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Vural et al.

[11] **3,909,148**

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[54] **VIBRATORY COMPACTING MACHINE**

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[52] **U.S. Cl.** **404/133**

[51] **Int. Cl.²** **E01C 19/34**

[58] **Field of Search** 404/133, 114

[56] **References Cited**

UNITED STATES PATENTS

2,084,983	6/1937	Baily	404/133
2,636,719	4/1953	O'Connor	404/114 X
3,024,861	3/1962	Clynch	404/133 X
3,283,677	11/1966	Uebel	404/133 X
3,834,827	9/1974	Linz	404/133

FOREIGN PATENTS OR APPLICATIONS

483,501	4/1938	United Kingdom	404/133
1,184,623	7/1959	France	404/133

Primary Examiner—Nile C. Byers, Jr.
Attorney, Agent, or Firm—Spencer & Kaye

[57] **ABSTRACT**

A vibratory compacting machine has a machine frame, at least two masses which are spring mounted relative to each other and to the frame, and a vibration exciting mechanism which is arranged to cause the masses to vibrate in a push-pull sense with respect to each other, the arrangement being such that the vibrations are substantially balanced and relatively little stress is placed on the machine frame. The masses may all be compacting tools which are sprung from the machine frame and are arranged to impact the ground. Alternatively one of the masses may be a compensating mass which is spring mounted between the machine frame and the other mass which forms a compacting tool. In a modification of this latter arrangement the compensating mass has portions which are also arranged to impact the ground so that the compensating mass doubles as a compacting tool. In an alternative arrangement the sensitive parts of the machine are mounted on the machine frame which is separated from the compacting parts of the machine by a flexible coupling which is connected to the compacting parts at the center of gravity.

5 Claims, 8 Drawing Figures

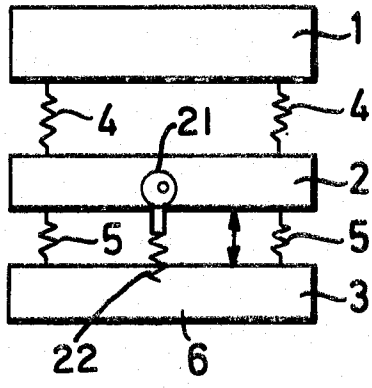


FIG. 1

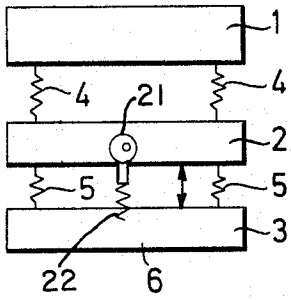


FIG. 2

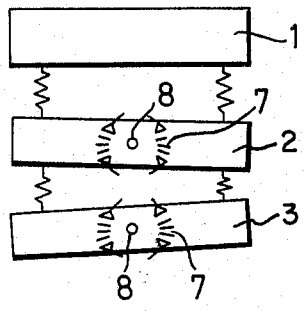


FIG. 3

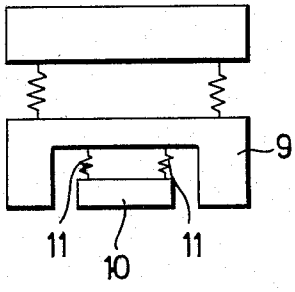


FIG. 4

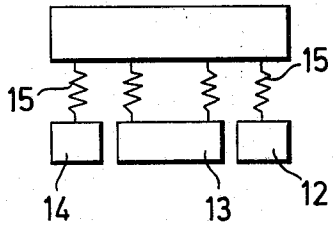


FIG. 5

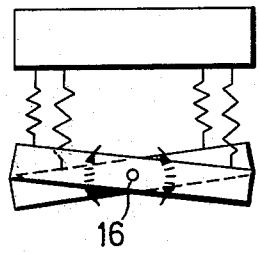


FIG. 6

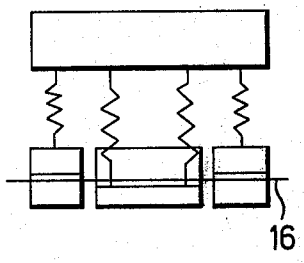


FIG. 7

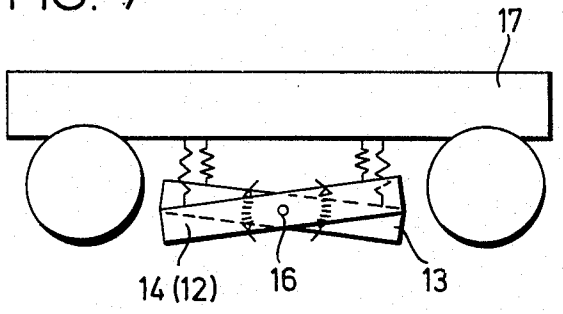
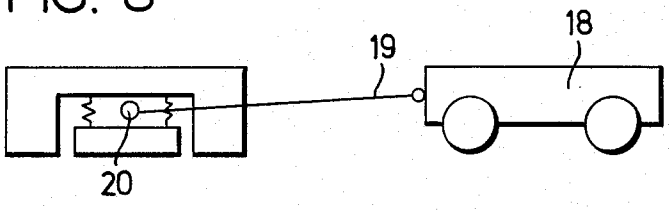


FIG. 8



VIBRATORY COMPACTING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to vibratory compacting machines, which are mainly used for compacting soil, of the kind comprising a machine frame, a compacting tool which is spring mounted relative to the frame, and a vibration exciting mechanism for vibrating the compacting tool.

