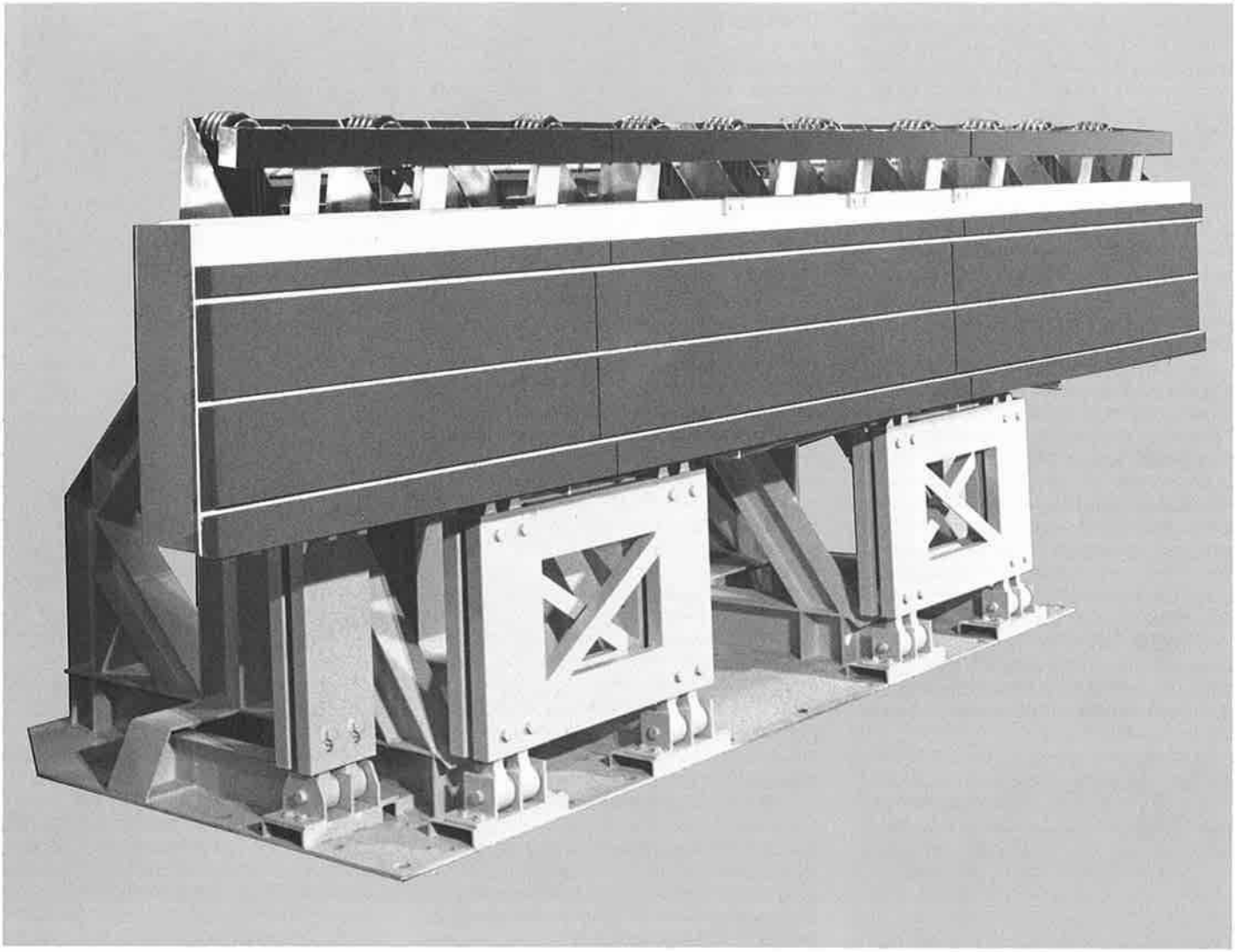
Induced Vertical Flow

Unloading Bottom-Dump Cars with the Rail Car Discharger

Kinergy Corporation



Cleaning Previously Loaded Cars
Unloading Fuels Delivered to Power Plants
Receiving Raw Materials
Barge and Ship Loading Terminals
Unloading Unitrains

These units unload bottom discharging rail cars with carrying capacities to 100 tons. The car construction can be of the "open top" or the "fully enclosed" design with either smooth, curved surfaces or vertical rib type side walls. Smaller units are available to unload only a portion or a specific compartment of a rail car, but repositioning will be required.

The Rail Car Discharger is shipped as a complete assembly. It is permanently installed alongside the rail track.

The rail cars do not have to be "uncoupled." After being positioned for unloading, the Discharger pneumatically extends its contacting member forward until it firmly presses against the rail car's side wall. Then, two electric motors, equipped with rotating eccentric weights, vibrate the car as a complete entity. The vibration "induces" the contained bulk solid to vertically flow in conjunction with the forces of gravity. This happens because the applied vibratory action reduces the contained material's shear strength, and wall, slope, and interparticle friction. The contacting member retracts to 24" to enable the emptied car to be moved and replaced.

Rail car damage is virtually eliminated. The operating sound levels are usually less than 90 dBA while the car is more than half full. When it approaches the empty condition, the sound level will momentarily rise to about 100 dBA. The operating sound level could be slightly higher if the unit is enclosed in a building or if the car has been previously damaged.

Unloading 100 ton rail cars of modern design can be accomplished in 3 minutes. If two units are used, the average time is only 1.5 minutes. Cars with more shallow internal slopes are emptied in about 8 minutes. If the material is frozen, the unloading time will be longer.

