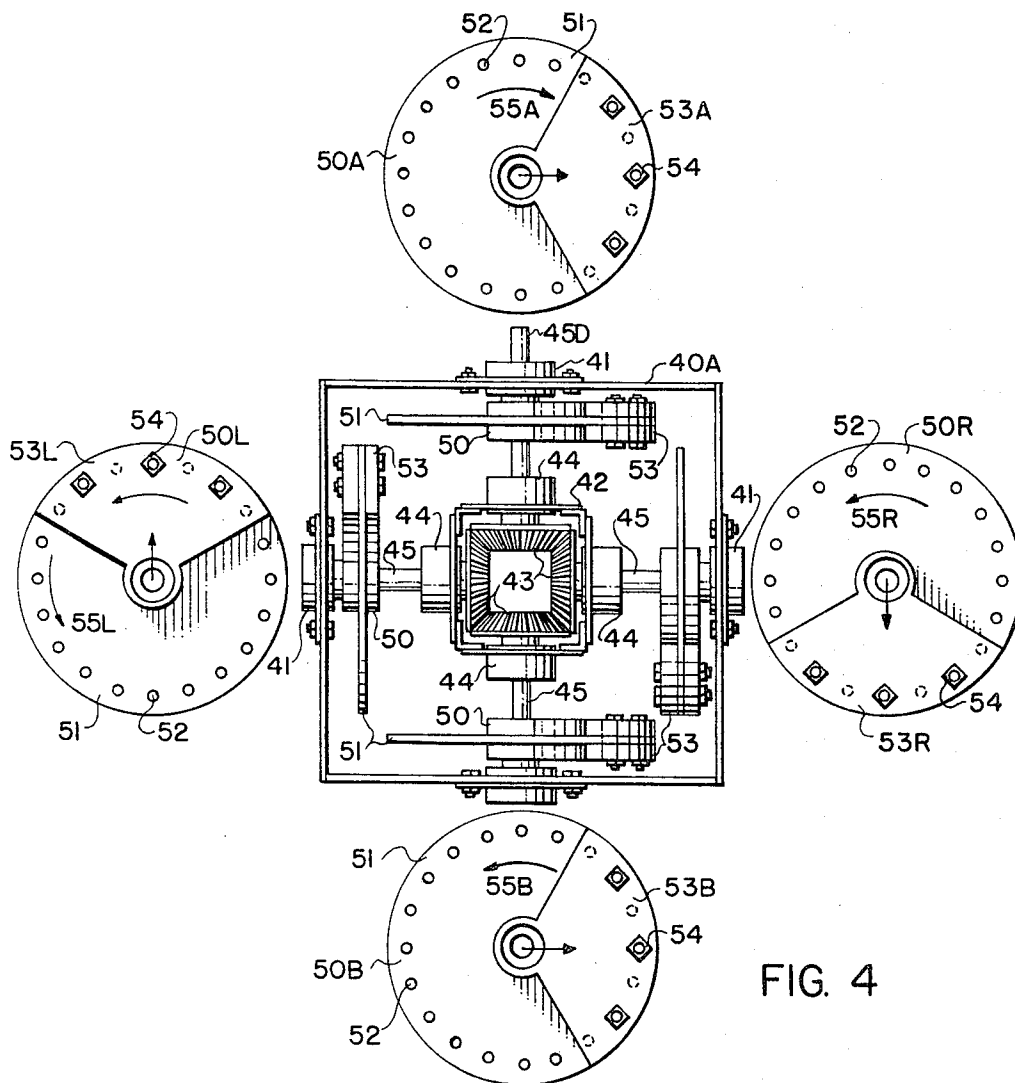


FIG. 4

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