

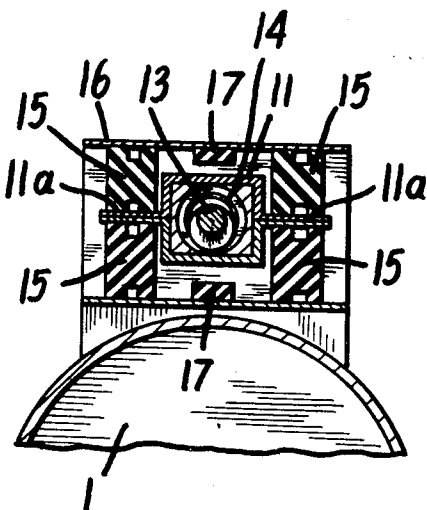
[54] **VIBRATING ROLLER**
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[51] Int. Cl.E01c 19/28
[58] Field of Search.....94/50, 50 V

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Primary Examiner—Jacob L. Nackenoff
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[57] **ABSTRACT**
A vibrating roller mechanism that includes a roller drum and a vibrating device mounted on the drum to form a tuned two-mass system in resonance. This arrangement provides for a high amplitude of vibration of the roller drum with the use of a vibrating device of relatively small mass.

17 Claims, 7 Drawing Figures



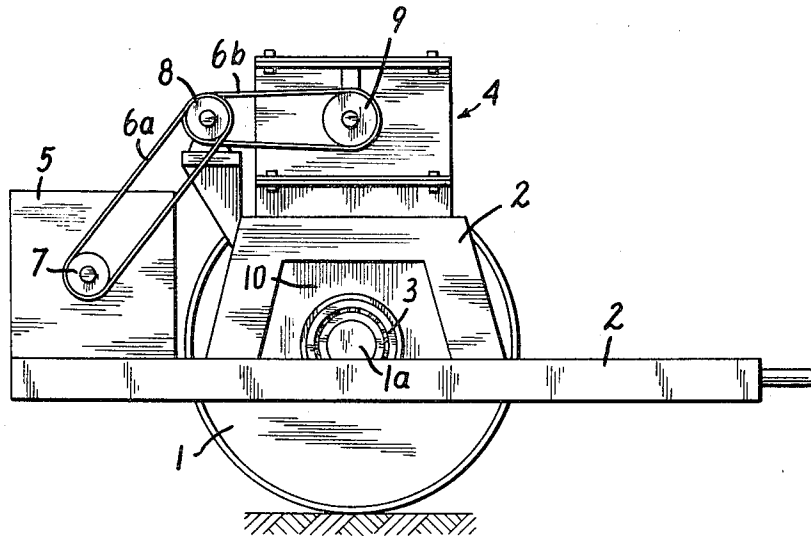


FIG. 1

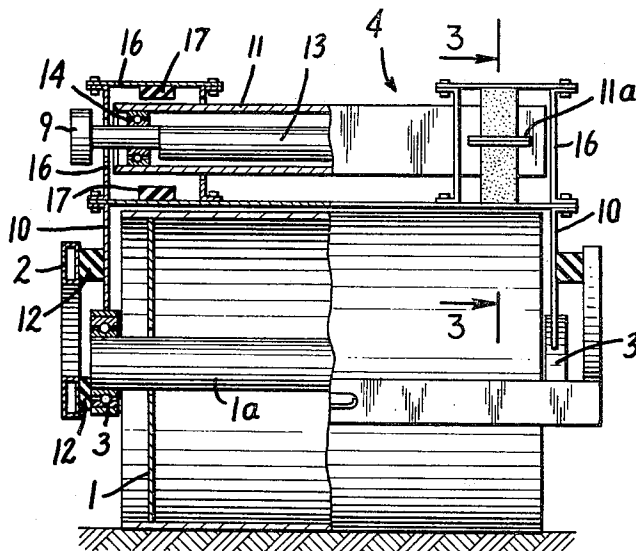


FIG. 2

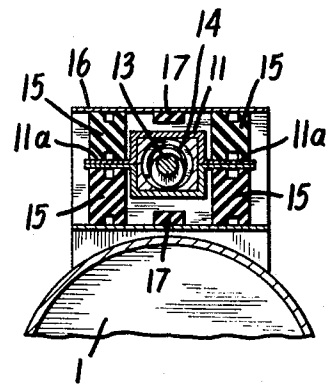