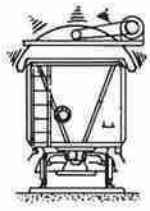
"Induced Vertical Flow" Concept

The Methods Previously Used:

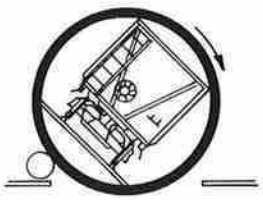
Bottom discharging rail cars are often difficult to unload. The inherent packing or densifying of the contained material from the normal bouncing of the rail car as it rolls over miles of tracks is one reason. Weather conditions, such as rain or snow, can adversely affect bulk solids being transported in "open top" type rail cars. When the ambient temperature falls below freezing, the situation becomes worse. By their innate characteristics, some bulk solids are just too obstinate to vertically flow by gravity alone. Consequently, various methods were conceived to make rail car unloading easier.

In the past, the contained material was "dug out" of the car with bucket type cranes. Another popular option was the use of "pounding" type car shakers that were either side or top mounted. In addition to damaging the rail cars, they almost always operated with loud noise levels that went as high as 130 dBA. High frequency, air or electric vibrators that mount on the sloping sides of the car's outlets have also been tried. Sophisticated "rotary car dumpers" were developed to accomplish the fast unloading of "unitrains." However, they are very expensive and technically complicated. More recently, special rail cars equipped with full length bottom doors were introduced.

After the Bin Activator came into being, the "Induced Vertical Flow" concept for discharging bulk solids from storage was eventually formulated. In turn, it indicated rail cars could be unloaded by applying the same principles. This idea led to the development of the Rail Car Discharger.



Noisy (to 130 dba) Car "Pounding" Devices



Rotary Car Dump (Expensive and Sophisticated)

Note: Full bottom opening cars are also available.

Shows most of the rail car unloading methods that were used prior to their "induced vertical flow" by means of a rail car discharger.

Applying the "Induced Vertical Flow" Concept to Rail Cars:

It was long known that Bin Activators, Activated Bins, Container Activators, and Storage Pile Dischargers, all operated very quietly as they reliably and efficiently performed their function of discharging bulk solids from storage with only minimal maintenance. With this in mind, a rail car was viewed as having similarity to an "Activated Bin." If this were so, then it was reasoned the same principles could be applied.

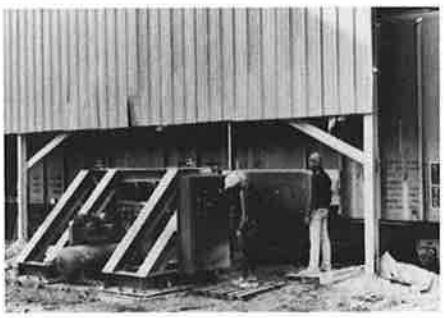
The car's body is essentially a large, rectangular shaped container that is supported on steel coil compression springs, which could also act as isolators. Its bottom discharge ports were analogous to "outlets" as used on other units. More comparative review revealed it only lacked a source of "vibratory excitation," and a means to temporarily apply it so the rail car could be vibrated as a complete entity.

This logic led to firmly pressing a long structural reinforcing member against the rail car side. To minimize any relative motion between the two surfaces, it should temporarily become an integral part of the rail car to be unloaded. Its contacting face would be lined with non-damaging materials. By mounting electric motors on this same structural member, a vibratory action could be uniformly transmitted to the rail car. After its use, it would be retracted so the unloaded car could be moved and replaced.

This explains the reasons why the Rail Car Discharger is the first vibratory machine to apply the principles of "Induced Vertical Flow" for the benefit of unloading rail cars. Introduced in 1979, it has been steadily improved upon in its application, design and operation by taking advantage of the many years of experience.

In addition to a reliable, efficient and simple operation, at an affordable cost, it has the advantages of being relatively quiet and virtually eliminating rail car damage.

A large "Activated Bin" was reasoned to be similar to vibrating an entire rail car.



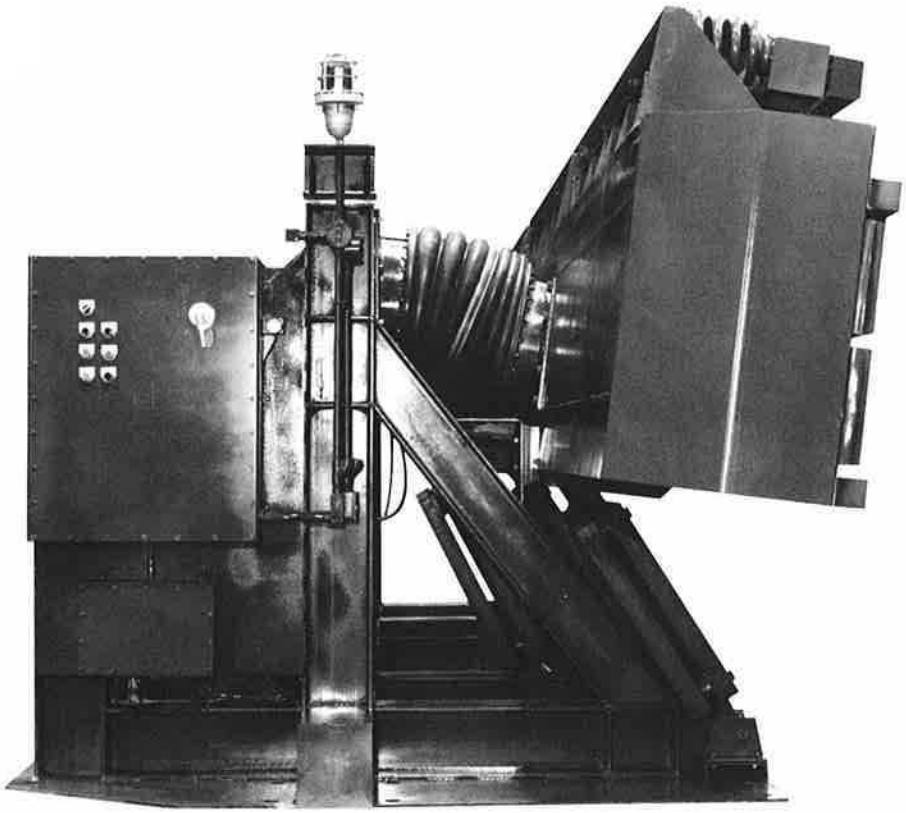
In 1979, the first unit to vibrate a rail car as a complete entity went into productive use. Instead of discharging, it performed the function of "densifying" kaolin clay that had been loaded into this "enclosed" car. Norfolk-Southern RR Engineers assisted in its development. It is still in productive use in central Georgia. Over the years, improvements in the machine's application, design and operation have been made.