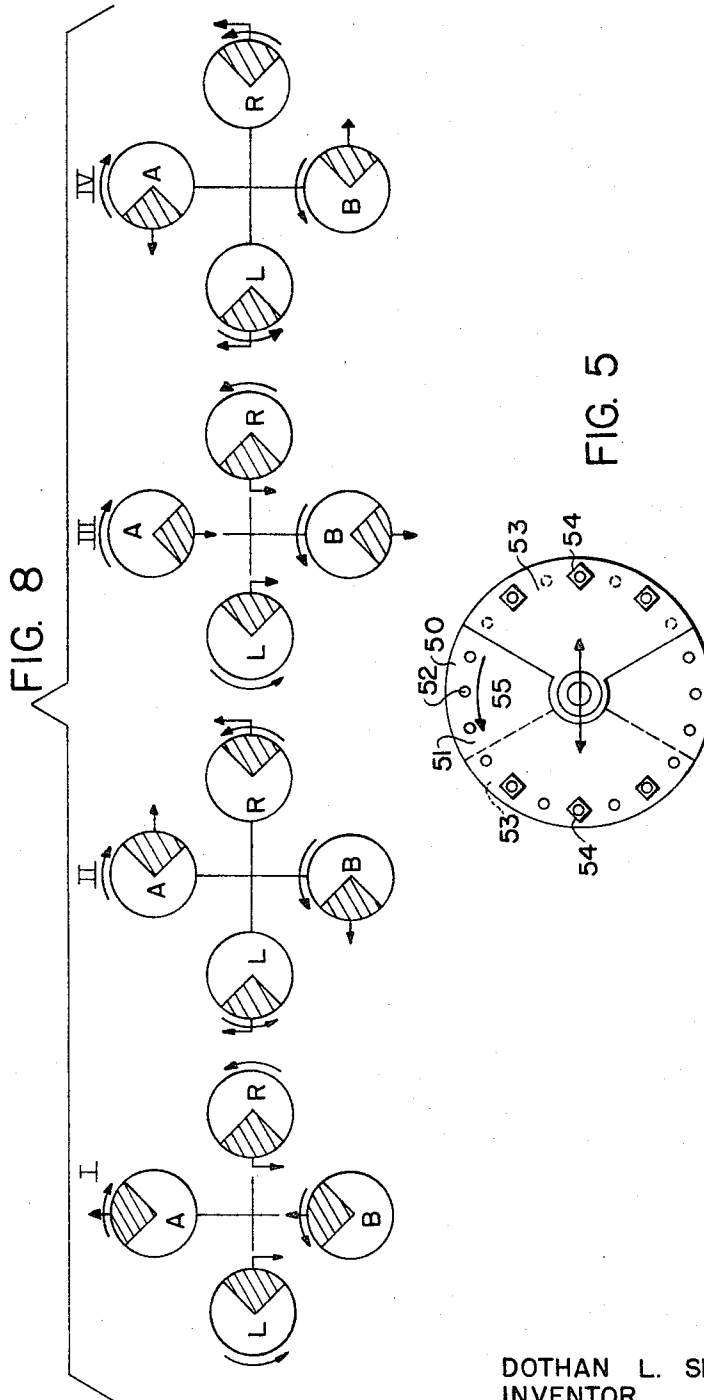
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6 Sheets-Sheet 4



