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.

Another 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.

Another 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 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. 2,353,492, 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-
2,500,293

prises a material contacting member 10 supported by springs 11 and 12 from a frame or base member 13 which in turn is resiliently mounted from a foundation 14 by springs 15 and 16. A shaft 17 journaled in the frame 13 carries an eccentric weight 18. Such a system is capable of several modes of vibration. The first mode of interest is a vibration in which the members 10 and 13 vibrate vertically on the springs 15 and 16. This type of vibration may be excited by rotating the shaft 17 at an appropriate speed. As another and higher speed, another mode of vibration in which the members 10 and 13 move in opposite directions may be produced. At an intermediate speed the member 10 may be caused to vibrate on the springs 11 and 12 in such phase and amplitude that the resulting forces applied to the frame 13 cancel the centrifugal force of the rotating unbalanced weight 18 leaving the frame 13 substantially quiescent. This last mode is very efficient because practically no energy is transmitted through the springs 15 and 16 to the foundation from the quiescent base or frame 13. Such a structure may be made portable, 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 bed or material containing box 31. Springs 32 allow unidirectional motion of the box 31 with respect to the frame 28 and 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 against the frame 28 so that the spring vibration is 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 a preferred form of resilient means for mounting the box 31, but any other form of spring which would allow motion of the box 31 along a straight path inclined in the direction toward which the material is to move would be operative.

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 which is connected to, or is integral with, the frame 28. The auxiliary transmission 37 is controlled by a lever 38 and provides 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 springs 32 and the springs 20 and 21. 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 eccentically weighted shaft but, of course, the particular mechanism employed to apply cyclical force to the truck body is immaterial. As is means such as a pneumatically reciprocated weight acting on a line at least approximately parallel to the direction of movement of the box 31 or other mechanisms, will function equally effectively.

In these structures, the resilient tires 29 serve as the base or isolating springs comparable to the springs 15 and 16 of Figure I. However, since the only function of the springs 15 and 16 is to vibrationally isolate the base 13 from the earth, the truck body 28 can be isolated either by the tires, as shown, or by ordinary vehicle springs (not shown). This structure (as shown in either Figure III or IV) is capable of unloading any type of load except perhaps a wet mud. Suppose for example a crate of machinery is on the bed 31 and the weight 34 is rotated clockwise. The centrifugal force of the weight will tend to slide the bed 31 horizontally under the crate of machinery while the vertical centrifugal force will alternately increase and decrease the pressure between the crate and the bed. With clockwise rotation the bed tends to move forward when the pressure is least and to move rearward when the pressure is greatest. The resulting net force moves the load toward the rear. If the direction of rotation is reversed the direction of travel of the load is reversed and a crate placed at the rear of the truck bed will travel toward the front of the truck. It is desirable that the acceleration of the bed of the truck produced by the centrifugal force exceed the gravitational constant "g" in order that the force between the load and the bed of the truck shall become zero or nearly so during the forward motion of the bed.

The material containers of the trucks 27 may be equipped with an adjustable end gate so that the truck so equipped may be used for spreading material over an area. Figure IV shows the truck 27 so equipped. The box or bed 31 is equipped with an adjustable end gate 35 provided with horizontally projecting ears 40 through which is threaded a vertical screw 41 journaled in a bracket 42 secured to the side of the box 31. The lower end of the screw 41 is provided with a hand wheel 43. When the truck is so equipped and the vibrator is operated the material in the box 31 is discharged until it jams against the end gate 35 and is discharged. The rate of discharge is con-
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.

If 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 top 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 the vibration of said container be produced by any resilient means 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 vibration of said container, and means for supporting 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.

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 of the vehicle chassis in such amount as to be 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 vehicle frame and that is rotated at a speed substantially 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 commodity 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 at 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 with the container a vibratory system having a resonant frequency, and 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 by 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 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 forming therein, 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 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.

8. A portable vibratory conveyor comprising, in combination, a wheeled vehicle having a frame resiliently mounted, 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 track frame resiliently supporting said track 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 body on said frame and forming with said body a vibratory system having a natural frequency of vibration, said springs being adapted to restrain movement of said body except along a path extending generally upwardly and rearwardly relative to said truck 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 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.

11. A vibratory dump truck comprising, in combination, a truck frame, resiliently mounted on said truck frame on the ground, 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 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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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>749,695</td>
<td>Litchfield</td>
<td>Jan. 12, 1904</td>
</tr>
<tr>
<td>833,761</td>
<td>Stevens</td>
<td>Oct. 23, 1906</td>
</tr>
<tr>
<td>1,620,239</td>
<td>Mers</td>
<td>Aug. 25, 1921</td>
</tr>
<tr>
<td>1,658,328</td>
<td>Heymann et al.</td>
<td>May 17, 1923</td>
</tr>
<tr>
<td>1,922,447</td>
<td>Miller et al.</td>
<td>Aug. 15, 1933</td>
</tr>
<tr>
<td>1,950,765</td>
<td>Wettlauffer</td>
<td>Feb. 12, 1935</td>
</tr>
<tr>
<td>2,060,130</td>
<td>Scott</td>
<td>Nov. 10, 1936</td>
</tr>
<tr>
<td>2,139,162</td>
<td>Jenkins</td>
<td>Dec. 6, 1938</td>
</tr>
<tr>
<td>2,243,936</td>
<td>Wurzbach et al.</td>
<td>June 3, 1941</td>
</tr>
<tr>
<td>2,353,492</td>
<td>O'Connor</td>
<td>July 11, 1944</td>
</tr>
<tr>
<td>2,358,876</td>
<td>Overstrom</td>
<td>Sept. 26, 1944</td>
</tr>
<tr>
<td>2,374,683</td>
<td>Garratt</td>
<td>May 1, 1945</td>
</tr>
</tbody>
</table>

FOREIGN PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Country</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>216,256</td>
<td>Great Britain</td>
<td>May 29, 1924</td>
</tr>
<tr>
<td>648,127</td>
<td>Germany</td>
<td>July 22, 1937</td>
</tr>
</tbody>
</table>