Description of the Unit

The Rail Car Discharger is supplied as a complete assembly. The large, bottom base plate enables it to be secured to anchor bolts embedded in a concrete mounting slab. The "reaction truss" is the rear stationary structure that absorbs the equal and opposite forces from pushing horizontally against the side of a rail car. Linear actuators, which look like large rubber bellows, pneumatically push the car contacting member up against the car's side wall. Its face has thick rubber bumpers to help secure its connection to the car. Either polyurethane or relatively thin hard rubber panels transmit the vibratory forces into the car. The vibratory action is generated by two electric motors turning rotating eccentric weights. Rubber bushed "legs" or stabilizing links support the movement of the car contacting member as it moves forward or retracts. Thick rubber bumpered attenuators are installed above and across the top of this moving member. They steady the upper side wall while the lower part of the rail car is being vibrated. The unit retracts a maximum distance of 24", which is greater than the 18" clearance normally required by the serving railroads.

The unit is prewired and an electrical control panel, complete with the needed push buttons and indicating lights, is included. It serves as the control station for the operator. If it is preferred, this control panel can be remotely located. Another option is an operator's pendant station, which provides them with more mobility. The air circuit is prepiped and the compressed air is provided by the facility or a compressor can be provided with the Discharger.

The Kinergy Rail Car Discharger



A Discharger that is ready for shipment.

Simple Operation

The rail cars do not have to be "uncoupled." The car is positioned in front of the Discharger. The unit's length centerline should reasonably agree with that of the car or the portion to be unloaded. A variation of plus or minus 8" or a total of 16" usually can be tolerated.

With the outlets opened, the operator initiates the flow of air into the two rubber bellows. This makes the car contacting member slowly move forward. When the proper air pressure is applied, the two electric motors, which turn rotating eccentric weights, are energized. Since the contacting member is firmly pressed against its side, the rail car vibrates as a complete entity. The vibration "induces" the contained bulk solid to vertically flow in conjunction with the forces of gravity. This happens because the applied vibratory action reduces the contained material's shear strength, and wall, slope, and interparticle friction. When the car is empty, the vibratory motors are de-energized and the air exhausted from the linear actuators. The car contacting member retracts and the empty car is moved and replaced.

Easy Installation

An appropriate concrete slab with embedded anchor bolts is required. If the rail tracks immediately in front of the Rail Car Discharger are not laterally reinforced, they should be. When it is used, the design configuration of the dump hopper, which is under the rail car, usually provides this lateral support at the location of the rail car's wheels at either end. Otherwise, parallel beams projecting from the concrete mounting pad will serve this purpose.

The Rail Car Discharger is shipped as a complete assembly that is prepiped and prewired. It is lifted and set on top of the concrete slab. The anchor bolts are made secure to the machine's base plate. The electrical incoming power connection, which is usually 3 phase, 60 hertz, 480 volts, is completed. If the unit is not supplied with an air compressor, then a connection is made to the available air supply. A rating of 28 CFM at 100 PSI is normally adequate. However, if a car is to be unloaded every 4 minutes, the air supply will increase to 70 CFM at 100 PSI.

The completed installation is usually accomplished in less than one day. The unit is then ready for productive use.

Maintenance

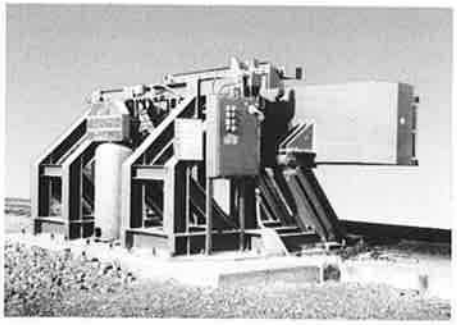
Except for some wear on the car contacting panels or bumpers, the maintenance should be minimal. All the other component parts have years of proven service life by their use on other vibratory machines supplied by Kinergy. This includes the vibratory excitors, rubber bushed arms in the linkages, and the springs used on the attenuators.

Operating Sound Levels Are Relatively Quiet

When the car contacting member is pushed forward so its rubber and plastic lined "face" is pressed firmly against the car's side, it temporarily becomes almost a "fixed" part of the rail car. Even though the dynamic, vibratory force output can be as high as 80,000 lbs., there is minimal "relative motion" between the unit's contact face and the car side. The entire car vibrates as a complete entity on its own supporting steel coil springs, which act as isolators. The result is the operating sound level is usually less than 90 dBA when the car is more than

In some applications, only one operator accomplishes the unloading.