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FIG. 6

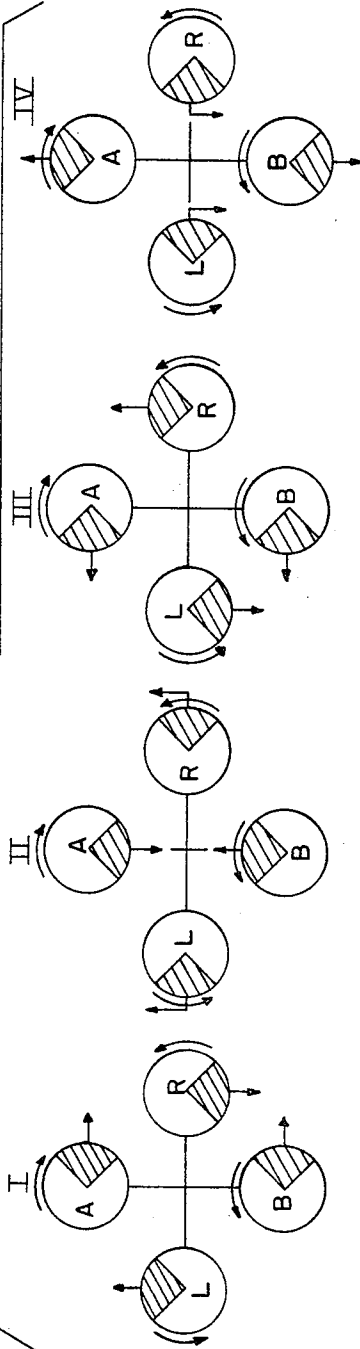
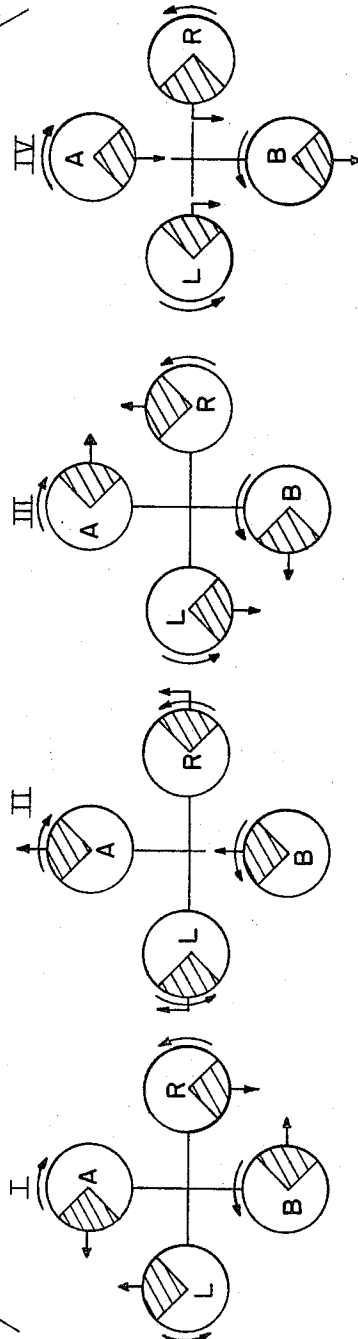


FIG. 7



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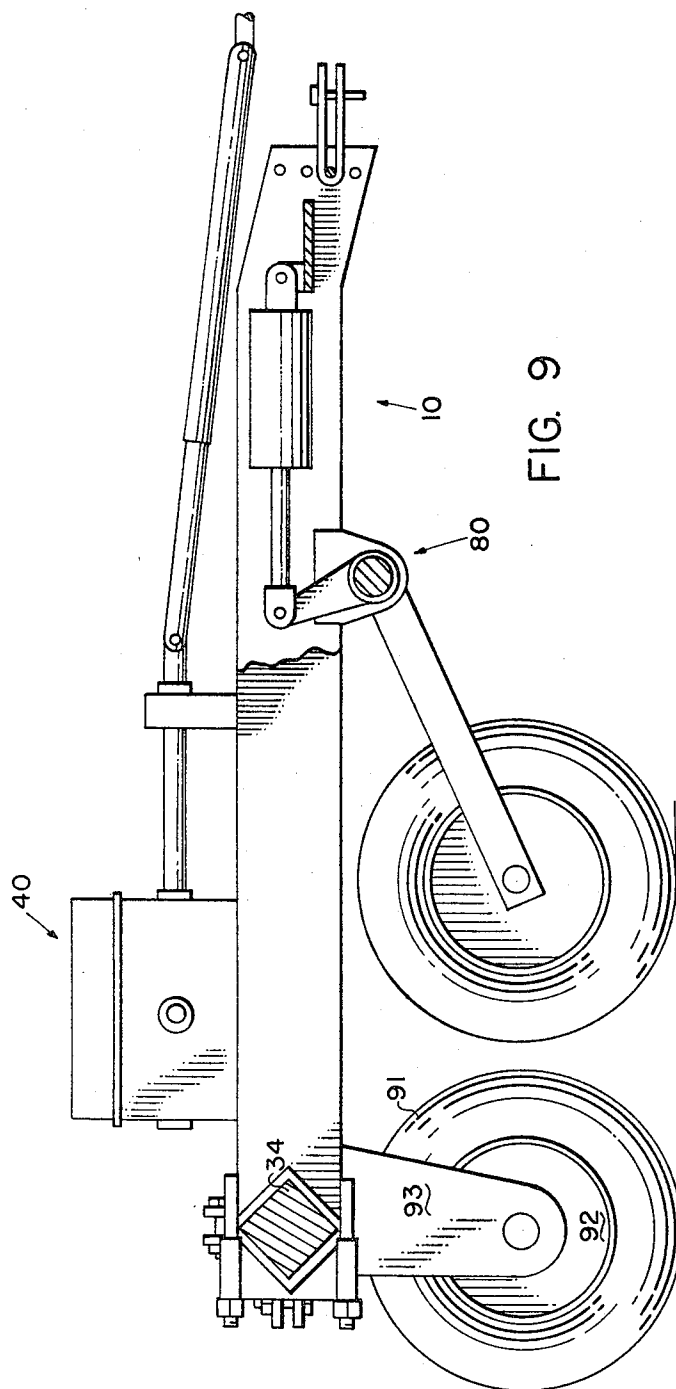