FIG. 3

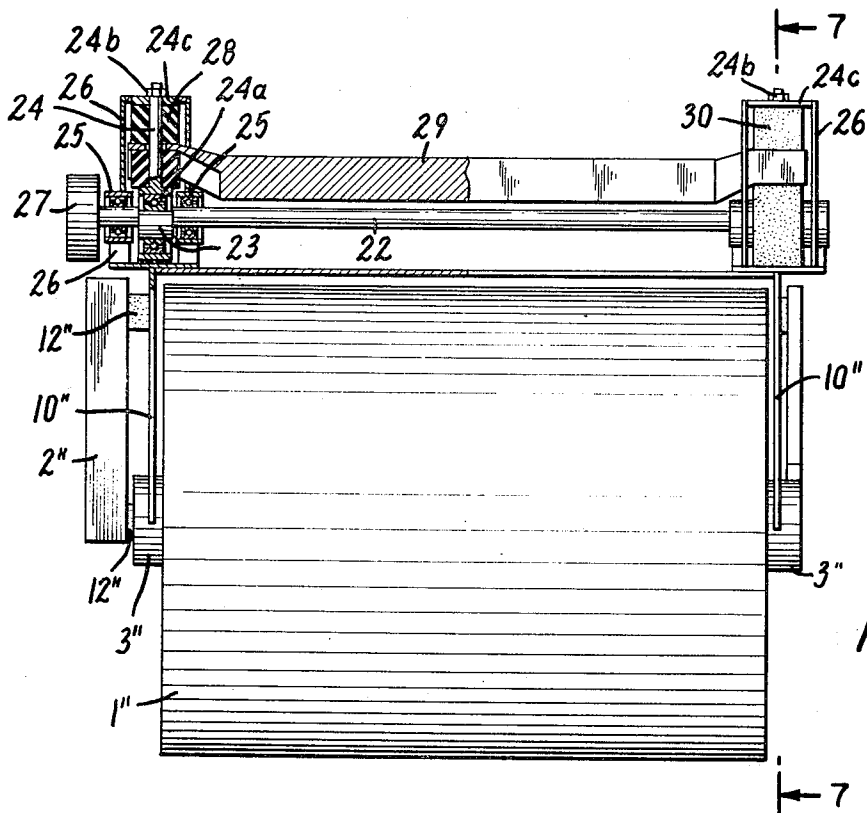


FIG. 6

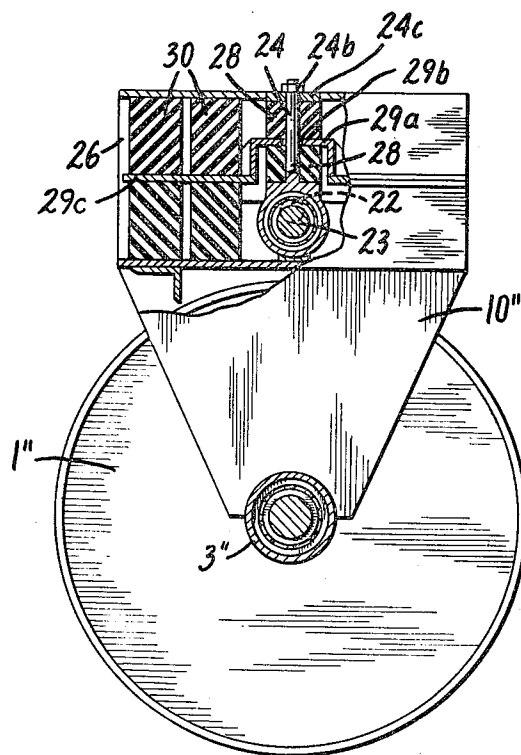


FIG. 7

VIBRATING ROLLER

BACKGROUND OF THE INVENTION

Rollers for compacting earth and the like are preferably of the vibrating type for improved efficiency. Vibrations have been provided in such rollers by using one or more rotating eccentric shafts driven by a separate engine. The rotating shafts are mounted and supported relative to the roller drum in such a manner that the centrifugal forces generated by rotation of the shafts are transmitted directly to the drum through the shaft bearings. The use of small bearings for journaling the relatively high speed shafts has severely limited the magnitude of the centrifugal forces that can be coupled therethrough to the drum.