Supplied in 1981, this Discharger was the first to utilize a top mounted, rubber bumpered attenuator to steady the upper part of the car's side wall. At that time, they were of short lengths.



To install, set the unit on a concrete mounting pad and connect the incoming electrical power supply and possibly a source of compressed air.

Future Operation
Financial Incentives

half full. As it approaches being "empty," the noise level will temporarily rise to about 100 dBA. The operating sound levels could be slightly higher if the unit is enclosed in a building or if the rail car has been previously damaged.

Full length, thick rubber bumpered attenuators are now used to restrain excessive movement in the upper part of the car's side wall. This helps to quiet the rail car as it approaches being "empty."

Rail Car Damage Is Virtually Eliminated

With the car contacting member firmly pressed against the rail car side, there is minimal movement between the two surfaces. The rubber and plastic panels lining the "face" of the car contacting member are designed to wear instead of the steel surfaces. It engages the extreme lower portion of the car side. This takes advantage of the bottom sill which is structurally strong. Inside the car, there are either vertical partitions, intermediate inverted "vee" type slope sheets and the end slopes that reinforce the rail car in the transverse or sideways direction. They help to transmit the vibratory action to the opposite side of the car. The thick, rubber bumpered "attenuators," mounted above and across the top of the car contacting member, restrain any excessive movement in the upper part of the side wall.

This unique concept of vibrating a rail car has virtually eliminated any damage. Confirming evidence is the many different types of rail cars that have been vibrated in this manner for more than 10 years, at hundreds of different locations, without complaints of damage. Of course, if the rail car is already in a dilapidated condition or it has been previously damaged, these realistic factors will have to be taken into consideration when applying or evaluating the Discharger.

These units are vibrating rail cars on tracks serviced by Burlington Northern, CSX, Conrail, Norfolk Southern, SOO Line, Southern Pacific, and Union Pacific.

Future Operation

Probably the most significant advantage of a Rail Car Discharger is its being permitted to be used in the years ahead. Government groups, such as OSHA or EPA, and the Labor Unions like the concept because of its low operating sound level. Railroad authorities or the rail car "Owners" favor the Discharger because it virtually eliminates damage to their cars. Eventually, these "officials" could insist upon "car pounding," noisy, or car damaging devices to be "shut down" or the "user" submit to added financial penalties for their continued use. This is the primary reason Rail Car Dischargers are being retrofitted into existing unloading stations that are excessively noisy or utilize car damaging devices. It is also one of the reasons it is being specified in newly designed unloading stations.

Enclosed cars of this type, as manufactured by ACF Industries and North American Car Company, have been vibrated for more than 10 years without complaints of damage. These cars are owned by the chemical company that uses them (1982).

Financial Incentives

Quite often, the freight rates charged by the serving railroad include a surcharge to cover anticipated rail car damage. This is often the situation when car damaging type "overhead" or "side pounding" shakers are being employed. Therefore, it is recommended that potential users of the Kinergy Rail Car Discharger contact their local railroad representative to investigate the possibility of a freight rate reduction.

Another "cash rebate" could be granted by the local electrical utility company for a reduction in energy consumption. Since the Rail Car Discharger is very "energy efficient" in comparison to other car unloading devices, it should qualify for this award.

Less than 8 HP is needed to unload this 100 ton car. Evaluating its "RMS" (root-mean-square) power consumption reduces it to only 1.75 HP. That's being "energy efficient"!

Safety Precautions

It is recommended the unloading station be classified as a "restricted" area to local plant personnel. All the people entering this area should be either escorted or qualified by being trained in the operation of the Rail Car Discharger and all the other related equipment. Warning horns and flashing lights are recommended to indicate the rail cars are about to be moved, that the Discharger's contact face is about to be extended, or that a rail car is already engaged by the Discharger and it should not be moved. The operator of the Rail Car Discharger should have a full visual view of the space above, under, and to either side of the car contacting member.

Types of Rail Cars to be Unloaded

Rail cars in the United States are almost always of a 100 ton "net load" rating. Their usable volumetric capacity is about 4,000 cubic feet, so they can carry their rated load with bulk solids of 50 PCF density. When heavier materials are transported, a lesser volume is put in the car. The car body typically measures 10 ft. in width, 50 ft. in length, and 10 ft. in height. 70 ton cars are still in existence, but they appear to have limited usage. Their width is the same, but their lengths are reduced to about 40 ft. and the height to 8 ft.

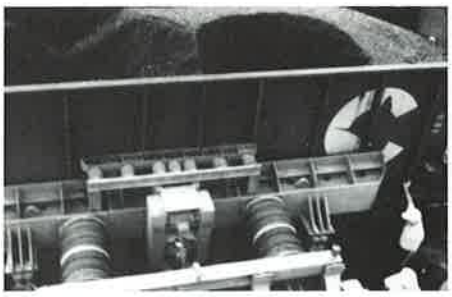
The rail cars can be of the fully "enclosed" type with either smooth surfaced, curved side walls or vertically ribbed. "Open top" rail cars almost always have vertically ribbed side walls. The number of outlets will normally be at least three and more likely four. On some cars, these outlet locations will be two paired ports that are side by side, so the opening can nearly extend across the width of the car. For the fastest unloading rate, the car end slopes should be 40° from the horizontal to

Applications:
Cleaning Rail Cars
Unloading Fuels
Receiving Raw Materials

45°. More shallow end slopes will increase the unloading time, but they are seldom less than 30°.

Large volume rail cars that are about 67'-0" in length can also be discharged. These cars were designed for the hauling of light density materials, such as wood chips.

Enclosed cars with smooth surfaces and curved side walls. Courtesy, ACF Industries, St. Charles, Mo.