FIG. 9

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VIBRATING EARTH WORKING APPARATUS

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1 Claim. (Cl. 172-1)

This invention relates to improvements in earth working implements and more particularly to that class of such implements provided with power driven means for inducing vibrations or oscillations in the ground working tool.

Machines of this type have been made, but due to the lack of control of the vibrating devices and their limited range, these machines have been greatly limited in their application. The particular design, structure, and combination of parts comprising this device, provides an implement offering a variety of improvements over existing devices.

Conventional earth compacting apparatus consists generally of heavily weighted rollers of various types ranging from broad steel rollers provided with a large number of packers projecting radially from the roller. All of these types of rollers when used as packers result in the progressive compaction of the upper surface whereby the material is bridged over to a relatively shallow depth, resulting in very limited compaction. Vibrating devices have been added to these various types of packers whereby settling of the subsurface materials is effected to give greater depths of compaction. However, where this has been done, only limited reduction in the weight of the apparatus has been accomplished for the reason that relatively heavy inertial weight is required to resist or contain the back-throw or upward thrust of the vibrator.

In this invention this difficulty has been overcome in that a vibrating mechanism having directional thrust has been derived and applied to earth compacting apparatus whereby a downward thrust having twice the force of the back-throw or upward thrust has been achieved. With the application of this improved vibrating device, the inertial weight of the apparatus required to contain the back-throw of the vibrator may be greatly reduced, thus reducing both the cost of operation and the cost of transporting the apparatus from one job to another.

It is an object of this invention to provide an earth working implement having an improved vibrator providing controlled thrust that may be gauged in force, intensity and frequency to the particular application at hand.

It is a further object of this invention to provide an implement having an improved vibrator designed to generate controlled directional thrust either vertically, laterally, or forward and back.

It is also an object to provide an improved implement having an articulated frame designed to relieve the axle and wheel assembly of excessive vibration.

Another object is to provide an improved vibrating device applicable to a variety of implements such as field cultivators, subsoilers, ditchers, listers, fertilizer or chemical applicators, cable and pipe layers, scarifiers, and earth compactors.

Another object is to provide an improved and more rugged and trouble free mounting for the furrowing blades or ripper teeth of vibrating earth working apparatus.

Another object is to provide an earth working implement having in combination the improved vibrator, the articulated frame and the improved ripper blade mounting.

Another object is to provide an improved earth compacting apparatus of relatively limited inertial weight yet capable of imparting a relatively heavy vibrational impact to the surface of the material being compacted.

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Another object is to provide a vibratory earth compacting machine having an improved vibrator capable of generating directional vibrations having greater intensity of force in one direction than in another.

It is a further object to provide an improved earth compacting apparatus of relatively light inertial weight yet capable of producing heavy compaction.

It is a further object to provide an improved earth compacting apparatus of relatively light inertial weight which combines the benefits of rapid light vibration with heavy directional thrust, thereby giving relatively deeper and denser compaction of materials treated than possible with conventional apparatus.

Still further objects are to achieve the above with a device that is sturdy, compact, durable, simple, and reliable, yet inexpensive and easy to manufacture and operate.

Still further objects are to achieve the above with a method that is rapid, inexpensive and does not require skilled people to operate.

