Oct. 23, 1951 R. HELM 2,572,339

VIBRATION ACTUATED TRANSFER DEVICE

Filed Oct. 18, 1948

2 SHEETS--SHEET 1

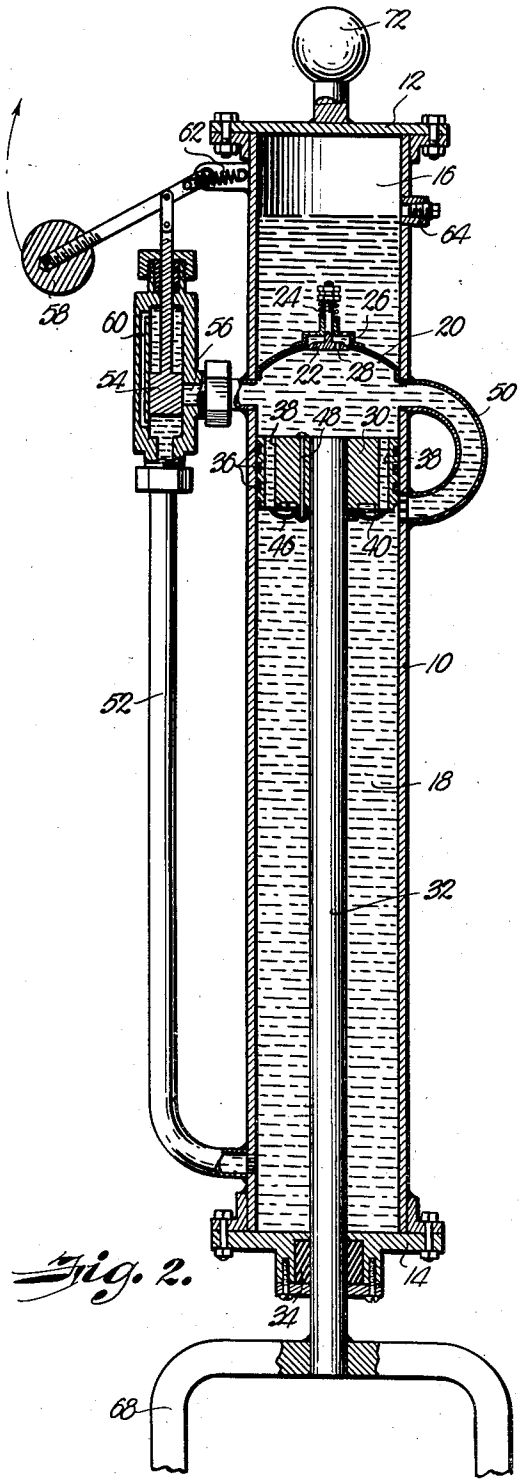


Fig. 2.

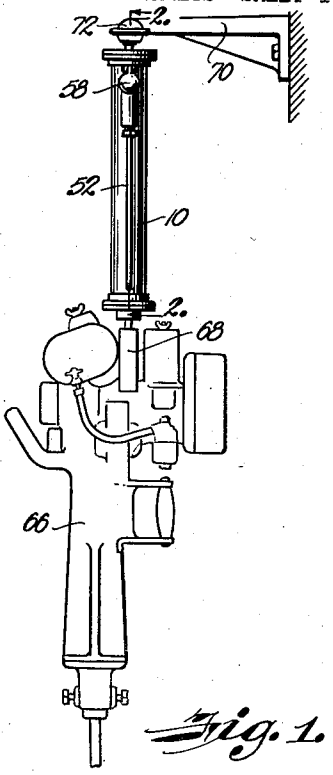


Fig. 1.

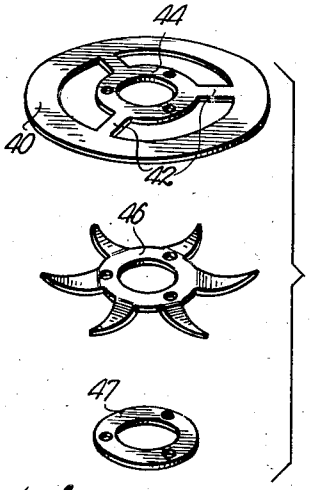


Fig. 3.

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Fig. 4.