"Open top" cars almost always have vertically ribbed side walls, as built by the Greenville Car Company of Greenville, Pa.

Car lengths can vary from 28 ft. (50 ton) to almost 70 ft. (7,000 cu. ft.) as shown by the large wood chip carrying car on the left. Courtesy Ortner Freight Car Company, Milford, Ohio.

Typical Applications

The Kinergy Rail Car Discharger can be utilized in many different types of applications. Some of them are:

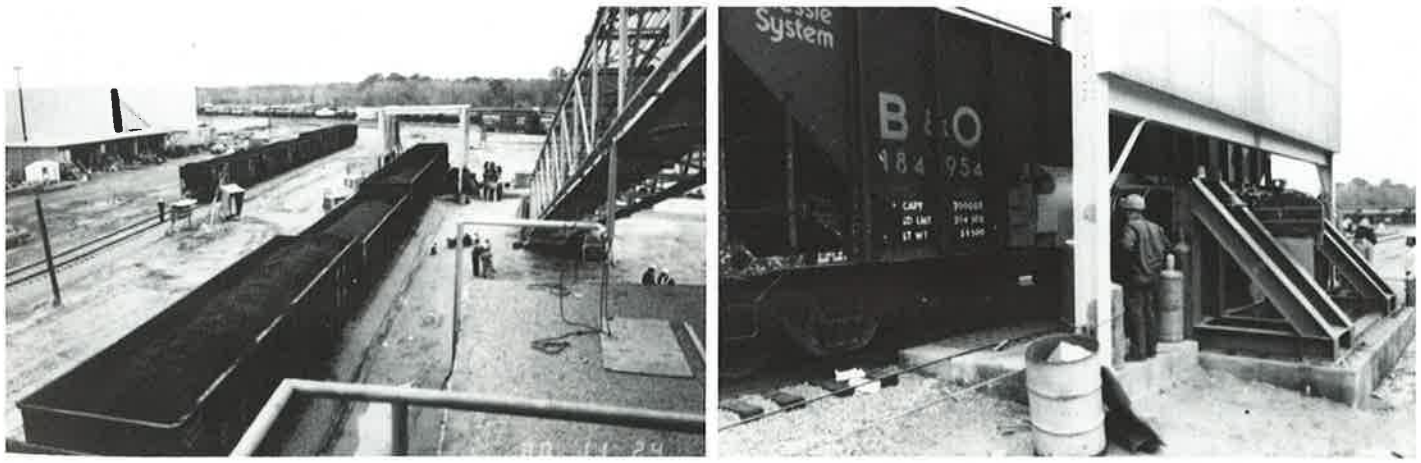
Cleaning Previously Loaded Cars: Empty rail cars can be vibrated to clear their inner surfaces of "tailings" left from previously loaded materials. For example, an enclosed rail car that was used for transporting fertilizer can be vibrated to help cleanse the internal surfaces of any clinging dust or tailings. This permits a different type of bulk solid to be loaded with the least amount of contamination. If this is the only function of the unit, it is of relatively light weight design.

Unloading Fuels Delivered to Power Plants: Often it is steam coal or lignite, but it can include "waste type fuels." Some examples are coal culm, gob, or silt. The various types of wood wastes such as bark, chips, shavings, and sawdust or shredded rubber tires are others.

The limestone needed for air pollution control can also be unloaded.

Receiving Raw Materials: Many plants depend upon incoming bulk solids to supply their processing type production lines. The unloading of rail car shipments to chemical, cement, gypsum, ore smelters, and food or grain facilities is typical.

Vibrating an empty car to clean it of residue from a previous loading.



In 1980, the first Discharger for unloading coal at a power plant went into service. The overview on the left shows the simplicity of the unloading station. Located in Plymouth, N.C., this Discharger of early design vintage is still in productive use.

Applications:
Barge/Ship Terminals
Unloading Unitrains
Retrofitting

Barge and Ship Loading Terminals: River barge and ocean ship terminals often bring in the bulk solid by rail cars to fill the waiting vessels. Unloading applications could involve many different types of bulk solids. Examples would be fertilizers, ores, petroleum coke, or various food stuffs.

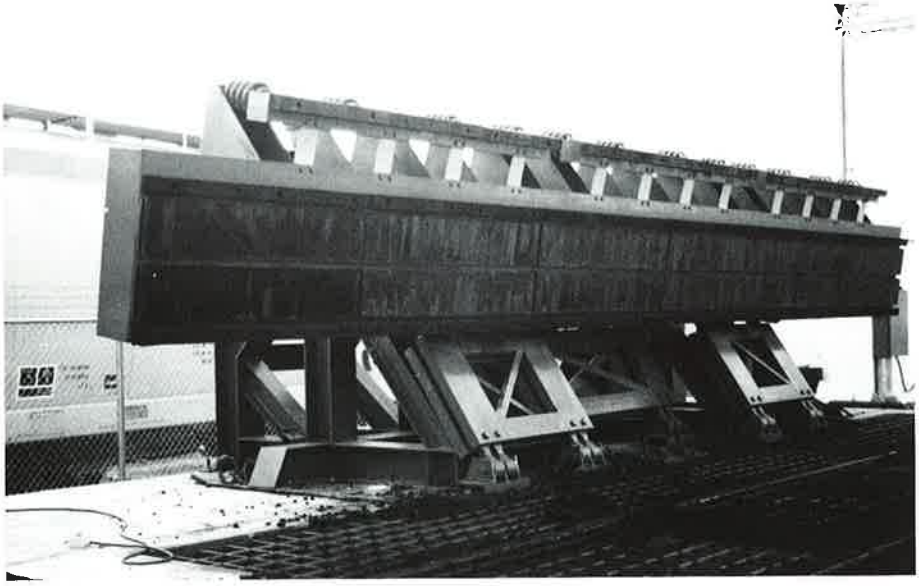
Many times, these rail cars will be of the "enclosed" type. If so, the trackside mounted Rail Car Discharger is ideal for unloading them.

