This invention relates to vibratory apparatus and in particular to vibratory apparatus attached to or forming part of a truck to facilitate the loading and unloading of freight.

Many trucks are built with self-contained means for discharging the load. The usual method is to employ a hydraulic cylinder or mechanical means to elevate the front end of the bed or box of the truck thus causing the material to slide to the rear and to be discharged therefrom. Another example of a self-unloading truck is one which is equipped with a concrete mixer. Such a truck is loaded with the ingredients at the builders' supply yard, mixes the ingredients during the transit to the customer's premises and discharges the mixed concrete by opening the mixer and continuing its operation.

The principal object of this invention is to provide a self-dumping truck in which the unloading is accomplished by vibrating the material containing portion of the truck.

Another object of the invention is to provide means for uniformly distributing a load of material over an area.

Another object of the invention is to provide a self-dumping truck having a low center of gravity.

Another object is to provide a self-dumping truck which is also capable of mixing the ingredients of a load prior to the discharge of the load.

A further object is to provide a self-unloading truck which is capable of unloading loose, packaged or crated material and which unloads the material without tipping the bed of the truck.

A still further object is to provide a self-unloading truck in which the unloading is performed by vibration with means for confining a vibration to the bed of the truck.

Other objects and advantages are apparent from the following description in which reference is had to the accompanying drawings.

In the drawings:

Figure I is a simple schematic diagram of a structure in which a material contacting member may be vigorously vibrated without materially vibrating the remainder of the structure or transmitting vibrational energy to the foundation.

Figure II shows a portable structure similar to that of Figure I.

Figure III shows a self-unloading truck in which the unloading is accomplished by vibration applied to the frame of the truck.

Figure IV is a fragmentary side elevation of a self-unloading truck similar to that which is shown in Figure III but equipped with an adjustable end gate.

Figure V is a fragmentary side elevation of a vibratory material mixing and conveying truck in which the vibratory force is applied to the frame of the truck.

Figure VI is a side elevation of a tractor and wagon in which the wagon is provided with vibratory unloading means driven from the tractor.

These specific examples are intended merely to illustrate the invention and not to impose limitations on the scope of the invention.

As mentioned in the objects, the present invention lies in utilizing vibration for the unloading of material from a truck. The vibration may also be used, under certain conditions, to move material from the rear end of the truck bed to the forward end thus minimizing the labor of loading. Various methods may be used to generate the vibrations and transmit the vibratory force to the bed of the truck. In a copending application Serial Number 427,039, now Patent No. 2,383,492, granted July 11, 1944, a method of generating vibration in one portion of a structure without materially vibrating other portions is described. The invention herein comprises the use of that method for producing the required vibration.

The simplest exciting mechanism, from the standpoint of performance and ease of maintenance, is a rotating shaft carrying eccentric weights. Such a shaft may be journaled in the frame of the truck. When the shaft is journaled in the frame of the truck the vibrational force is transmitted through the frame and the resilient member supporting the bed to the bed of the truck in the manner described in the mentioned copending application. According to that invention the vibratory system comprising the resilient members and the bed of the truck is designed to have a resonant frequency in the range of the speed of the rotating shaft. When the speed of the shaft substantially equals the natural frequency of the vibratory system the vibratory system acts as a tuned undamped vibration absorber and by its own vibration absorbs and counteracts the vibratory force applied to the frame of the truck by the rotating eccentric weights.

The invention also contemplates using the vibrating conveying action as a mixer. In this use the discharge end of the container or bed of the truck is closed and the material is allowed to accumulate and circulate at that end.

Figure I schematically illustrates a structure in which vibratory force applied to one member causes vibration of another member without vibrating the first member. The structure com-
The vibration is produced by the centrifugal force of a rotating eccentric weight 33 carried on a shaft 34 transversely journaled in the frame 28. The shaft 34 is driven by a V-belt 35 from a pulley 36 extending from an auxiliary transmission 37 controlled by a lever 38 and providing means for connecting the pulley 36 to the engine of the truck. In this structure vibration of the box 31 is produced by the centrifugal forces of the weight 33 which are transmitted through the frame 28 and the springs 29. This type of truck is unloaded either while it is in motion or while it is standing still by engaging the auxiliary transmission 37 and driving the unbalanced weight 33 at a speed substantially equal to the resonant frequency of the box 31 on the springs 32.

In the dump trucks of Figures III, IV, V, and VI, the vibration is shown as being produced by rotation of an eccentrically weighted shaft but, of course, the particular mechanism employed to apply cyclical force to the truck body is immaterial. As illustrated in Figure II, by substituting resiliently tired wheels for the springs 15 and 16. The resulting structure comprises a material contacting or containing member 19, which may be a mold box, a short vibratory conveyor, or similar object to be vibrated, mounted on springs 20 and 21 from a frame 22. The frame 22 is carried on resiliently tired wheels 23 and 24. The frame 22 also journals a shaft 25 bearing an eccentric weight 26. The centrifugal forces produced by the rotation of the shaft 25 and eccentric weight 26 are transmitted through the frame 22 to the springs 20 and 21 and through them to the material contacting member 19. If the speed of rotation of the shaft 25 corresponds to the natural frequency of the material contacting member 19 on the springs 20 and 21 a resonant vibration is set up in the member 19 without producing an appreciable vibration of the frame 22. This structure thus has the advantages of being capable of producing a vigorous efficient vibration and of being easily transported from one location to another.