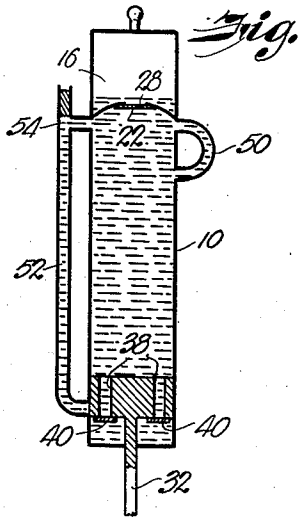
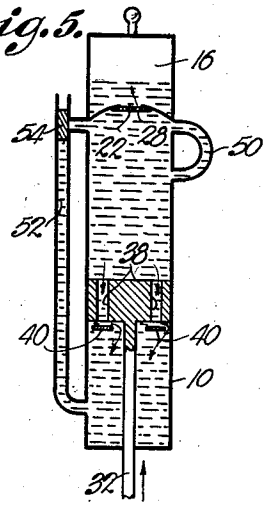


Fig. 5.



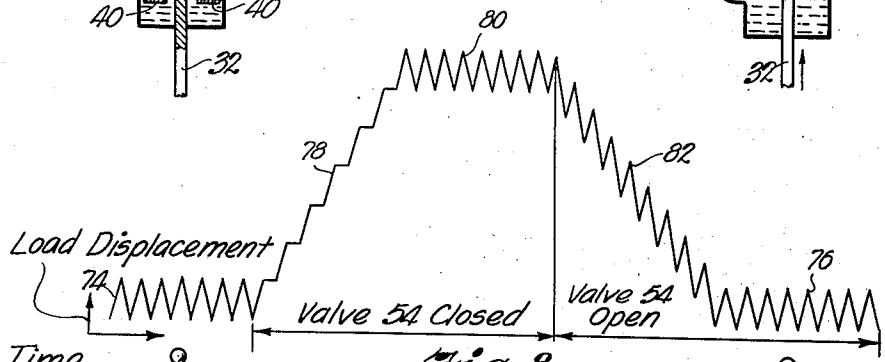


Fig. 8.

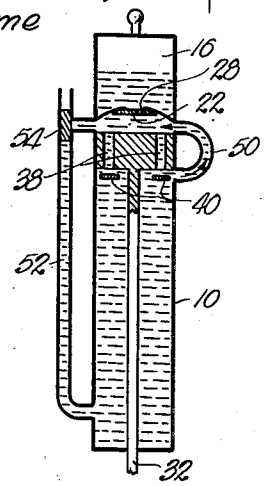


Fig. 6.

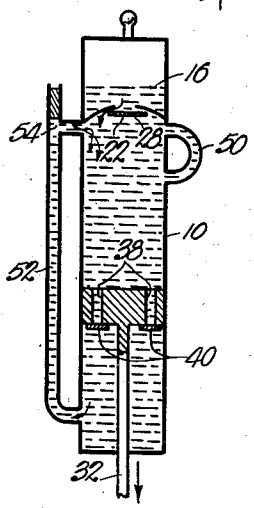


Fig. 7.

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UNITED STATES PATENT OFFICE

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VIBRATION ACTUATED TRANSFER DEVICE

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Application October 18, 1948, Serial No. 55,073

18 Claims. (Cl. 74—88)

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The present invention relates in general to vibrating bodies, and it deals more particularly with the transfer of such bodies from place to place.

Many forms of apparatus contain moving parts whose operation causes the apparatus as a whole to vibrate. Illustrative of this class of device are such power tools as riveters, spike drivers, jack hammers, railroad tie tampers, etc. Ordinarily when the need arises, these units are lifted, shifted or moved from place to place either manually or by some other means involving the application of an auxiliary source of power to the unit.

Broadly speaking, it is the object of the present invention to obviate the need for an auxiliary source of power to achieve this end. More specifically, the invention is aimed at utilizing the vibration of the machine itself to move the machine.

To this end, an important object of the invention is to provide a method and apparatus for resisting movement of a vibrating body to a greater degree in one direction than in the opposite direction, whereby the body will advance step by step in the direction of least resistance as it vibrates.

Another object is to provide means for producing a retrograde movement of the body whenever desired.