The specific nature of the invention as well as other objects, uses, and advantages thereof will clearly appear from the following description and from the accompanying drawing, the different views of which are not necessarily to the same scale in which:

FIG. 1 is a side sectional view of an earth furrowing implement which embodies the improvements inherent in my invention.

FIG. 2 is an enlarged partial plan view showing the hinge section of the improved articulated frame of the implement disclosed in FIG. 1, broken away in parts.

FIG. 3 is a side elevational view of a ripper blade showing an improved method of attachment to the tool bar.

FIG. 4 is an enlarged plan view and schematic representation of the improved vibrator embodied in this invention.

FIG. 5 is a side elevational view of one of the eccentric rotors.

FIG. 6 is a schematic diagram of the vibrating mechanism showing the four interlocking eccentric rotors in four different positions comprising a complete cycle as set for inducing both vertical and lateral vibrations, together with rotational and directional vectors of the forces and their components.

FIG. 7 is the same as FIG. 6 except that the rotors are set for vertical thrust only.

FIG. 8 is the same as FIGS. 6 and 7 with the left and right hand rotors set to a gear ratio of two to one, giving a relatively heavy downward impact.

FIG. 9 is a partial elevational view showing a compaction roller attached to the tool bar in place of the ripper blade.

One form of ground working apparatus embodying my invention generally comprises, as shown in the accompanying drawings with particular reference to FIG. 1, a vertically adjustable and articulate main frame assembly 10 comprising a forward frame section 20 to which is pivotally connected a rearward section 30 by means of hinge 70. The rearward frame section 30 is designed to support a vibrator assembly 40 and a ripper assembly 60. The forward frame section 20 is mounted on a wheel assembly 80 for transport and depth control.

Referring to FIGS. 1 and 2, the forward frame section 20 comprises two matching side members 21 which extend forwardly and are joined together by cross braces 22 and 23 and terminate in matching hitch plates 24. The hitch plates 24 are provided with a number of matching vertically spaced holes 25 adapted to receive bolt 26 for attaching the hitch link 27, which serves to hitch the im-

plement to a tractor drawn bar (not shown) for draft or transport.

The rearward frame section 30 comprises two matching side members 31 which extend rearwardly and terminate in a clamping means consisting of rearwardly extending bolts 32 which are welded to the side members 31 and on which is mounted clamp cap 33. The clamping device is designed to receive and secure tool bar 34 to the rearward end of the frame section 30.

The hinge assembly 70 by which the main frame 10 is articulated between the forward section 20 and the rearward section 30 consists of a hinge pin 71 which is secured to the forward side members 20 by means of bushings 72 and locking pin 73. The forward end of the rearward side plates 31 are joined together by means of a hinge sleeve 74 through which is passed the hinge pin 71 to form the hinge joint between the forward and rearward frame sections 20 and 30. The length of the hinge sleeve 74 is shorter than the space between the forward side members 21 so that the forward end of the rearward frame section 30 is spaced between the side members 21 of the forward frame section 20. A coil spring is mounted on the hinge pin 71 near each end thereof. Each spring 75 is interposed between the inner face of the forward side member 21 and the outer face of the rearward side member 31. The springs 75 serve to center the forward end of the rearward frame section 30 on the hinge pin 71 and also allow limited lateral movement in order to relieve the forward frame section 20 and the wheel assembly 80 from side thrust induced by the vibrator 40.

Bolts 36 extend through holes in the cross brace 23 and cross brace 35 which extends between the side members 31. Coil compression springs 37 surround the bolts 36 between the cross braces 23 and 35. Coil compression springs 38 surround the bolts 36 between the cross brace 23 and double locknuts 39 on the end of the bolts 36. Thus the forward frame section 20 is maintained yieldable manner in aligned relation with rearward frame section 30.

Mounted on the tool bar 34 at the rearward end of the frame section 30 is the ripper assembly 60 which consists of a ripper blade 61 with tool point 62 for earth penetration (FIGS. 1 and 3). The upper part of the ripper blade 61 is provided with an aperture designed to receive the tool bar 34 so as to enclose or embrace the tool bar on three sides.

