Jan. 6, 1953 A. MUSSCHOOT ET AL 2,624,479

VIBRATOR FOR DISCHARGING HOPPER BOTTOM CONTAINERS

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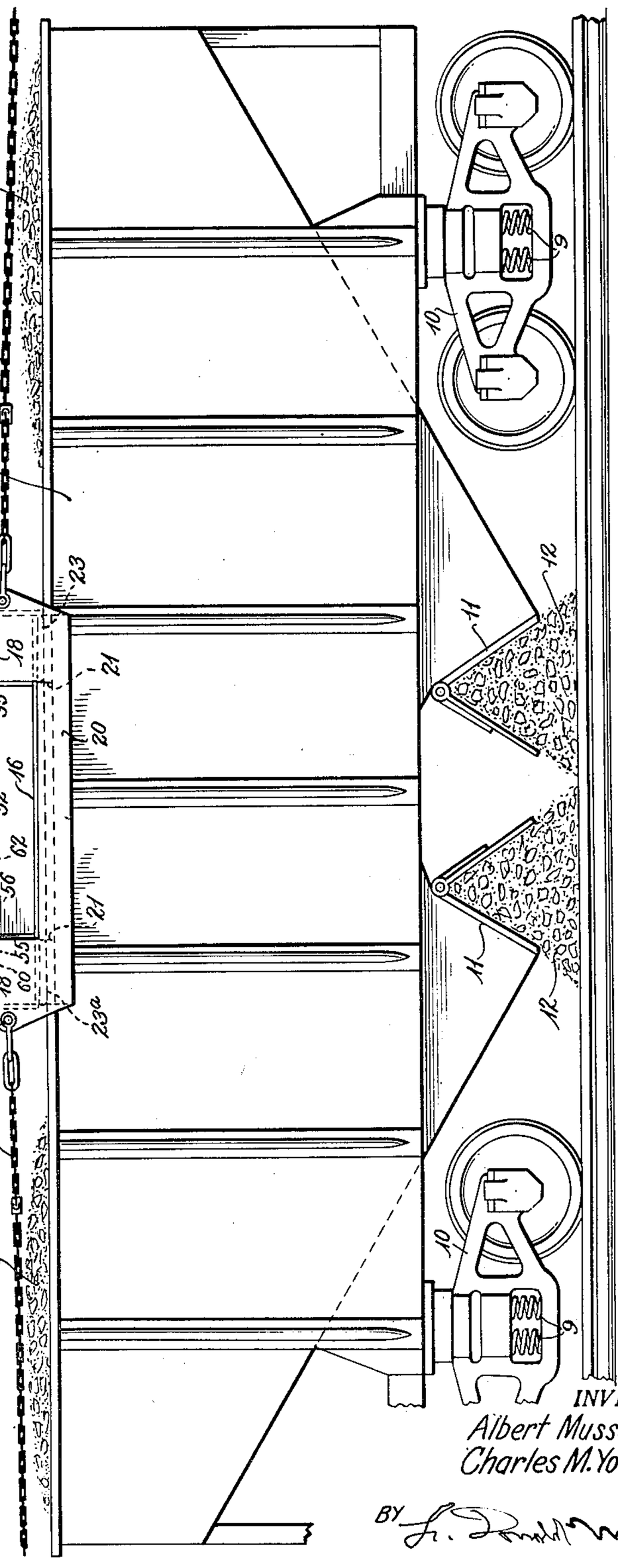
Fig. 1.