A further object resides in the provision of apparatus for instituting the step by step advance of the body at will. Still another objective is to provide means for halting the advance of the body, when once started, automatically without the need for further supervision or control when the body reaches a predetermined point.

Other objects, together with the features of novelty by which the objects are achieved, will appear in the course of the following description of the invention.

In the accompanying drawings which form a part of the specification and are to be read in conjunction therewith, and in which like reference numerals are employed to indicate like parts of the various views,

Fig. 1 is a side elevational view of the tie-tamper supported by a lifting device constructed according to the invention,

Fig. 2 is an enlarged cross sectional view taken along the line 2—2 of Fig. 1 in the direction of the arrows,

Fig. 3 is an exploded perspective view showing the component parts of the valve assembly associated with the piston of my device,

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Figs. 4 to 7 are schematic diagrams of the device, Fig. 4 showing the piston in its lowermost position, Fig. 5 showing it with the piston ascending, Fig. 6 showing the piston in its uppermost position and Fig. 7 showing it with the piston descending, and

Fig. 8 is a graph wherein load displacement is plotted against time, illustrating schematically the character of the piston's movement.

The construction of my unit may readily be understood by reference to Fig. 2. Its housing comprises a cylinder 10 closed at the top by an end cap 12 and at the bottom by an end cap 14, both end pieces being bolted in place and forming with the cylinder a fluid tight enclosure.

The cylinder is divided into upper and lower compartments 16 and 18 by a rigid, dome shaped partition 20 welded about its margin to the interior wall of the cylinder. In the partition is a check valve 22 biased toward closed position by a coiled spring 24 encircling the valve stem; the stem is slidably supported in a perforate frame or guide 26 welded to the partition, and it will be noted that the valve is provided with a small bleeder opening 28, the function of which will be explained presently.

In the lower compartment of the cylinder is a piston 30 whose piston rod 32 extends downwardly through a packing gland 34 in the bottom cap. The piston is secured to the piston rod with a shrink fit and is sealed relative to the interior of the cylinder by conventional piston rings 36. A series of holes 38 are drilled through the piston parallel to the piston rod, these being arranged in a circle about the rod and having their lower extremities covered by an annular valve plate 40.

As seen in Fig. 3, the valve plate is connected by radial arms 42 to an inner collar 44. Under the valve plate is a star-shaped spring 46, these two members, together with a backing washer 47, being secured to the underside of the piston by rivets 48. Thus assembled, it will be observed that the upwardly tensioned points of the star spring bear against the underside of the annular valve plate and hence maintain same tight against the face of the piston in sealing relation to the holes 38.

The lower compartment of the cylinder is provided with a pair of fluid by-pass lines 50 and 52, the former having its upper end connected into the cylinder wall at a point immediately below the partition 20 and its lower end connected into the cylinder only a short distance therebelow, such distance however being sufficient

to permit the piston to occupy a position intermediate the inlet and outlet of duct 50. By-pass 52 has its upper end connected into the cylinder wall immediately below partition 20 and its lower end connected into the lower end of the cylinder a short distance above the bottom.

The latter by-pass line is provided with a balanced pressure type of valve having a slidable piston 54 adapted to cover the port 56 when the handle 58 is in the position illustrated and to uncover the port when the handle is pivoted upwardly as shown by the arrow. The valve housing is provided with a relief line 60 whereby the fluid pressure on the top and bottom of the piston is substantially balanced; actually, of course, there is a slight excess of pressure on the bottom resulting from the somewhat smaller effective area of the upper face of the piston, but this is compensated for by the weight of the handle and by a light spring 62, so that the valve always will remain in the position to which it was last operated.

Through the opening normally closed by filler plug 64 there is introduced into the cylinder oil or other suitable liquid in an amount sufficient to fill the cylinder substantially as shown. That is, the lower compartment is completely filled and, in the upper compartment, there is a volume of liquid not completely filling the compartment yet somewhat exceeding the volume of liquid displaced by the piston rod 32 when the piston is in its uppermost position.