With vibratory compacting machines in general it is desirable to avoid the transmission of vibrations from the compacting tool to the machine frame during operation. Such transmitted vibrations affect the stability of the machine frame as well as other parts carried by the frame, and furthermore the vibrations are not pleasant for the machine operator who is either seated on the machine frame or is hand guiding the machine depending on the type of machine being used. The type and extent of strain produced in the machine frame by such transmitted vibrations depends greatly on the form of vibration exciting mechanism used in the machine. Various forms of vibration exciting mechanism are known, such as those providing vibration producing forces by means of mass acceleration, those producing vibration producing forces by means of elastic deformation, and those providing vibration producing forces by means of unbalanced centrifugal force generators, sometimes known as inertial force exciters. Also known are mechanisms which make use of a motor driven crank gear to provide the vibration producing forces.

With this latter type of mechanism, the vibration producing forces are transmitted to the compacting tool through a spring, and tensile and compressive stresses are produced alternately in the spring as a result of the crank stroke. Although it is known to support the compacting tool and the vibration exciting mechanism from the machine frame by means of springs, satisfactory suppression of the transmission of vibration from the compacting tool to the machine frame during use has not yet been achieved. This is evident from the fact that vibratory compacting machines with a crank type of vibration exciting mechanism are invariably made as light hand guided machines having a dead weight of no more **100** kilograms. With machines having a dead weight greater than this the vibrations transmitted to the machine frame during operation are virtually uncontrollable.

SUMMARY OF THE INVENTION

According to the present invention, such operationally transmitted vibrations in vibratory compacting machines of the kind described can be very much reduced if: a compensating mass is spring mounted between the machine frame and the compacting tool, and the vibration exciting mechanism is arranged to vibrate the compensating mass and the compacting tool in a push-pull sense; or there are at least two compacting tools spring mounted from the machine frame, and the vibration exciting mechanism is arranged to vibrate the tools in a push-pull sense; or the machine is mobile, having a tractive unit and a compactor unit including the compacting tool, the vibration exciting mechanism comprises exciter means carried by the compactor unit and a power source for the exciter means carried by the tractive unit, and there is a connecting member between the tractive unit and the compactor unit, the member being connected to the compactor unit substantially at its center of gravity.

By arranging that in a vibratory compacting machine of the kind described there are at least two masses, at least one of which is a compacting tool, which are spring mounted relative to each other and to the machine frame, and that the vibration exciting mechanism causes the masses to vibrate in a push-pull sense, the push-pull vibrations may be substantially balanced so that little vibration is transmitted to the machine frame. Virtually total compensation occurs when the masses vibrate in a push-pull sense with equal products of mass and stroke.

In a particular form of machine of this construction, a compacting tool is spring mounted from a compensating mass which in turn is spring mounted from the machine frame, and the vibration exciting mechanism is arranged to vibrate the compacting tool and the compensating mass in a push-pull sense, the compensating mass being arranged to double as a second compacting tool which in use acts on the surface to be compacted.

Alternatively, the transmission of vibrations to the sensitive parts of a vibratory compacting machine is reduced by separating the sensitive parts from the compacting part of the machine by a flexible coupling by which power is delivered to the vibration exciter in the compacting part, and by which the compacting part may also be moved.

BRIEF DESCRIPTION OF THE DRAWING

Various examples of vibratory compacting machines in accordance with the present invention will now be described briefly with reference to the accompanying diagrammatic drawings, in which

FIG. **1** illustrates a first example having a single compacting tool;

FIG. **2** illustrates a second example which is similar to the first except that the compacting tool is arranged to execute oscillatory vibrations instead of linear vibrations;

FIG. **3** illustrates a third example having two compacting tools, one of which doubles as a compensating mass;

FIG. **4** illustrates a fourth example having three compacting tools:

FIGS. **5** and **6** together illustrate a fifth example which is similar to the fourth except that the compacting tools are arranged to execute oscillatory vibrations instead of linear vibrations;

FIG. **7** illustrates a self-propelled machine which is otherwise similar to the example of FIGS. **5** and **6**; and,

FIG. **8** illustrates a seventh example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the embodiment shown in FIG. **1**, a compensating mass **2** is spring mounted between a machine frame **1** and a compacting tool **3** by means of springs **4** acting between the frame **1** and the mass **2**, and further springs **5** acting between the mass **2** and the tool **3**. A crank type of vibration exciting mechanism **21** may be housed in the compensating mass **2** with the crank arranged to act on the compacting tool **3** through a spring **22**. In operation, the vibration exciting mechanism sets the compensation mass **2** and the compacting tool **3** vibrating linearly in opposition to each other, that is in a push-pull sense, as indicated by the arrows **6**. The stiff-

ness of the springs 4 is such that their resistance to the motion of the compensating mass 2 is lower, and consequently the vibrations of the compacting tool 3 and of the compensating mass 2 will not be transmitted to the machine frame 1 to any great extent.