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VIBRATOR FOR DISCHARGING HOPPER BOTTOM CONTAINERS

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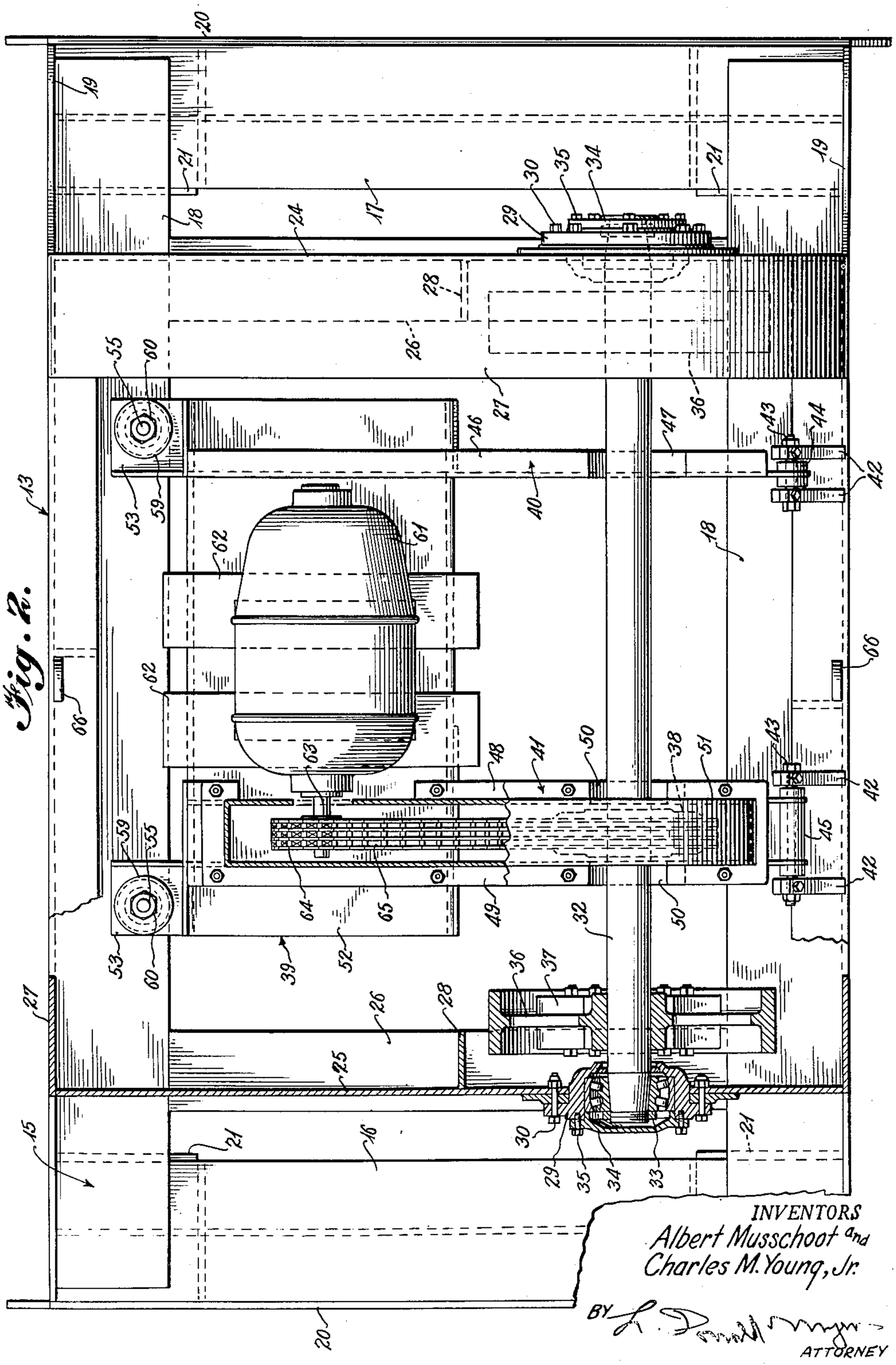
Fig. 2.



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VIBRATOR FOR DISCHARGING HOPPER BOTTOM CONTAINERS

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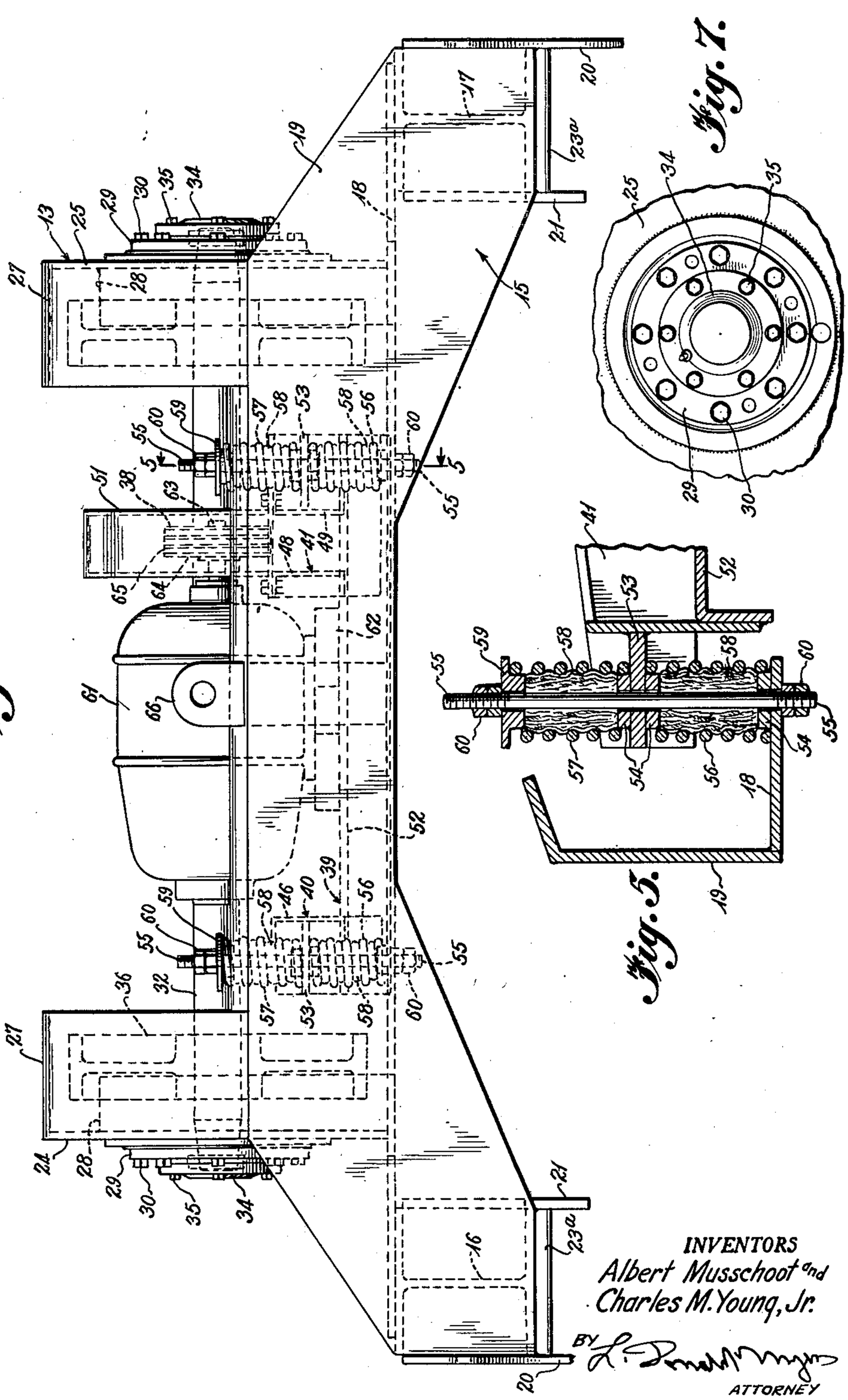