For purposes of description it will be assumed that the vibrating instrumentality to be supported by my device is a tie tamper 66; the construction and operation of this instrument form no part of the present invention but it should be understood that it is a self-powered unit used in railroad construction and maintenance work for the purpose of tampering ties, its mechanism being of such a nature as to cause the tool as a whole to vibrate in a more or less vertical direction. The unit is connected to the lower extremity of the piston rod 32 in any convenient fashion, for example by means of a yoke 68. The cylinder 10 of my device in turn is supported in any suitable fashion, it being understood that the bracket 70 and the ball and socket joint 72 are intended only to be illustrative of a suitable form of support.

The operation of the device now will be explained in connection with Figs. 4 to 8. Referring first to Fig. 4, it will be noted that the weight of the tool connected to the piston rod 32 has drawn the piston down to a point near the bottom of the cylinder. The liquid in the cylinder beneath the piston has no avenue of escape when the piston occupies the position shown and, being relatively incompressible, it prevents the piston from descending lower in the cylinder; since the piston never reaches the bottom of the cylinder, there is no possibility of damage to the check valve mechanism on the underside of the piston. Fig. 4 thus represents the lowermost position of the loaded piston, and so long as the tool or other instrument connected to the piston remains in the state of quietus, the parts will remain as illustrated.

Let it now be assumed that the tool is rendered active and that due to its vibration, it applies to the piston rod a longitudinal force urging same alternately up and down. The fluid in the cylinder offers no substantial resistance to upward movement of the piston inasmuch as it can escape from the upper end of the cylinder through the open valve 54 and, passing downwardly, reenter the cylinder below the upwardly moving piston; moreover, as the piston is urged upwardly, any excess of fluid pressure on the upper side of the piston will open the check valve 40, relieving the pressure and allowing the piston to ascend while the liquid escapes downwardly through the apertures 38 into the space below the piston. After an upward stroke of the piston, the liquid likewise offers little resistance to downward movement of the piston when, on the succeeding power impulse, it is urged in that direction. That is to say, the liquid below the piston can escape through duct 52 and reenter the cylinder at the top.

From the foregoing it will be clear that with a vibratory force applied to the piston rod 32 while valve 54 is open as shown, the piston and the instrument carried thereby will oscillate up and down a short distance approximately as indicated by sections 74 and 76 of the load displacement diagram, Fig. 8.

Assuming that it is desired now to elevate the vibrating tool, valve 54 is manually closed as shown in Fig. 5. This makes it impossible for the piston to descend in the cylinder because there is no avenue of escape for the liquid below the piston; however, the piston still can ascend because the check valve 40 opens whenever an upward force is applied, allowing the liquid above the piston to flow downwardly through apertures 38 thereby to make way for the piston. Accordingly, with each upward impulse applied to the piston rod by the vibrating tool, the piston ascends a short distance and there remains suspended, unable to drop back, until it is carried up another step by the succeeding impulse. In the last analysis, my device simply allows the tool to jump up, catches and holds it when it endeavors to move back, then allows it to jump again on the next cycle of vibration. In effect, then, the tool "walks up" under its own power, advancing step by step as indicated by section 78 of the load displacement diagram, Fig. 8.

With each upward step there is, of course, an increase in the liquid space below the piston and a corresponding decrease in the space above; the increase and the decrease are nearly, but not quite, equal, the difference in the two being due to the space occupied by the piston rod on the underside of the piston. In other words, as the piston travels upwardly, more and more of the piston rod 32 enters the cylinder, displacing liquid and making it necessary to accommodate the displaced liquid if the device is to function without jamming. This is the purpose of the upper compartment 16 into which excess liquid slowly flows through the bleeder opening 28 in accordance with the increasing volume occupied by the advancing piston rod. Such action is illustrated in Fig. 5.

If at any time during its ascent the vibrating instrument connected to the lower end of the piston rod is rendered inoperative so that it ceases to apply upward power impulses to the piston rod, it will be apparent that the piston will halt and remain in whatever position it then occupies. Even though there is a downward force due to the weight of the suspended instrument, it is impossible for the piston to descend in the cylinder so long as valve 54 remains closed, and accordingly the load is held in elevated position.

Assuming, however, that the instrument connected to the piston rod continues to vibrate, the piston will continue to travel upwardly un-

til it finally reaches the position shown in Fig. 6, wherein duct 50 connects the space above the piston with the space below. At the end of the upward power stroke bringing it to this position, a downward force is applied to the piston rod and, because the liquid underneath the piston can escape through duct 50 and return to the space above the piston, the piston drops back until it covers the opening at the lower end of duct 50. The next upward power impulse again lifts the piston, after which it once more drops back, and so on, its movement being depicted by section 80 of the load displacement diagram, Fig. 8.