As the material contacting member may be a conveyor and as the whole structure is portable, such a structure could be used to transport material from one location to another by loading the conveyor and then by the vibratory action of the conveyor automatically discharge the material from the conveyor at the destination. A structure used in this manner might be called a self-unloading or self-dumping truck. Figures III and IV show trucks so equipped. In each of these structures a truck 27 having a frame 28 carried on resilient wheels 29 and 30 (not shown in Figure IV) supports a box containing box 31. Springs 32 allowing unidirectional motion of the box 31 with respect to the frame 28 are interposed between the frame 28 and the box 31. The springs 32 are in the form of cantilevers extending upwardly and forwardly from the frame 28 to the box 31. These springs are stressed by bending so as to produce the resulting vibration along a path inclined toward the rear in such a direction that material contained in the box 31 will be conveyed toward the rear of the truck. The springs 32 are preferred form of resilient means for mounting the box 31, but any other form of spring which will allow motion of the box 31 in a general straight path inclined in the direction toward which the material is to move would be operative.
trolled by adjustment of the opening below the end gate and by the amplitude of the vibration produced by the centrifugal forces of the rotating weight.

The material is not allowed to escape the vibration of the bed merely piles it up against the end gate and the top layers or strata slide forward while the bottom strata are fed toward the gate. The material thus circulates and in the process of circulation becomes thoroughly mixed. Because while being mixed, the material tends to accumulate at the rear end of the material container it is desirable to supply a hood or other cover to prevent its escape over the sides of the box. Figure V is a fragmentary view of the truck 27 showing a hood 44 added to the box or container 31. The hood 44 is attached to the top of the material container 31 and cooperates with the sides and the end gate 39 to prevent the escape of the material as it circulates. After the material has been mixed by the circulation it is discharged by opening the end gates.

It is not necessary that motive power for driving or rotating the material be self-contained within the vehicle. The vibrating structure may be built into a wagon and the wagon drawn by a tractor equipped with a power take-off. The structure shown in Figure VI includes a wagon 45 adapted to be drawn by a tractor 46. The wagon 45 comprises a frame 47 supported on resilient wheels 48 and 49 and a wagon box or bed 50 supported from the frame 47 by a series of springs 51. A shaft 52 is journaled transversely in the frame 47 and carries an eccentric weight 53. The shaft 52 is adapted to be driven through a shaft 54. Each end of the shaft 52 supports a universal joint 55 at each end of the shaft 54. The universal joint 55 at each end of the shaft 54 permits the operation of the vibrator without requiring alignment of the wagon and tractor. A tongue 56 acts both as draw bar for the wagon and to steer the wagon. Because this structure is conventional it will not be described further except to say that the power take-off is of a type which may be controlled independently of the power transmission to the driving wheels. In this arrangement, as in the others, the box 50 and the spring 51 comprise a vibratory structure having the resonant frequency on the speed range of the shaft 52 bearing the unbalanced weight 53. Therefore, as in the other structure, a vibration of the box may be excited by rotation of the shaft 52 without materially vibrating the frame 48. This structure is admirably suited to the spreading of materials such as gravel on roads and lime or fertilizer on cultivated land.

The specific structures described illustrate the essential elements needed to produce a vibratory dump truck. A vibratory dump truck possesses several distinctive advantages over conventional dump trucks. One advantage is the fact that it may be built with a much lower center of gravity and is, therefore, much less likely to upset when maneuvering in construction areas. Another advantage is that it is capable of discharging the load without lowering the rear end of the bed. Another advantage is that it does not require the necessity for jacking the material up to get rollers under it or employing a block and tackle to slide it along the bed. When a truck incorporating the invention is provided with a hood it offers the added advantage of being able to completely confine the material without mixing them over an area or discharge them into a pile. In fact it may even be used as a low center of gravity concrete mixer and in that use is much more maneuverable than conventional transit mixers.

Having described my invention, I claim:

1. In a device of the class described, in combination, a vehicle, a commodity container, resilient means supporting said container from said vehicle and forming therewith a vibratory system having a resonant frequency, a shaft bearing eccentric weights journaled transversely in said vehicle, and means for rotating said shaft at substantially the resonant frequency of the vibratory system comprising said container and said resilient means.

2. In a device of the class described, in combination, a vehicle, means for moving said vehicle, a material container, resilient means supporting said container on said vehicle and forming therewith a vibratory system, a shaft extending transversely of said vehicle and journaled therein, eccentric weights carried on said shaft, means for rotating said shaft at substantially the natural frequency of said system thereby exciting a vibration of said container and means for moving a material in said container toward an end thereof, and an adjustable gate closing that end of said container adapted to control the discharge of material from said container.