In still another prior vibrating roller, a circular ball race is fixed to the inside of the roller drum. By driving one or more balls along the race by a driver mounted on a central drive shaft in the roller drum, centrifugal forces are transmitted directly to the shell of the roller drum, thereby unloading the rapidly rotating bearings of the drive shaft. However, this type of vibratory mechanism requires careful assembly and frequent maintenance and, moreover, is difficult to dismantle, repair and reassemble.

SUMMARY OF THE INVENTION

The present invention overcomes the problems inherent in prior vibrating roller mechanisms through the use of a vibrating roller mechanism comprised of a two-mass system in resonance. In exemplary forms of the invention, the vibrations are generated by a rotating eccentric shaft or by a crank mechanism.

More particularly, interacting and flexibly connected masses in the two-mass system consist of the roller drum on the one hand and a vibrating device (mass) vibrating out of phase relative to the drum on the other. The ratio between the two masses is so selected that the vibration system is unaffected by variations in the nature of the ground being compacted, the mass vibrating out of phase being relatively small compared to that of the drum.

In the case of the vibration system using an eccentric shaft in a housing, preferably the shaft is driven at a speed close to the natural frequency of the system, i.e., the roller drum, springs and housing (vibrating device), or a speed that deviates so little from this frequency that a suitable vibration amplitude of the roller drum is obtained. With this arrangement, high vibrating forces and large vibration amplitudes of the drum can be generated with considerably less power than that required in prior vibratory mechanisms. Moreover, since far less power is transmitted directly through the small and rapidly rotating eccentric shaft bearings, longer service life is obtained from such bearings.

In accordance with certain embodiments of the inventive vibrating roller mechanism, the vibrating device is mounted above and resiliently coupled to the roller drum. Due to the low speed of rotation of the drum, large and strong bearings, having an improved capacity for transmitting large centrifugal forces, are used to journal the drum axle. The vibrating forces from the vibrating device are transmitted through the resilient coupling to such large slowly rotating bearings of the roller drum to the drum, which is in contact with the ground or some other surface.

In accordance with the invention, vibrations can also be generated by a weighted member vibrated by a crank mechanism which, as in the case of the rotating eccentric shaft, is driven at a speed close to the natural frequency of the vibration system or deviates so little from such frequency that the desired amplitude of drum vibration is obtained. With this arrangement, the weighted member of suitable mass, corresponding to the eccentric shaft housing, is set in vibration by the crank mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of a towed roller incorporating a vibrating roller mechanism in accordance with the invention;

FIG. 2 is an elevational view, partly in section, of the roller of FIG. 1 as viewed from the right-hand side of FIG. 1;

FIG. 3 is a cross-sectional view of a vibrating housing and spring assembly incorporated in the roller of FIG. 1 taken along view line 3—3 of FIG. 2;

FIG. 4 is a longitudinal cross-section of a roller drum in accordance with the invention having a vibrating device located within the drum;

FIG. 5 is a composite view of the roller drum of FIG. 4, showing in the right-hand position a vertical sectional view taken through the middle of the roller drum and looking outward toward the right-hand end of FIG. 4 and in the left-hand portion an elevational view of the right-hand side of the roller drum of FIG. 4 with the frame broken away for clarity;

FIG. 6 shows another embodiment of the invention which includes a roller drum mounting a vibrating device of modified design; and

FIG. 7 is a side view of the roller drum of FIG. 6 partly broken away to show a partial cross-section along the view line 7—7 of FIG. 6.