Again if the vibrating instrument is rendered inoperative, it will remain suspended in a state of quietus inasmuch as the piston cannot descend below the point where it covers the end of duct 50.

If it is desired to lower the tool, however, it is only necessary to manually open valve 54 as shown in Fig. 7, whereupon the liquid below the piston flows through duct 52 and returns to the cylinder above the piston while the latter moves downwardly. The rate of descent can of course be controlled by the valve. Such downward movement will take place upon the opening of the valve whether the tool is vibrating or not, the descent being at a uniform rate if there is no vibration and being as indicated at 82 in Fig. 8 if the contrary is true.

In either case, as the piston rod 32 moves out of the cylinder, the liquid capacity of the cylinder increases proportionately and therefore valve 22 opens as shown in Fig. 7 to permit liquid in the reservoir 16 to flow downwardly, preventing the creation of a partial vacuum above the piston, which might otherwise impede the descent of the device. When the piston reaches the position shown in Fig. 4, it covers the inlet to duct 52 and accordingly its descent is halted by the cushion of liquid remaining below the piston.

Although for purposes of description a tie tamper has been considered to be the instrument supported by my lifting device, it will be self-evident that the operation would be the same if a jack hammer, a spike driver or any other type of vibrating tool were substituted. It is not essential, as a matter of fact, that the vibration of the attached instrument take place along the axis coinciding precisely with the axis of the cylinder; so long as some component of the vibration is along the axis of the cylinder, the device will function satisfactorily. No matter how much or how little the instrument moves up on each vibratory cycle, it will be caught and held so that it will progress upwardly step by step.

While especially useful as a lifting device, my unit obviously can be inclined from the vertical to produce a lateral movement as well, if this is desired. Other modifications will be apparent to those versed in the art, and inasmuch as many possible embodiments of the invention can be made without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

From the foregoing it will be seen that this invention is one well adapted to attain all the ends and objects hereinbefore set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It should be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the appended claims.

Having thus described the invention, I claim:

1. In combination with a prime mover which is movable in space as a unit, said prime mover effective when in operation to vibrate at a substantially uniform frequency, a device for shifting said prime mover in space for distances exceeding the normal amplitude of free vibration of the prime mover, comprising a stationary member, a movable member connected to the prime mover for vibration therewith, one of said members comprising an enclosed tube with hydraulic fluid therein, the other of said members comprising a piston slidable in the tube, the stroke of the piston in the tube exceeding the normal amplitude of free vibration of said prime mover, said piston having a port through which fluid can flow from one side of the piston to the other as the piston travels through the tube, and a check valve associated with said port to prevent the flow of fluid therethrough in one direction.

2. In combination with a prime mover which is movable in space as a unit, said prime mover effective when in operation to vibrate at a substantially uniform frequency, a device for shifting said prime mover in space for distances exceeding the normal amplitude of free vibration of the prime mover, comprising a stationary member, a movable member connected to the primer mover for vibration therewith, one of said members comprising an enclosed tube with hydraulic fluid therein, the other of said members comprising a piston slidable in the tube, the stroke of the piston in the tube exceeding the normal amplitude of free vibration of said prime mover, a duct connecting the fluid space on one side of the piston with the fluid space on the other side, and a check valve associated with said duct to control the flow of fluid therethrough.

3. In combination, a pair of relatively movable members, one comprising an enclosed upright tube and the other comprising a piston in the tube, means supporting one of said members, a prime mover mounted on the other member and having substantially its entire weight carried thereby, said prime mover effective when operating to vibrate at a substantially uniform frequency and consequently urge said last member alternately up and down, hydraulic fluid in said tube on both sides of said piston, a duct connecting the fluid space on one side of the piston with the fluid space on the other side, thereby to permit flow of fluid and movement of the piston through the tube, and a check valve associated with said duct to prevent the flow of fluid therethrough in such a direction as to oppose downward movement of said last member but not upward movement thereof.