3. In a device of the class described, in combination, a vehicle chassis the frame of which is resiliently supported, a material container, resilient means for supporting the container from the vehicle frame and for forming with the container a vibratory system having a resonant frequency, and means for applying vibratory force to the frame only at a frequency substantially equal to the resonant frequency of the vibratory system whereby the vibration of the vibratory system absorbs substantially all of the vibrational energy supplied to the frame.

4. In a device of the class described, in combination, a vehicle chassis the frame of which is resiliently supported, a material container, resilient means for supporting the container from the vehicle frame and for forming with the container a vibratory system having a resonant frequency, and an unbalanced rotating weight that is journaled in the resonant frame that is rotated at the resonant frequency of the vibratory system.

5. In a device of the class described, in combination, a vehicle chassis the frame of which is resiliently supported, a material container, resilient means for supporting the container from the vehicle frame and for forming with the container a vibratory system having a resonant frequency, and an unbalanced weight that is mounted on a shaft journaled in and extending transversely of the frame and that is rotated at a speed substantially equal to the resonant frequency of the vibratory system.

6. In a device of the class described, in combination, a vehicle chassis the frame of which is resiliently supported, a commodity container, resilient means for supporting the container from the vehicle frame and for forming therewith a vibratory system having a resonant frequency, a mass supported from and movable with respect to the frame, and means for cyclically moving the mass with the reaction force from the means applying vibratory force to the frame, said means operating at a frequency substantially equal to the resonant frequency of the vibratory system whereby the vibratory system of its own vibration absorbs substantially all the
vibrational energy imparted to the frame by the means for moving the mass.

7. In a device of the class described, in combination, a vehicle, means for moving said vehicle, a material container having a longitudinally extending substantially planar bed, a plurality of forwardly and upwardly extending leaf springs for supporting said container on said vehicle and forming with said container a vibratory system having a natural frequency of vibration, a shaft extending transversely of said vehicle and substantially parallel to said bed, eccentric weights carried on said shaft, means for rotating said shaft at substantially the natural frequency of said system thereby exciting vibration of said container tending to move said material in said container toward an end thereof, and an adjustable gate closing that end of said container adapted to control the discharge of material from said container.

8. A portable vibratory conveyor comprising, in combination, a wheeled vehicle having a frame resiliently isolated from the ground, a conveyor body having a longitudinally extending substantially planar bed, a plurality of upwardly inclined, substantially parallel leaf springs for supporting said body on said frame and forming with said conveyor body a vibratory system having a natural frequency of vibration, and means for applying cyclical force to said frame at substantially the natural frequency of said system thereby exciting vibration of said container tending to move material therein toward one end thereof.

9. A vibratory dump truck comprising, in combination, a dump frame resiliently including wheels for supporting said dump frame, a material container having a longitudinally extending, substantially planar bed and an open rear end, an adjustable rear end gate, springs for supporting said container on said frame and forming with said container a vibratory system having a natural frequency of vibration, said springs being adapted to restrain movement of said container except along a path extending generally upwardly and rearwardly relative to said dump frame, and means for applying a cyclical force to said frame at substantially the natural frequency of said vibratory system thereby exciting vibration in said body for moving the material contained therein toward the rear end thereof.

10. A vibratory dump truck comprising, in combination, a truck frame, resilient means including wheels for supporting said truck frame, a material container having a longitudinally extending, substantially planar bed and an open rear end, an adjustable rear end gate, a plurality of generally parallel, forwardly and upwardly extending leaf springs for supporting said container on said frame and forming with said body a vibratory system having a natural frequency of vibration, the ends of each of said springs being fixedly connected to said truck frame and to said body respectively, and an eccentrically weighted, transversely extending, shaft journalled in said truck frame and rotatable in its journals for applying cyclical force to said frame at substantially the natural frequency of the vibratory system formed by said body and said springs and thereby inducing vibration in said body along a generally upwardly and rearwardly directed path for moving the material contained therein toward the rear end thereof.

11. A vibratory dump truck comprising, in combination, a truck frame, resilient tires wheels for supporting said truck frame on the ground, motive power means for said truck frame, a material containing body having a longitudinally extending, substantially planar bed and an open rear end, an adjustable rear end gate, a plurality of generally parallel, forwardly and upwardly extending leaf springs for supporting said body on said frame and forming with said body a vibratory system having a natural frequency of vibration, the ends of each of said springs being fixedly connected to said truck frame and to said body respectively and an eccentrically weighted, transversely extending, shaft journalled in said truck frame and rotatable in its journals for applying cyclical force to said frame at substantially the natural frequency of the vibratory system formed by said body and said springs and thereby inducing vibration in said body along a generally upwardly and rearwardly directed path for moving the material contained therein toward the rear end thereof.

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