DESCRIPTION OF THE INVENTION

Referring to a typical embodiment of the invention with particular reference to FIGS. 1, 2 and 3, a roller drum 1 includes an axle 1a rotatably mounted or journaled in bearings 3 which are connected to a frame 2. Vibrations are imparted to the roller drum, as explained hereinafter, by a vibrating device or unit 4 located above the drum. An engine 5 mounted on the frame 2 drives the vibrating unit 4 through pulleys 7, 8 and 9 connected by drive belts 6a and 6b. The pulley 7 is mounted on the engine 5, the pulley 8 on the frame 2 and the pulley 9 on an eccentric shaft 13 (FIG. 2).

A yoke 10, supported by the bearings 3, carries the vibrating unit 4 above the roller drum 1. To maintain the vibrating device 4 in position, resilient couplings 12 formed of rubber, for example, flexibly mount the yoke 10 to the frame 2.

The vibrating unit 4 is formed by the eccentric shaft 13 rotatably mounted in an eccentric housing 11, and both the housing and shaft extend along the width of the drum. Bearings 14 positioned in each end of the housing 11 rotatably support the shaft 13. A pair of horizontal flanges 11a at each end of the housing 11 are resiliently mounted in a pair of spring assemblies 15 (FIG. 3). Frames 16, secured to the yoke 10 at each end of the housing 11, support the spring assemblies 15.

In order to obtain a highly progressive spring rate and thereby eliminate the effect of the drum supporting surface on the amplitude of drum vibration, stops 17 are incorporated in the frames 16 and are engaged by the housing 11 after its vibrations have reached a certain amplitude.

In operation of the vibrating roller mechanism shown in FIGS. 1, 2 and 3, the driving engine 5 rotates the eccentric shaft 13 through the pulleys 7, 8 and 9, and the belts 6a and 6b, thereby causing the eccentric housing 11 to vibrate. The spring assemblies 15 transmit such vibrations to the bearing frame 16, the yoke 10 and the roller drum 1. Note that the two-mass system consists on the one hand of the eccentric housing 11 and the eccentric shaft 13 and on the other of the bearing frames 16, the yoke 10 and the roller drum 1, the two masses being resiliently connected by the spring assemblies 15. The two masses will vibrate out of phase with the mutual vibration amplitudes of the masses being partly determined by the relationship between the magnitudes of the masses. As is well known, tuning the frequency of the periodic forces generating the vibrations produces resonance effects, when such periodic forces are close to the natural frequency of the vibration system, with the result that relatively small periodic forces suffice to provide very high vibration amplitudes.

In other words, by selecting (1) a suitable relationship between the magnitudes of the two masses, i.e., the eccentric housing 11 and contents on the one hand and the roller drum 1 and attached structures on the other, (2) a suitable choice of spring rate of the spring assemblies 15 between the two masses, and (3) a suitable frequency of vibration, a desired amplitude of vibration of the roller drum is produced. These factors are determined and designed into the roller at the time of its manufacture, and generally are not subsequently changed. Moreover, the small bearings 14 are not unduly loaded by vibrating forces, the high vibratory forces being transmitted through the large heavy duty bearings 3.

Although the eccentric shaft 13 generates circular vibrations, the resilient spring assemblies 15 provide for transmission of the vertical components of such vibratory forces to the roller drum. With this arrangement, the so-called "bulge" which in the past has been formed ahead of a vibrating compacting roller drum, is eliminated.

In another embodiment of the invention shown in FIGS. 4 and 5, in which parts similar to those of FIGS. 1 through 3 have been designated by primed reference numerals, an eccentric housing 11', located centrally within a roller drum 1', is flexibly mounted at its ends by resilient rings 18. A sleeve-shaped section 19 with central opening 20, formed in each end plate 21 of the drum 1, on one side provides a support for the resilient rings 18 and on the other side forms a stub axle 22 journaled by bearing 3'. Resilient couplings 12' mount the bearings to frame 2'.

An eccentric shaft 13' is rotatably mounted by bearings 14' inside of the eccentric housing 11'. One end of the shaft 13' protrudes through the opening 20 to receive a pulley 21 which is adapted to be driven by a belt to impart rotary motion to the shaft.