4. In combination, a pair of relatively movable members, one comprising an enclosed tube and the other comprising a piston having a piston rod extending through a fluid seal at one end of the tube, a source of power connected to one of said members urging same alternately in opposite directions relative the other member, hydraulic fluid in said tube on both sides of the piston, a duct connecting the fluid space on one side of the piston with the fluid space on the other side, a check valve associated with said duct to control the flow of fluid therethrough, a fluid-tight

reservoir, a fluid passageway between the reservoir and the interior of said tube, a check valve associated with said passageway to control the flow of fluid therethrough, and a restricted passageway between the reservoir and the tube through which fluid can flow when said last valve is closed.

5. In combination, a pair of relatively movable members, one comprising an enclosed tube and the other comprising a piston in the tube, means anchoring one of the members against movement, a prime mover connected to the other member, said prime mover effective when in operation to vibrate at a substantially uniform frequency and consequently urge said last member alternately in opposite directions relative the anchored member, hydraulic fluid in said tube on both sides of said piston, a duct connecting the fluid space on one side of the piston with the fluid space on the other side, thereby to permit flow of fluid and movement of the piston through the tube, a check valve associated with said duct to prevent the flow of fluid therethrough in one direction but not the other, a second duct through which fluid can pass from one side of the piston to the other, and a valve operable to open and close said second duct at will.

6. In combination, an enclosed tube with a piston therein, hydraulic fluid on both sides of the piston, said piston having a fluid passageway connecting the fluid space on one side of the piston with the fluid space on the other side, a check valve associated with said passageway to control the flow of fluid therethrough, a by-pass duct outside of the tube having its ends communicating with the tube adjacent the opposite ends thereof, a valve operable to open and close said duct at will, and a second by-pass duct outside of the tube having its ends connected into the tube at points spaced axially apart a distance substantially equal to the axial dimension of the piston, one of said points being adjacent one end of the tube.

7. A combination as in claim 6, wherein one end of said first by-pass duct is spaced axially inward from one end of the tube.

8. In combination, a pair of relatively movable members, one comprising an enclosed tube and the other comprising a piston in the tube, a source of power connected to one of said members urging same alternately in opposite directions relative the other member, hydraulic fluid in said tube on both sides of said piston, a duct connecting the fluid space on one side of the piston with the fluid space on the other side thereby to permit flow of fluid and movement of the piston through the tube, a check valve associated with said duct to prevent the flow of fluid therethrough in one direction but not the other, and a permanently open by-pass duct outside the tube having its ends communicating with the tube at points spaced axially apart by a distance substantially equal to the axial thickness of said piston.

9. In combination, a pair of relatively movable members, one comprising an enclosed tube and the other comprising a piston having a piston rod extending through a fluid seal at one end of the tube, a source of power connected to one of said members urging same alternately in opposite directions relative the other member, hydraulic fluid in said tube on both sides of the piston, a duct connecting the fluid space on one side of the piston with the fluid space on the other side, a check valve associated with said duct to control the flow of fluid therethrough, a fluid tight reservoir, a fluid passageway between the reservoir and interior of said tube, a check valve associated with said passageway to control the flow of fluid therethrough, a restricted passageway between the reservoir and the tube through which fluid can flow when said last valve is closed, a by-pass duct outside the tube having its ends communicating with the tube adjacent the opposite ends thereof, and a valve operable to open and close said duct at will.

10. In combination, a pair of relatively movable members, one comprising an enclosed tube and the other comprising a piston having a piston rod extending through a fluid seal at one end of the tube, a source of power connected to one of said members urging same alternately in opposite directions relative the other member, hydraulic fluid in said tube on both sides of the piston, a duct connecting the fluid space on one side of the piston with the fluid space on the other side, a check valve associated with said duct to control the flow of fluid therethrough, a fluid tight reservoir, a fluid passageway between the reservoir and interior of said tube, a check valve associated with said passageway to control the flow of fluid therethrough, a restricted passageway between the reservoir and the tube through which fluid can flow when said last valve is closed, a by-pass duct outside the tube having its ends communicating with the tube adjacent the opposite ends thereof, a valve operable to open and close said duct at will, and a second by-pass duct outside of the tube having its ends connected into the tube at points spaced axially apart a distance substantially equal to the axial dimension of the piston, one of said points being adjacent one end of the tube.