Flanges 65 are provided on each side of the aperture for attachment of the clamp cap 63, by means of clamp bolts 64 which pass through matching holes provided in the cap 63 and the flanges 65. The cap 63 is so designed that the tightening of the bolts 64 will clamp the tool bar 34 securely within the aperture provided in the upper end of the ripper blade 61.

The vibrator assembly 40 is mounted on the rearward frame section 30 immediately forward of the ripper assembly 60 (FIG. 4). Vibrator housing 40a is securely mounted between the side members 31 of the rearward frame section 30. In each of the four walls of the vibrator housing 40a there is mounted a ball bearing assembly 41. Gear box 42 is concentrically located within the vibrator housing 40a and includes four beveled gears 43 which are intermeshed each with the other so that they rotate in unison. A ball bearing assembly 44 is mounted on each side of the gear box 42. A drive shaft 45d passes through the bearings 41 and 44 and is keyed to the forward bevel gear 43. The drive shaft 45d is connected by universal joint 47 and connecting shaft 46 to the power take off of the draft vehicle (not shown). Each of the other three bevel gears 43 is keyed to a shaft 45 which passes outward through corresponding ball bearing assemblies 44 and 41. On each of the shafts 45 and on shaft 45d there is mounted in the space between the bearings 41 and 44 an eccentric rotor designated generally by the numeral 50 and more specifically by the numeral 50 combined with the letters A, B, L and R. The letter A being applied to

the forward rotor, the letter B, to the back rotor, the letter L to the left rotor and the letter R to the right rotor. Each of the eccentric rotors 50 consists of a wheel like web or disc 51 provided with a series of holes 52 spaced concentrically near the outer periphery. Two eccentric weights 53 are secured in place one on each side of the web 51 by bolts 54. Each eccentric rotor 50 is keyed to the respective shaft 45 on which it is mounted so as to turn with the shaft.

FIG. 5 illustrates an arrangement of weights 53 upon web 51 so that the rotor 50 is balanced and does not result in vibrating forces.

Allowing that the forward drive shaft 45d is turned in a right hand direction as indicated by the arrow 55A shown on rotor 50A, the rotors 50B, 50L, and 50R would each turn in the direction indicated by the arrows 55 shown on the respective rotors. Assuming that the eccentric weights 53 are set as shown in FIG. 4, the rotation of the drive shaft 45d by means of the gears 43 will rotate each of the shafts 45 and the eccentric rotor 50 mounted thereon.

Referring to FIGS. 6 and 7 there is disclosed a schematic diagram showing the cycle of rotation of each of the eccentric rotors 50 and the forces exerted thereby. The shaded area represents the eccentric weights 53 of the rotor. The directional arrow is positioned at the top of the rotor so that as displayed on the chart the tops of rotors A and B are upward while the top of rotor L is to the left and rotor R to the right. By reference to FIG. 4 it will be observed that the four eccentric rotors 50 are geared together by means of shafts 45 and beveled gears 43 so that they rotate in unison and at the same speed. The rotors 50A and 50B as a pair rotate in opposite directions about an axis parallel to the direction of draft of the implement, while rotors L and R as a pair rotate in opposite directions about an axis normal to the direction of draft.

With particular reference to FIG. 6 there is disclosed a series of four positions comprising a complete cycle of rotation whereby the vibrator is set to generate both vertical and lateral vibrating forces. Reading the schematic diagram from left to right in position I the rotors 50A and 50B are positioned with their weights to the right, hence they exert a right hand directional force. Rotors 50L and 50R are disposed with their weights one forward and one back, hence they cancel out or balance their forces, leaving the vibrator 40 under a right hand thrust. In position II rotor 50A is disposed with the weights 53 down and 50B with the weight 53 up, thus balancing out the thrust of rotors 50A and 50B. Rotors 50L and 50R are disposed with their weights up, thereby exerting a vertical upward thrust. In position III rotors 50A and 50B exert a thrust to the left and rotors 50L and 50R balance each other. In position IV rotors 50A and 50B balance each other and rotors 50L and 50R exert a downward thrust. Thus each cycle of rotation in turn will produce a right hand, an upward, a left hand, and a downward thrust.