In the embodiment of FIGS. 4 and 5, the two masses constituting the two-mass system consists of the eccentric housing 11' and eccentric shaft 13' (together forming the vibrating device) on the one hand and the roller drum 1' and bearings 3' on the other, the two masses being resiliently coupled by the springs (resilient rings) 18. Operation of this embodiment is substantially the same as that described in connection with the embodiment of the invention shown in FIGS. 1, 2 and 3, except that the vibrations are transmitted directly to the drum 1' and such vibrations are not limited to vertical vibrations.

In still a further embodiment of the invention shown in FIGS. 6 and 7, vibrations are provided by a weighted member actuated by a crank mechanism. Note that elements corresponding to those shown in FIGS. 1 through 3 have been designated by double primed reference numerals. Examining the structure shown in FIGS. 6 and 7 in greater detail, a shaft 22 carries at each end a crank 23 journaled by a bearing 24a to a connecting rod 24. A frame 26 carried by a yoke 10'' mounts a pair of bearings 25 on each side of the crank 23 to rotatably support the shaft 22. A pulley 27 on one end of the shaft 22 is adapted to be driven by the driving engine 5 (FIG. 1) through a suitable belt transmission.

A solid member 29 (the vibrating device), extending the width of the roller drum 1'', is formed at each end with flattened portions 29a having openings 29b therein. The connecting rod 24 extends through the opening 29b, as shown in FIG. 7, and includes a plate 24c at its upper end secured by a nut 24b. Resilient couplings 28, for example rubber blocks, resiliently connect the rod 24 to the flattened portions 29a of the solid member 29.

Also forming part of the solid member 29 are flanges 29c depending from flattened portions 29a and extending horizontally at each end into spring assemblies 30 mounted in the frame 26.

In this embodiment of the invention, the two-mass system is constituted on the one hand by the weighted member 29 and on the other by the crank mechanism, the frame 26, the yoke 10'' and the drum 1'', the two masses being resiliently coupled by the spring assemblies 30. Vibrations generated by the member 29 are transmitted by the spring assemblies 30 to the frame 26, the yoke 10'' and the drum 1''.

As discussed in connection with the operation of the FIGS. 1 through 3 embodiment of the invention, the frequency, spring rate and magnitude of the two masses constituting the vibrating system are selected so that a desired vibration amplitude of the roller drum is obtained. Note that in this embodiment, as in the embodiment of FIGS. 1 through 3, only vertical vibrations are transmitted to the roller drum. Also note that large vibrating forces are transmitted through the heavy duty bearings 3'' and not through the small bearings 25.

It will be apparent that the inventive vibrating roller mechanism can take other forms not shown and described herein. Therefore, the invention is not to be limited to the specific apparatus disclosed but is to be defined by the appended claims.

I Claim:

1. Vibrating roller mechanism comprising roller drum means, including a roller drum, constituting a

first mass; a vibrating device constituting a second mass; spring means resiliently coupling the vibrating device to the roller drum means in vibration transmitting relation; the roller drum means, the vibrating device and the spring means forming a two-mass vibration system having a predetermined natural resonant frequency; and means for vibrating the vibrating device at a frequency close enough to the natural resonant frequency of the two-mass system to produce an amplification of the amplitude of vibration of the roller drum due to resonance effects in the two-mass system.

2. Vibrating roller mechanism as defined in claim 1, wherein the vibrating device comprises an eccentric shaft rotatably mounted in a housing.

3. Vibrating roller mechanism as defined in claim 2, wherein the spring means mounts the housing on and couples the housing to the roller drum means.

4. Vibrating roller mechanism as defined in claim 3, wherein:

the housing is located above and in generally vertical alignment with the rotational axis of the roller drum and includes generally horizontal surfaces;

the roller drum means includes vertically spaced, generally horizontal members positioned above and below the horizontal housing surfaces; and

the spring means is interposed between the horizontal housing surfaces and the horizontal members of the roller drum means whereby substantially only vertical vibrations are transmitted to the roller drum means.

5. Vibrating roller mechanism as defined in claim 3, in which the roller drum means includes stop means positioned in spaced relation to the housing for limiting the amplitude of vibration of the housing to a predetermined magnitude.