11. In combination, a pair of relatively movable members, one comprising an enclosed upright tube and the other comprising a piston having a piston rod extending through a fluid seal at one end of the tube, means supporting one of said mmebers, a vibrating body mounted on the other member and having substantially its entire weight carried thereby, said body effective due to its vibration to urge said last member alternately up and down, hydraulic fluid in said tube on both sides of the piston, a duct connecting the fluid space on one side of the piston with the fluid space on the other side, a check valve associated with said duct to control the flow of fluid therethrough, a fluid tight reservoir, a fluid passageway between the reservoir and the interior of the tube, a check valve associated with said passageway to control the flow of fluid therethrough, and a restricted passageway between the reservoir and the tube through which fluid can flow when said last valve is closed.

12. In combination, an enclosed upright tube having a transverse partition subdividing same into an upper compartment and a lower compartment, a piston in the lower compartment having a piston rod extending downwardly through a fluid seal in the lower end of the tube, hydraulic fluid filling the lower compartment on both sides of the piston and partially filling the upper compartment, said partition containing a fluid passageway connecting the compartments, a check valve associated with said passageway to check the upward but not the downward flow of fluid therethrough, a restricted passageway between the compartments through which fluid can flow when said valve is closed, a duct connecting the fluid space above the piston in said lower com-

partment with the fluid space below the piston, and a check valve to control the flow of fluid through said duct.

13. In combination, a stationary support, a prime mover below said support, said prime mover depending from said support on a tension link which extends downwardly from the support to the prime mover and transmits the full weight of the prime mover to said support, said tension link comprising a pair of vertically elongated members one connected at its upper end to the support and the other connected at its lower end to the prime mover, said other member being freely movable in an upward direction relative to said one member, a connection between the members substantially blocking downward movement of said other member relative to said one member, and said prime mover being effective when in operation to urge said other member alternately up and down due to its vibration, whereby said tension link is adapted to draw the prime mover upwardly toward said support step by step under the influence of the vibration of the prime mover.

14. In combination with a body vibrating at substantially uniform frequency, at least a component of its vibration being in a vertical direction, a stationary support spaced above the body, a tension link depending from the support and carrying said body at its lower end whereby the entire weight of said body is imposed upon said support through said link, said tension link comprising a pair of vertically elongated members one connected at its upper end to the support and the other connected at its lower end to said body, said other member being freely movable in an upward direction relative to said one member, and a connection between said members substantially blocking downward movement of said other member relative to said one member.

15. In a combination as in claim 14, means operable at will for disabling said connection, thereby to permit said body to draw said other member downwardly relative said one member under the influence of gravity.

16. In combination, a stationary support, a prime mover below said support, said prime mover depending from said support on a tension link which extends downwardly from the support to the prime mover and transmits the full weight of the prime mover to said support, said tension link comprising an upright cylinder member with a piston member therein and hydraulic fluid filling the cylinder member on both sides of the piston member, one of said members connected to said support and the other member

connected to said prime mover, said prime mover effective when in operation to urge said other member alternately up and down relative to said one member due to its vibration, a duct connecting the fluid space on one side of said piston member with the fluid space on the other side, said hydraulic fluid being adapted to flow freely through said duct in such a direction as to permit said other member to move upwardly relative to said one member, and a check valve for said duct substantially preventing flow of the hydraulic fluid therethrough in the reverse direction.

17. In combination with a body vibrating at substantially uniform frequency, at least a component of its vibration being in a vertical direction, a stationary support spaced above the body, a tension link depending from the support and carrying said body at its lower end whereby the entire weight of said body is imposed on said support through said link, said tension link comprising an upright cylinder member with a piston member therein and hydraulic fluid filling the cylinder member on both sides of the piston member, one of said members connected to said support and the other connected to said body whereby said other member is urged alternately up and down relative said one member due to the vibration of said body, a duct connecting the fluid space on one side of said piston member with the fluid space on the other side, said hydraulic fluid being adapted to flow freely through said duct in such a direction as to permit said other member to move upwardly relative to said one member, and a check valve for said duct substantially preventing flow of the hydraulic fluid therethrough in the reverse direction.

18. In a combination as in claim 17, a second duct through which fluid can pass freely in either direction from one side of the piston member to the other side, and a manually operable shut-off valve for said second duct.

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