Unloading Unitrains: This means 100 cars of 100 ton capacity will have to be unloaded in a total time that usually varies from 4 to 8 hours. For this fast unloading, two rail cars should be discharged at the same time.

If the rail cars are virtually the same length, then two Rail Car Dischargers can be mounted, side by side, alongside a single track. The two cars are unloaded simultaneously. As the empty cars are moved, two more are positioned for unloading.

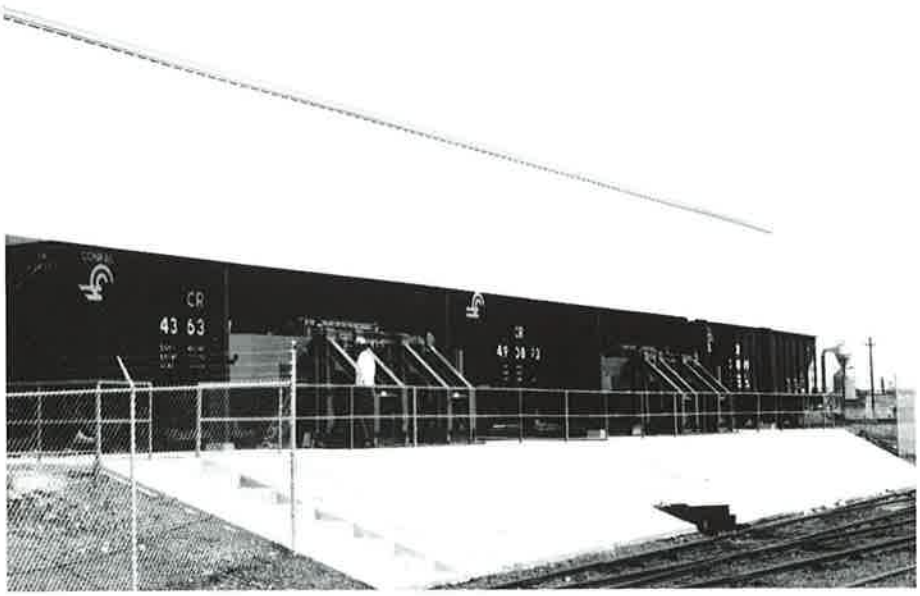
When the rail cars vary in length, then the incoming single track should sub-divide into two parallel tracks. This allows the cars to be independently positioned in front of the Rail Car Discharger even though the lengths vary. The two Rail Car Dischargers can be mounted "back to back" in between the two parallel tracks. Another option is to mount them opposite to one another on the outside of each track. Still another is to mount one Rail Car Discharger in between the tracks, and the other alongside the other track.

The advantage of using two Rail Car Dischargers is the ability to achieve the unloading rate of a "rotary car dumper." The total installed cost of the unloading station would probably be no more than 25% of one that uses a rotary car dumper. This 75% reduction in initial cost represents millions of dollars in savings. Taking into account the complicated operation of a rotary car dumper, there are additional savings in operating and maintenance expenses when it is compared to the use of Rail Car Dischargers.



Terminals usually need fast unloading of 100 ton cars. To accomplish it, this unit has a car contacting member that is 32 ft. long so it can fully engage both end slopes.

Inside, two units are mounted "back to back" for the simultaneous unloading of a Unitrain of cars that vary in their lengths.



Two units installed "side by side" for the rapid unloading of a Unitrain of cars of near equal length.

Retrofit to Existing Rotary Car Dumper Installation: For unloading stations that already have an existing rotary car dumping unit, the problem of material sticking and remaining on one side of the car can be alleviated. This usually happens when frozen material such as coal or lignite is being unloaded. After the car is dumped, 2 to 15 tons of material often remains adhered to one side of the car. By locating a Rail Car Discharger so it can vibrate the material adhering side for about 40 seconds prior to its dumping, the sticking material is broken loose and falls out of the car when it is rolled over. By proper coordination with the rotary car dumper's electrical control scheme, the "vibration" of the car can be automated. Thus the financial penalties issued by the serving railroad for not fully relieving the rail car sides of adhered or frozen material are avoided.

Rail Car Unloading Time

Rail Car Unloading Time

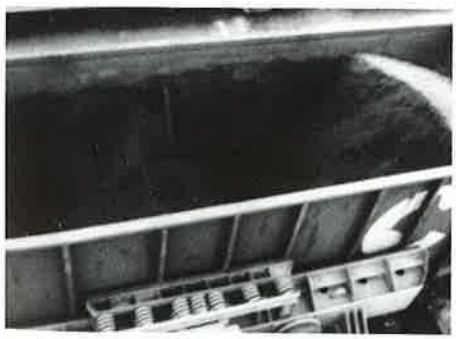
The actual unloading time of a rail car needing a Discharger is going to be primarily determined by the angle of its internal slopes, the structural condition of the rail car itself, whether the contained material is frozen or not, the number and size of the car's outlets combined with any grating below them, and the "take away" rate of the equipment used to accomplish it.