6. Vibrating roller mechanism as defined in claim 1, in which is provided a frame; the roller drum means including axle means extending from each end of the roller drum, bearings journaling the axle means and coupled to the frame, and a yoke supported by the bearings; and the spring means coupling the vibrating device to the yoke.

7. Vibrating roller mechanism as defined in claim 1, in which is provided a frame; the roller drum means including axle means extending from each end of the roller drum, bearings journaling the axle means and coupled to the frame, and end plates of the roller drum including supporting means; and the spring means being mounted in the supporting means and coupling the vibrating device to the end plates.

8. Vibrating roller mechanism as defined in claim 1, in which the vibrating device comprises a weighted member having a selected mass; and the vibrating means includes a rotatable shaft carrying a crank and a connecting rod on the crank resiliently coupled to the weighted member; and the spring means coupling the weighted member to the roller drum means.

9. Vibrating roller mechanism as defined in claim 8, wherein:

the weighted member is located above and in generally vertical alignment with the rotational axis of the roller drum and includes generally horizontal surfaces;

the roller drum means includes vertically spaced, generally horizontal members positioned above

and below the horizontal surfaces of the weighted member; and

the spring means is interposed between the horizontal weighted member surfaces and the horizontal members of the roller drum means whereby substantially only vertical vibrations are transmitted to the roller drum means.

10. Vibrating roller mechanism comprising a frame; a roller drum having axle means; bearings journaling the axle means and coupled to the frame; a yoke carried by the bearings; a vibrating device; spring means coupling the vibrating device to the yoke in vibration transmitting relationship; a two-mass vibration system having a predetermined natural resonant frequency being formed by the resiliently coupled roller drum, bearings and yoke on the one hand and the vibrating device on the other; and means for vibrating the vibrating device at a frequency close enough to the natural resonant frequency of the two-mass system to produce an amplification of the amplitude of vibration of the roller drum due to resonance effects in the two-mass system.

11. Vibrating roller mechanism as defined in claim 10, wherein the vibrating device comprises an eccentric shaft rotatably mounted in a housing.

12. Vibrating roller mechanism as defined in claim 11, wherein:

the housing is located above and in generally vertical alignment with the axle of the roller drum and includes generally horizontal surfaces;

the yoke includes vertically spaced, generally horizontal members positioned above and below the horizontal housing surfaces; and

the spring means is interposed between the horizontal housing surfaces and the horizontal yoke members, whereby substantially only vertical vibrations are transmitted to the roller drum.

13. Vibrating roller mechanism as defined in claim 11, in which the vibrating device comprises a weighted member having a selected mass; and the vibrating means includes a rotatable shaft carrying a crank and a connecting rod on the crank resiliently coupled to the weighted member.

14. Vibrating roller mechanism as defined in claim 13, wherein:

the weighted member is located above and in generally vertical alignment with the rotational axis of the roller drum and includes generally horizontal surfaces;

the yoke includes vertically spaced, generally horizontal members positioned above and below the horizontal surfaces of the weighted member; and

the spring means is interposed between the horizontal weighted member surfaces and the horizontal yoke members, whereby substantially only vertical vibrations are transmitted to the roller drum.

15. Vibrating roller mechanism comprising a frame; a roller drum having axle means; bearings journaling the axle means and coupled to the frame; end plates included in the roller drum, the end plates including supporting sleeves; a vibrating device within the drum; spring means in the supporting sleeves mounting and coupling the vibrating device to the roller drum in vibration transmitting relationship; a two-mass vibra-

tion system having a predetermined natural resonant frequency being formed by the resiliently coupled roller drum on the one hand and the vibrating device on the other; and means for vibrating the vibrating device at a frequency close enough to the natural resonant frequency of the two-mass system to produce an amplification of the amplitude of vibration of the roller drum due to resonance effects in the two-mass system.

16. Vibrating roller mechanism as defined in claim 15, wherein the vibrating device comprises an eccentric shaft rotatably mounted in a housing.

17. Vibrating roller mechanism as defined in claim 16, wherein the spring means mounts the housing in the supporting sleeves.

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