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 7.

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VIBRATOR FOR DISCHARGING HOPPER BOTTOM CONTAINERS

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Fig. 4.

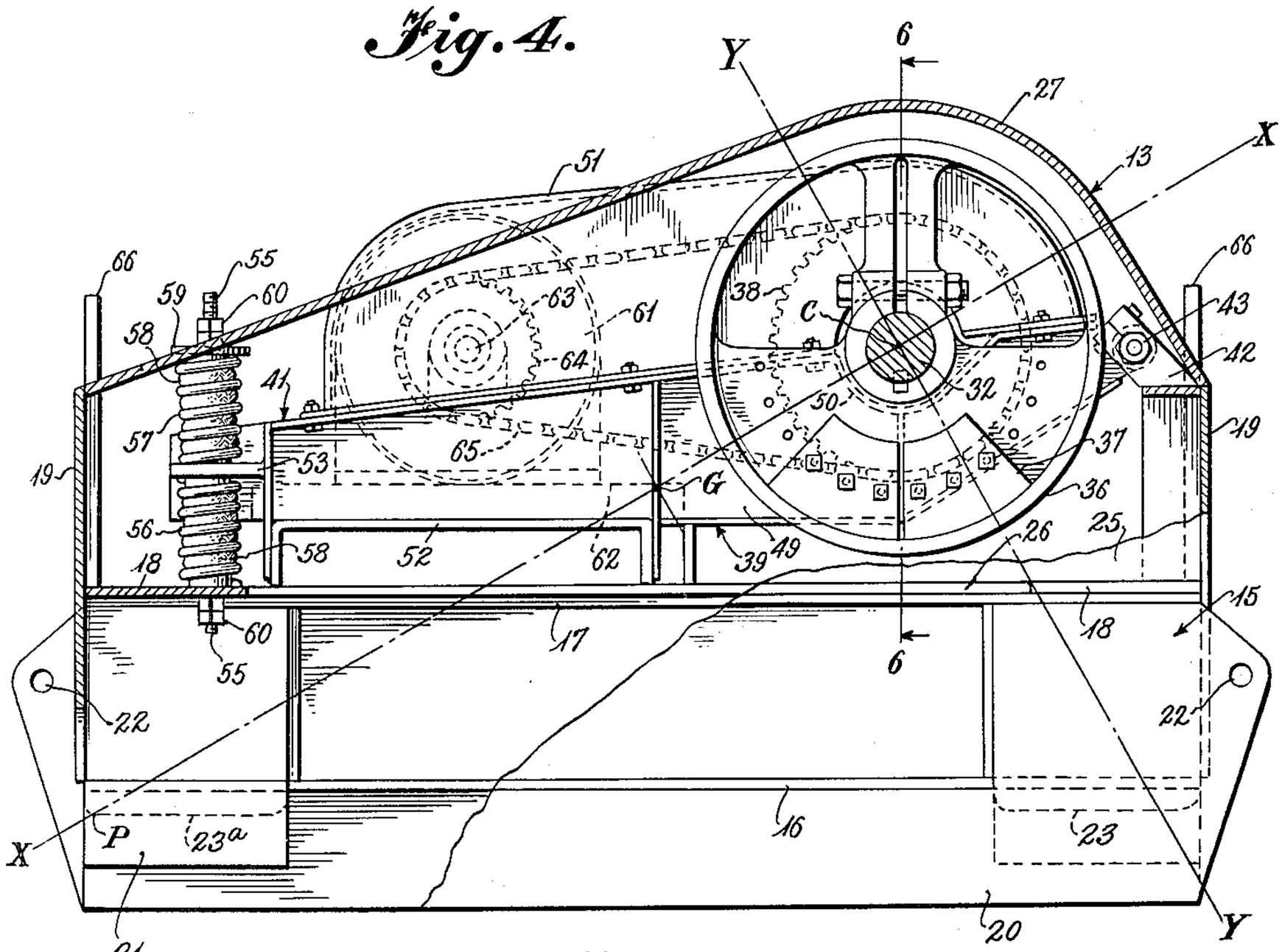
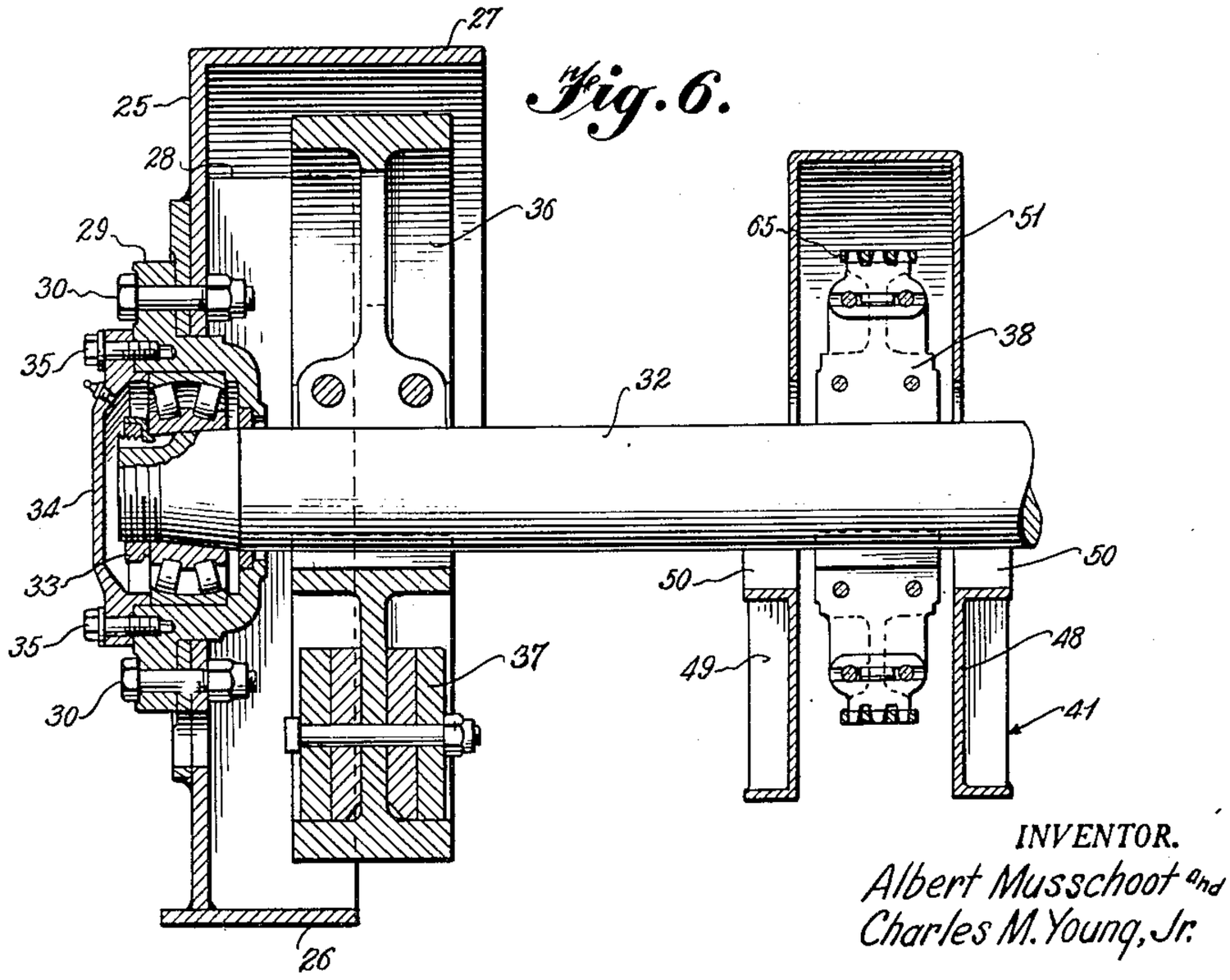


Fig. 6.



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Patented Jan. 6, 1953 2,624,479

UNITED STATES PATENT OFFICE

2,624,479

VIBRATOR FOR DISCHARGING HOPPER BOTTOM CONTAINERS

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Application March 15, 1949, Serial No. 81,467

9 Claims. (Cl. 214—83.3)

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This invention relates to new and useful improvements in vibrators for hopper bottom containers, and deals more specifically with vibrators for discharging hopper bottom railway cars used for the transportation of coal, ore and the like.

It is the primary object of this invention to provide a vibrator for discharging hopper bottom containers which will vibrate the containers at a magnitude and in a direction to give most satisfactory results without damage to the containers.