Non-Frozen Conditions: If the end slopes are 45°, and the contained material is -2" steam coal that is so soaked from rain that water drips from its closed outlets, an "open top" type 100 ton rail car equipped with four paired outlets can be completely emptied in three minutes. If two cars are discharged simultaneously, the average unloading time per car is reduced to 1.5 minutes. **This represents the best unloading rate achievable with a Rail Car Discharger.**

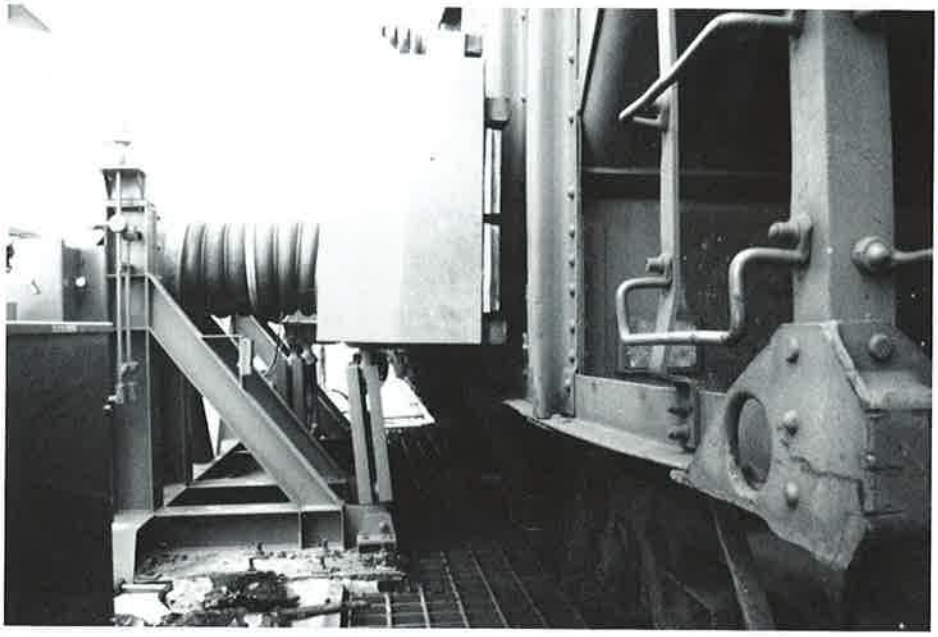
If the end slopes are only 30°, with only three paired outlets, then the unloading time of 100 tons of the same type of wet coal would increase to about 8 minutes. Discharging two cars simultaneously reduces the average time to 4 minutes.

Usually, bulk solids with more adverse flow properties only add about 10 to 35% to the unloading time. However, the vibratory force input to the rail car will be markedly greater.

When it's applicable, this suggestion will save time. As the loaded rail car is being slowly moved into position, the operator, standing adjacent to one end of the unit, hammer strikes the latch locking mechanism of each of the outlet doors as they are passing over the extreme end of the dump hopper. By following this procedure, the operator does not have to stand between the face of the unit and the rail car. It saves in the "turn around" time because the car doors are being opened while the rail car is being moved into position.



Cars with 30° end slopes require more time to unload. As the photo shows, the lagging of material flow down the shallow end slopes makes the difference.



100 ton cars with steep, internal slopes can be unloaded in 3 minutes. The grating covering the top of the dump hopper should not impede the material's flow through it. Also, the "take away" rate needs to be adequate.

Frozen Materials: When lump type particles freeze with a "point to point" contact which has interparticle voids, many of their bonds will be shattered by the vibration produced by the Rail Car Discharger. However, any "immersion" type of freeze will normally not be broken. This condition typically occurs along the end slopes and at the outlets of the rail cars. External heat applied to the car's outlets and its end slopes will be required to speed up the unloading. Even so, the unloading time will most likely be extended to 15 minutes for steep slope cars, and to 30 minutes for those that are more shallow. If chemical "non-freeze agents" are applied to the surfaces inside the car and to the material at the point of loading, it will help to decrease these unloading times.

When material that has frozen is discharged, it should be recognized the inherent large lumps can block the car's outlets. The same lumps can also interfere with the material's flow through any grating located under the car's outlets.

If the bulk solid is already in a frozen state when it is loaded into the rail car, and provided it remains frozen during transit, it will discharge at the same rate as if it were not frozen. This unique situation occurs with lump type bulk solids. Examples would be coal and lignite.

Gratings: When it is used, the top of a dump hopper is covered with a steel grating that has square or rectangular openings down to 4" dimensions. However, if the bulk solid being discharged is very adhesive and cohesive, or of oversize lumps, then the openings should be increased to 8 to 12" or larger in the area immediately adjacent to the car's outlets. Otherwise, the grating will impede the flow of the bulk solid from the rail car, and slow down the unloading.

Take Away Rate: If a 100 ton rail car is unloaded in 4 minutes, and the "car spotting" time is 3 minutes, then the "turn around" time is 7 minutes. This means the comparable "take away" rate from the unloading station needs to be about 850 tons per hour. If it's less, the unloading time will increase proportionally. Consequently, it can be slowed and governed by the "take away" rate.

Rail cars that are in a dilapidated condition will almost always increase the unloading time.

To determine the "turn around" time, the interval needed for "car spotting" should be added to the unloading times stated above. Switch engines or various types of car pullers are usually used to accomplish this.

In many applications, the unloading rate of the rail car is a secondary consideration, because it is not the limiting factor controlling the "turn around" time.