This is also the case in the second example, represented in FIG. 2, where the vibration exciting mechanism causes the compacting tool 3 and the compensation mass 2 to vibrate in an oscillatory fashion, as indicated by arrows 7, each pivoting about its own axis 8 so that adjacent ends move alternately towards and away from each other as shown in FIG. 2.

In the third example, shown in FIG. 3, the arrangement and operation is similar to that of the first example shown in FIG. 1 except that the compensating mass 9 which is spring mounted from the machine frame is of inverted U-shape and straddles the compacting tool 10 which is supported from the mass 9 by springs 11. The free ends of the mass 9 are arranged to contact the ground on opposite sides of the compacting tool 10, and hence the compensating mass 9 also acts as a second compacting tool.

As with the example shown in FIG. 1, the example of FIG. 3 forms a three mass oscillation system (comprising the machine frame, the compensating mass, and the compacting tool), and undesirable stresses placed on the machine frame by operational vibrations can be avoided by appropriate selection of the masses of the members 9 and 10 and arrangements of their supporting springs. A machine having the basic construction shown in FIG. 3 may also be made in which the masses 9 and 10 are arranged to execute oscillatory vibrations.

In the two examples illustrated in FIGS. 4, 5 and 6, each of three compacting tools 12, 13, and 14 are supported side by side from a machine frame by springs 15. The two outer tools 12 and 14 are similar to each other and together have a mass equal to that of the center tool 13. The machines are provided with vibration exciting mechanisms which generate vibration producing forces by means of elastic deformations and which are arranged to vibrate the compacting tools 12 and 14 in the same mode as each other and to vibrate the other tool 13 with the same frequency as the tools 12 and 14 but 180° out of phase, i.e., in a push-pull sense with the tools 12 and 14. In the example of FIG. 4 the compacting tools are arranged to vibrate linearly, whereas in the example of FIGS. 5 and 6 the tools are arranged to vibrate in an oscillatory fashion about a common axis 16.

In these two examples substantial compensation of the reaction forces from the vibration exciting mechanism which is carried by the machine frame is achieved and it thus becomes possible and practical to construct a similar machine which is mobile with a built in driving motor. Such a machine is illustrated diagrammatically in FIG. 7. In the example shown the three compacting tools are arranged to vibrate in an oscillatory mode about an axis 16, although it is just as feasible to arrange for the tools to vibrate linearly as in the example of FIG. 4.

In the example shown in FIG. 8 the compacting tool and compensation mass are not mounted directly below the machine frame, but form a separate unit which is pivotally connected at its center of gravity 20 to a coupling member 19 which connects the unit to the machine frame 18 which is constructed as a mobile tractive unit for propelling the compacting tools. The compacting tools are arranged in a similar fashion to those in the example of FIG. 3 and carry a vibration exciter. The source of motive power for the exciter is however located in the tractive unit 18 and is conducted to the exciter via the coupling member 19. In this example the vibration exciter will be hydraulically or electrically driven.

In all of the examples illustrated the compacting tools are in the form of plates or beams, although they may instead be in the form of rollers. Similarly, the springs illustrated between the machine frame, the compensating mass, and the compacting tools may be simple coil springs or any other suitable spring systems.

We claim:

1. A vibratory compacting machine comprising:
a machine frame;
a compacting tool;
a compensating mass;
spring means having a low spring stiffness connected between said frame and said compensating mass for supporting said mass from said frame;
means connected to support said tool from said mass; and
oscillating vibration means connected between, and to each of said compacting tool and said compensating mass for causing said mass and said tool to vibrate in phase opposition whereby no more than a small portion of such vibrations is transmitted to said frame.

2. An arrangement as defined in claim 1 wherein said compensating mass constitutes a second compacting tool of inverted U-shape, straddling said first-recited compacting tool and arranged to act on the same surface as the first-recited compacting tool.

3. A vibratory compacting machine comprising: a machine frame;
a pair of first similar compacting tools;
a second compacting tool disposed between said first tools and equal in mass to the sum of the masses of said first tools;
spring means supporting each said tool from said frame; and
oscillating vibration means connected between said frame and each of said tools for vibrating said first tools in unison with one another and in phase opposition to said second tool so that no more than a small portion of the vibrations is transmitted to said frame.

4. An arrangement as defined in claim 3 where said frame is a transportable vehicle.

5. A vibratory compacting machine comprising:
a machine frame in the form of a tractive unit;
a compactor unit having first and second compacting tools and spring means connected between said tools;
oscillating vibration means connected between, and to each of, said tools for vibrating said tools in phase opposition;
flexible coupling means connected between said tractive unit and said compactor unit and connected for delivering operating power to said vibration means, said coupling means being connected to said compactor unit substantially at the center of gravity thereof.

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