A further object of the invention is to so mount a prime mover on the frame of a vibrator as to minimize the shocks or impact forces applied to the prime mover.

A still further important object of the invention is to provide a vibrator that is so proportioned and actuated as to partake of bodily pivotal movements about a point of contact between the vibrator frame and a container to apply impact blows to the container.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification, and in which like characters are employed to designate like parts throughout the same,

Figure 1 is an end elevational view of the vibrator embodying this invention shown positioned for operation in unloading a hopper bottom railway car,

Figure 2 is a horizontal sectional view, partly broken away, of the vibrator,

Figure 3 is a side elevational view of the vibrator,

Figure 4 is a partly vertical sectional view and partly end elevational view of the vibrator,

Figure 5 is a fragmentary sectional view taken on line 5—5 of Fig. 3,

Figure 6 is an enlarged fragmentary sectional view taken on line 6—6 of Fig. 4, and

Figure 7 is a fragmentary end elevational view of a shaft bearing housing.

In the drawings, wherein for the purpose of illustration, is shown a preferred embodiment of the invention, and first particularly referring to Fig. 1, reference character 8 designates a hopper bottom railway car supported in the conventional manner by the springs 9 on the wheeled trucks 10 and provided with the gate controlled discharge openings 11 for unloading the coal 12 or other material which the car contains. The vibrator 13 is shown in an operative position with its end portions resting on the tops of the opposite sides of the car 8. The chains 14 are connected to the vibrator 13 for maintaining it in the desired position.

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Referring now to Figs. 1 through 7 for a detailed description of the vibrator 13, reference character 15 designates a bridge which is rectangular in plan, and consists basically of two transverse I-beams 16 and 17 having their corresponding end portions connected by the horizontal plates 18. Vertical side plates 19 are suitably connected to the ends of the transverse beams 16 and 17 and the outer edges of the horizontal plates 18.

Outer retaining plates 20 are connected to the outer flanges of the transverse beams 16 and 17 and depend from the lower flanges throughout the entire lengths of the beams. Short inner retaining plates 21 are positioned at and connected to the inner flanges at each end portion of the I-beams 16 and 17 and depend from the lower flanges. The ends of the outer retaining plates 20 extend beyond the ends of the beams 16 and 17 and are provided with openings 22 for connecting the chains 14 to the bridge 15, see Fig. 1.

The bottom surface of each one of the I-beams 16 and 17 is provided with a suitably connected impact shoe 23 at one end, and a pivot shoe 23*a* at the other end.

The length of the bridge 15 is such that the shoes 23 and 23*a* will rest on the tops of the sides of the car 8. The bridge 15 will be prevented from moving laterally off of the car by the depending retaining plates 20 and 21 which extend below the shoes 23.

Bearing support plates 24 and 25 are mounted vertically near the ends of the bridge 15 and are connected to the horizontal plates 18 and the vertical side plates 19. The stiffening flanges 26 are connected to the bottoms of the vertical plates 24 and 25 between the horizontal plates 18. Cover flanges 27 project laterally inwardly from the top edges of the vertical plates 24 and 25 and extend between the vertical side plates 19. A stiffening brace 28 is connected to the flanges 26 and 27 of each of the vertical plates 24 and 25.

Each of the vertical plates 24 and 25 is provided with a reinforced opening near one side of the bridge 15 for receiving a roller bearing cartridge 29 which is fastened to the vertical plate by the bolts 30. A shaft 32 extends between and is supported by the bearings 29. The inner races of the bearings 29 are tapered as are the end portions of the shaft 32 so that the lock nuts 33 prevent lateral movement of the shaft relative to

the bearings. The outer side of the housing of each bearing cartridge **29** includes a cover plate **34** which is removably fastened in place by the bolts **35**.

A pair of identical fly-wheels **36**, provided with counter-weights **37**, are mounted one on each end portion of the shaft **32** and keyed to the shaft to prevent relative rotary movement therebetween. The locations of the fly-wheels **36** on the shaft **32** are such that they are peripherally enclosed by the cover flanges **27** which therefore act as housings.

The shaft **32** is also provided with a sprocket **38** which is keyed to the shaft so that rotation of the sprocket will cause rotation of the shaft and its counter-weighted fly-wheels.

A support **39** is provided for properly mounting a driving motor on the bridge **15**. The motor support includes two arms **40** and **41** which are each pivotally connected at one of their extremities to one side of the bridge **15**. As illustrated in Figs. 2 and 4, the pivotal connections between the arms **40** and **41** and the bridge **15** each consists of a pair of hinge posts **42** with a bolt **43** extending therebetween for receiving the bushing **44** on the arm **40** or the bushing **45** on the arm **41**. The arm **40** consists of a single channel member **46** extending across the bridge and having a notch **47** to provide clearance between the shaft **32** and the arm. The arm **41** consists of a pair of channel members **48** and **49** extending across the bridge in spaced back-to-back relation, each located adjacent to and on opposite sides of the lower portion of the sprocket **38**. Each of the channel members **48** and **49** is provided with a notch **50** to provide clearance between the shaft and the arm **41**.