Referring to FIG. 7 the weight 53 on rotor 50A has been rotated one half revolution from the position shown in FIGS. 6 and 4. In position I of FIG. 7 the 50A and 50B rotors balance each other and the 50L and 50R rotors balance each other so that no vibratory force is generated in this position. In position II all rotors are exerting an upward thrust. In position III they are all balanced, while in position IV all rotors exert a downward thrust. With this setting the vibrator 40 will exert an up and down vibratory force with each rotation with no side thrust.

Referring to FIG. 8 there is disclosed a schematic diagram showing an arrangement of eccentric rotors 50 adapted to give a heavy down thrust with relatively light upward thrust. This application is adaptable for use on material compacting machines such as used on road beds and the like in that it can be set to generate a relatively heavy downward thrust without the use of a great deal

of static or inertial weight as hereinafter more fully explained. In operation this arrangement requires that the ratio of the gears driving rotors 50L and 50R is such as to rotate twice with each rotation of the rotors 50A and 50B. In position I shown in FIG. 8, rotors 50A and 50B are set to thrust upward while rotors 50L and 50R thrust downward with an equal force, thus balancing out the forces to give no vibrating action. In the second position, rotors 50A and 50B have rotated one fourth revolution while rotors 50L and 50R have rotated one-half revolution, giving a right hand thrust to 50A and a left hand thrust to 50B, balancing out their forces. Rotors 50L and 50R both generate an upward thrust. In position III, all rotors are set to thrust downward, giving a vibrating impact equal to the combined thrust of all of the rotors. In the position IV rotors 50A and 50B balance each other and rotors 50L and 50R give an upward thrust. With each revolution of the drive shaft 45d the vibrator will generate two relatively light upward thrusts and one heavy downward thrust.

In terms of vibratory forces generated, if in FIG. 8 the rotors 50A and 50B are provided with eccentric weights of one hundred pounds each with an average radius or throw of ten inches and driven at a speed of 300 r.p.m., they will each exert approximately 2,500 pounds of thrust, with a combined thrust of 5,000 pounds. If the rotors 50L and 50R are provided with thirty-pound weights with an average throw of eight inches and driven at a speed of 600 r.p.m., they will each exert approximately 2,500 pounds of thrust, or a combined thrust of 5,000 pounds. In positions II and IV (FIG. 8) the vibrator will generate an upward thrust of 5,000 pounds, while in position three a combined downward thrust of 10,000 pounds is generated. Thus it is obvious that with 260 pounds of centrifugal weight a downward thrust of 10,000 pounds can be generated. The two relatively light actions occurring between each heavy action will serve to vibrate the materials being compacted into closer position while the heavy action will serve to compact the materials into set position.

The wheel assembly 80 is mounted on the forward frame section 20 by means of bearing 81 and comprises an axle 82, axle arms 83, and wheels 84 mounted in the conventional manner. Centrally located on the axle 82 is secured a lift arm 85 to which is attached a hydraulic plunger 86 which is controlled by a hydraulic cylinder 87 which is pivotally mounted at 88 to cross the member 22. This cylinder is connected by flexible hydraulic lines, not here shown, to the hydraulic system of the draft tractor and serves to elevate or lower the implement in relation to the ground.

FIG. 9 illustrates the device with compacting roller 91 attached to the tool bar 34. As discussed above the vibration results in better compaction. Also earth compaction is considered a phase of earth working, therefore roller 91 is considered a earth working tool.

The roller 91 is in the form of a pneumatic tire mounted on rim 92 which is journaled for rotation in shank 93. The shank 93 is clamped to the tool bar 34 by the same means as the ripper assembly 60 previously described.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction, materials, and arrangement within the scope of the invention as defined in the appended claims.

I claim as my invention:

1. The method of vibrating earth working tools comprising:

- (a) rotating two eccentric weights in
- (b) an opposite direction about
- (c) a single axis,
- (d) rotating two additional eccentric weights
- (e) in opposite direction about
- (f) a second single axis,
- (g) said second single axis at right angles to the first mentioned single axis,
- (h) rotating all weights about a single axis at the same speed, and
- (i) rotating the weights about one axis at twice the speed as about the other axis.

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