A housing **51**, having a flanged lower edge around its four sides, rests upon and is connected to the upper flanges of the channel members **48** and **49** to cover the upper portion of the sprocket **38**. The housing **51** is provided with a notch in the lower margin of each side to provide clearance between the shaft **32** and the housing.

A platform **52** is positioned beneath and connected to the bottom flanges of the end portions of the arms **40** and **41** opposite their pivotal connections with the bridge **15**. The platform **52** extends between the arms and is provided with downwardly flanged side portions to increase its strength.

As illustrated in Figs. 3, 4 and 5, the arms **40** and **41** are each provided beyond the platform **52** with a horizontal mounting fin **53** lying directly above and parallel to the adjacent horizontal side plate **18**.

Lugs **54**, having centrally located openings, are suitably connected in vertical alinement to each side of the mounting fins **53** and to the upper surface of the side plate **18**. Openings are provided in the fins **53** and the side plate **18** in alinement with the openings in the lugs **54**. Stud bolts **55** are inserted through the above-mentioned openings and extend upwardly from the mounting fins. A coil spring **56** is positioned on a bolt **55** between each mounting fin **53** and the side plate **18**. A second coil spring **57** is positioned over that portion of each bolt **55** which extends upwardly from a mounting fin. A roll of belting or similar material **58**, which will dampen the vibratory movements, is enclosed within the convolutions of each of the springs **56** and **57**. A washer **59**, having an offset bottom surface, is fitted onto the upper end of each bolt **55** and rests upon the top of the associated spring

57 so that the offset portion lies within the uppermost coil of the spring. Nuts **60** are threaded onto each end of the bolts **55** and tightened to compress the springs **56** and **57** and the belting **58** into tight frictional contact with the springs. Lateral movement of the springs **56** and **57** is prohibited by the lugs **54** and the offset portion of the washer **59**.

As a result of the above described connection between the mounting fins **53** and the horizontal side plate **18**, upward and downward movements of the platform **52** are resisted by the springs **57** and **56**, respectively.

An electric motor **61**, having a laterally adjustable base **62**, is mounted on the platform **52** so that its shaft **63** extends into the space within the housing **51** and between the channel members **48** and **49** of the arm **41**. The portion of the shaft **63** within the above space is provided with a driving sprocket **64**. A chain **65**, or other suitable device, drivingly connects the sprockets **64** and **38** so that operation of the motor will rotate the shaft **32** and its attached fly-wheels **36**.

An apertured ear **66** is mounted near the longitudinal center of each vertical side plate **19** so that a hoisting chain or cable may be connected to the vibrator **13** for movement to and from the tops of cars which are to be discharged.

Referring now to Fig. 4 for a detailed discussion of the locations and proportions of various parts of the vibrator **13**, the design is such that when the fly-wheels **36** and their counter-weights **37** are rotated, the bridge will partake of pivotal movement about the point P, or the outer extremities of the two shoes **23***a*, to deliver impact blows at the other side of the bridge **15** through the two shoes **23**. In order to provide for the above described operation, the axis of the shaft **32** is located substantially at the center of percussion C of the vibrator **13** with respect to the pivotal movement about the point P. Further, the center of gravity G of the vibrator **13** lies in the line X—X that passes through the axis of the shaft **32** and the pivot point P. In other words, the shaft **32** is so located that forces may be applied along the line Y—Y through the shaft in a direction normal to the line X—X without causing a reaction at the pivot point P. This line Y—Y illustrates the direction of the application of forces when pivotal movement of the bridge **15** about the point P brings the shoes **23** on the impact side into contact with the tops of the sides of the car **8**.

Looking now to the operating characteristics of the vibrator **13**, actuation of the motor **61** causes rotation of the shaft **32** with its fly-wheels **36** and their attached counter-weights **37**. As a result of the unbalanced condition of this rotating mass, radial forces are developed which sweep through each one of the 360° of a complete revolution. These forces can be resolved into two comonents, one along the line Y—Y, and the other along the line X—X. Because of the location of the shaft **32** at the center of percussion C, the components along line Y—Y produce pivotal movements about the point P. The components of the forces along the line X—X result in reciprocal sliding movement of the vibrator **13** along the top of the car **8**.

The operation of the vibrator **13** may be divided into two phases:

(1) When the impact shoes **23** are out of contact with the car.

(2) When the impact shoes 23 are in contact with the top of the car.

When the impact shoes 23 are out of contact with the top of the car 8, the vibrator 13 may be considered as a body with rotation about the point P. The rotating shaft 32 with its counter-weights 37 turns in bearings 29 mounted on the bridge 15. Centrifugal forces produced by the counter-weights 37 are opposed by the inertia and centrifugal forces of the bridge 15, the motor support 39 and the motor 61.

If no other external forces were applied to the vibrator 13, an instantaneous spin axis or center of rotation would exist at some point between the center of the shaft 32 and the center of gravity of the counter-weights 37 with the result that the centrifugal force of the vibrator 13 is equal and opposite to that of the counter-weights. This means that when the center of the unbalanced weights 37 is in the lowest position, the device 13 is at the top of its movement.

Components along the line X—X that tend to produce reciprocal sliding movement of the bridge 15 are opposed by frictional forces at the pivot point P. These frictional forces reduce the amplitude of movement along the top of the car 8 so that the center of the shaft 32 moves through a path of partial ellipse having its major axis along the line Y—Y and its minor axis along the line X—X.

When the impact shoes 23 contact the top of the car 8 the rotational energy of the bridge 15 is converted to an impact blow which produces vibrational movement in the body of the car. The material in the car 8 is, therefore, discharged through the hopper openings 11 by the impact blows on the top of the car sides. At the moment before impact, the vibrator 13 is pivoting about the point P so that when impact occurs the entire energy of the resultant blow is concentrated at the shoes 23 on the line Y—Y. Since the line Y—Y intersects the line X—X at the center of percussion C and the resultant of the impact forces lies along the line Y—Y, the pivot shoes 23*a* will remain in contact with the tops of the sides of the car 8 and the entire impact energy will be applied through the shoes 23.

It is noted that the motor support 39 is resiliently connected to the pivotal side of the bridge 15 so that the motor 61 is not subjected to undue impact forces when the vibrator 13 is in operation. Further, the belting material 58 within the springs 56 and 57 acts to dampen the vibratory movements of the motor support 39 so that motor vibration is reduced to a minimum. Inasmuch as the point of pivotal connection between the motor support 39 and the bridge 15 is on the opposite side of the shaft 32 from the motor 61, vibrations of the motor 61 and its support 39 will not appreciably change the distance from the axis of the motor shaft 63 to the axis of the shaft 32.

As illustrated in Fig. 1 the vibrator 13 is positioned on the car 8 so that the shoes 23 and 23*a* rest upon the tops of the car sides. The chains 14 are attached through the holes 22 to the ends of the outer retaining plates 20 so that the vibrator 13 may be guided to its desired location on the car sides, and the chains 14 are then employed to maintain the vibrator in the desired location.

It is to be understood that the form of the invention herewith shown and described, is to be taken as a preferred example of the same, and that various changes in the shape, size, and arrangement of parts may be resorted to, without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described the invention, we claim:

1. A vibrator for discharging hopper bottom discharge containers, comprising a bridge, means on the bottom of said bridge at each end portion thereof for supporting the bridge on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the extremities of the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, an unbalanced shaft rotatably mounted longitudinally of said bridge at the side which delivers said impact blows, said shaft having its axis passing through the center of percussion relative to the pivotal extremities of said supporting means, a motor support pivotally connected at one of its end portions to the impact delivering side of said bridge, resilient means connecting the other end portion of said motor support to the pivotal side of said bridge for limited movement relative to the latter, a motor mounted on the resiliently connected end portion of said motor support, and means drivingly connecting said motor and said shaft for rotating said shaft to cause the unbalanced condition of the shaft to effect said pivotal movement of the bridge for delivering said impact blows, the line of force of said impact blows passing substantially through the impact delivering portion of said supporting means and the axis of said shaft.

2. A vibrator for discharging hopper bottom discharge containers, comprising a bridge, means on the bottom of said bridge at each end portion thereof for supporting the bridge on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the extremities of the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, an unbalanced shaft rotatably mounted longitudinally of said bridge at the side which delivers said impact blows, said shaft having its axis passing through the center of percussion relative to the pivotal extremities of said supporting means, a pair of arms each having one end portion pivotally connected to the impact delivering side of said bridge, resilient means connecting the other end portions of said arms to the pivotal side of said bridge for limited relative movement therebetween, a platform mounted on said arms adjacent the resiliently connected end portions thereof, a motor mounted on said platform, and means drivingly connecting said motor and said shaft for rotating said shaft to cause the unbalanced condition of the shaft to effect said pivotal movement of the bridge for delivering said impact blows, the line of force of said impact blows passing substantially through the impact delivering portion of said supporting means and the axis of said shaft.

3. A vibrator for discharging hopper bottom discharge containers, comprising a bridge, means on the bottom of said bridge at each end portion thereof for supporting the bridge on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the extremities of the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, an unbalanced shaft rotatably mounted longitudinally of said bridge at the side which de-

livers said impact blows, said shaft having its axis passing through the center of percussion relative to the pivotal extremities of said supporting means, a pair of arms each having one end portion pivotally connected to the impact delivering side of said bridge, resilient means connecting the other end portions of said arms to the pivotal side of said bridge for limited relative movement therebetween, means associated with said resilient means for damping the movement of said arms, a platform mounted on said arms adjacent the resiliently connected end portions thereof, a motor mounted on said platform, and means drivingly connecting said motor and said shaft for rotating said shaft to cause the unbalanced condition of the shaft to effect said pivotal movement of the bridge for delivering said impact blows, the line of force of said impact blows passing substantially through the impact delivering portion of said supporting means and the axis of said shaft.

4. A vibrator for discharging hopper bottom discharge containers, comprising a bridge, means on the bottom of said bridge at each end portion thereof for supporting the bridge on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the extremities of the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, an unbalanced shaft rotatably mounted longitudinally of said bridge at the side which delivers said impact blows, said shaft having its axis passing through the center of percussion relative to the pivotal extremities of said supporting means, a pair of arms each having one end portion pivotally connected to the impact delivering side of said bridge, resilient means connecting the other end portions of said arms to the pivotal side of said bridge for limited relative movement therebetween, a platform mounted on said arms adjacent the resiliently connected end portions thereof, a motor mounted on said platform, means drivingly connecting said motor and said shaft for rotating said shaft to cause the unbalanced condition of the shaft to effect said pivotal movement of the bridge for delivering said impact blows, the line of force of said impact blows passing substantially through the impact delivering portion of said supporting means and the axis of said shaft, and housing means mounted on one of said arms for cooperation therewith to substantially enclose said drive means.

5. A vibrator for discharging hopper bottom containers, comprising a bridge, means on the bottom of said bridge at each end portion thereof for supporting the bridge on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the extremities of the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, the center of percussion of the vibrator, relative to the pivotal extremities of said bridge supporting means, being located at the side of the bridge which delivers said impact blows to minimize the reaction at the pivotally supported side of said bridge due to the impact blows, an unbalanced shaft rotatably mounted longitudinally of said bridge in parallel relationship with said pivotal extremities and having its axis passing through said center of percussion, a motor attached to said bridge and located at the pivotally supported side of the latter, and means drivingly connecting said motor and said shaft for rotating said shaft to effect said pivotal movement of the bridge for delivering said impact blows, the line of force of said impact blows passing substantially through the impact delivering portion of said supporting means and the axis of said shaft.

6. A vibrator for discharging hopper bottom containers, comprising a bridge, means on the bottom of said bridge at each end portion thereof for supporting the bridge on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the extremities of the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, an unbalanced shaft rotatably mounted longitudinally of said bridge at the side which delivers said impact blows, said shaft having its axis passing through the center of percussion relative to the pivotal extremities of said supporting means, mounting means associated with said bridge, a prime mover attached to said mounting means, means for pivotally supporting said mounting means for movement about an axis fixed relative to said bridge spaced from said prime mover and paralleling said unbalanced shaft, means for resiliently supporting said mounting means, said pivotal and resilient supporting means for said mounting means being located in spaced relation to each other relative to the length of said mounting means, and means drivingly connecting said motor and said shaft for rotating said shaft to effect said pivotal movement of the bridge for delivering said impact blows, the line of force of said impact blows passing substantially through the impact delivering portion of said supporting means and the axis of said shaft.

7. A vibrator for discharging hopper bottom containers, comprising a bridge, means at each end portion of said bridge for supporting the latter on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, an unbalanced shaft rotatably mounted longitudinally of said bridge on the side which delivers said impact blows, mounting means extending across said bridge at right angles to said shaft, means for pivotally supporting said mounting means on the impact delivering side of the bridge for movement about an axis, fixed relative to said bridge, paralleling and adjacent to said shaft, a prime mover rigidly attached to said mounting means on the pivotal side of said bridge, means for resiliently supporting said mounting means, said pivotal and resilient supporting means for said mounting means being located in spaced relation to each other relative to the length of the prime mover mounting means, and flexible means drivingly connecting said prime mover and said shaft for rotating the latter to impart said pivotal movement to the bridge.

8. A vibrator for discharging hopper bottom containers, comprising a bridge, means at each end portion of said bridge for supporting the latter on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, an unbalanced shaft rotatably mounted longitudinally of said bridge on the side which delivers said impact blows, a pair of parallel arms extending across said bridge at right angles

to said shaft, means for pivotally supporting said pair of arms on the impact delivering side of said bridge for movement about a common axis, fixed relative to said bridge, paralleling said shaft, a platform mounted on said arms on the pivotal side of said bridge, a prime mover rigidly attached to said platform, means for resiliently supporting the pair of arms on the bridge, and flexible means drivingly connecting said prime mover and said shaft for rotating the latter to impart said pivotal movement to the bridge.

9. A vibrator for discharging hopper bottom containers, comprising a bridge, means at each end portion of said bridge for supporting the latter on the tops of the sides of the container to be discharged, said bridge being adapted to pivot about the supporting means at one side of the bridge for delivering impact blows through the supporting means at the other side of the bridge, an unbalanced shaft rotatably mounted longitudinally of said bridge on the side which delivers said impact blows, an elongated mounting base extending across said bridge at right angles to said shaft, means for pivotally supporting one end portion of said mounting base on the

impact delivering side of the bridge for movement about an axis, fixed relative to said bridge, paralleling said shaft, a prime mover rigidly attached to the other end portion of said mounting base on the pivotal side of said bridge, spring means for supporting the end portion of said mounting base on which said prime mover is mounted, and flexible means drivingly connecting said prime mover and said shaft for rotating the latter to impart said pivotal movement to the bridge.

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