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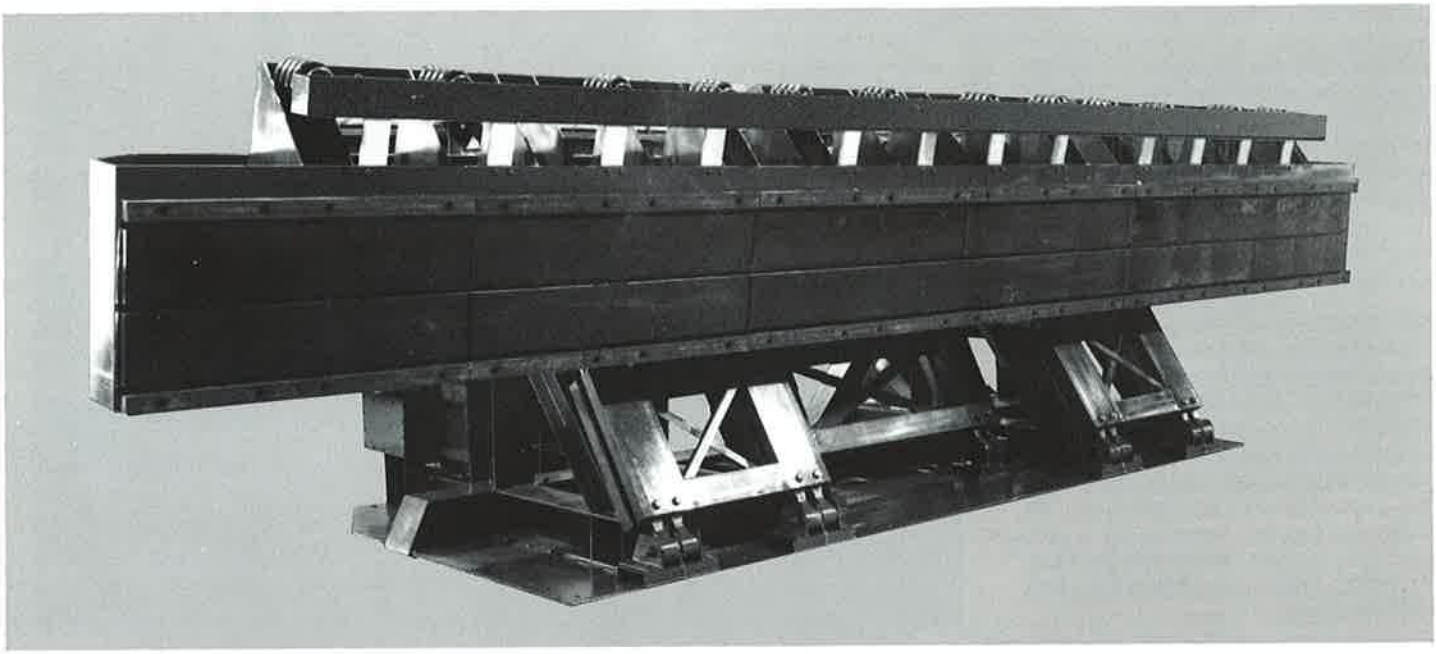
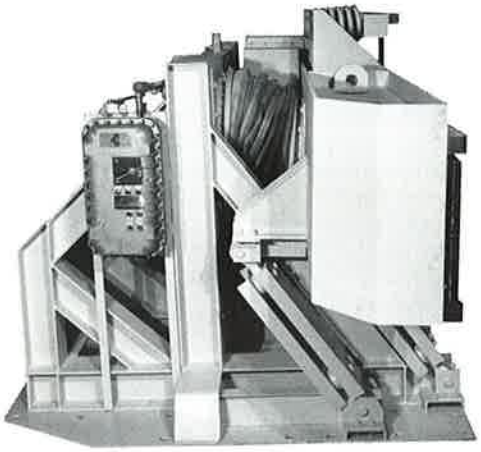
Different Designs are Available

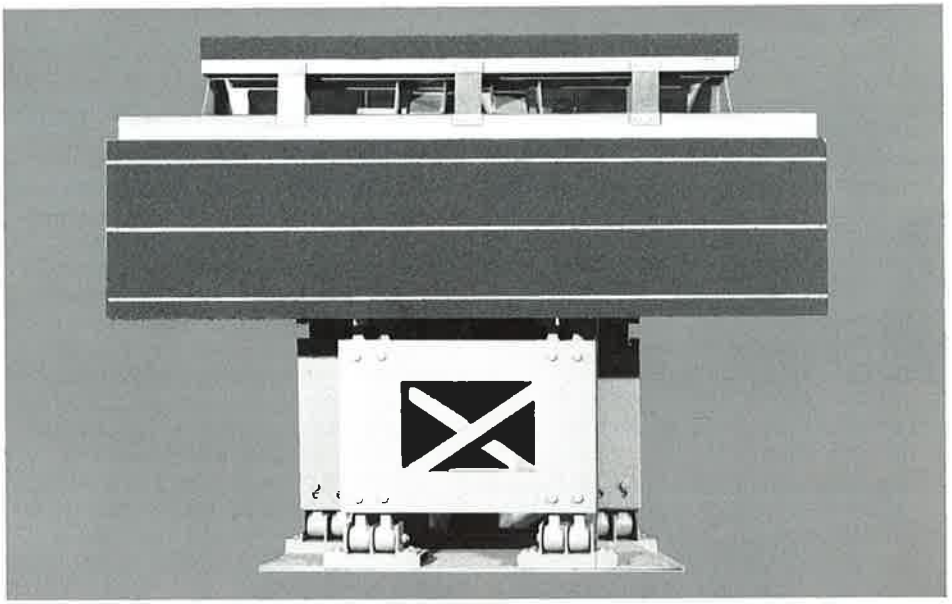
The most complete line of vibratory machines for "inducing" bulk solid materials to vertically flow or convey.



The current design of a Discharger to completely unload 100 ton rail cars. Its car contacting member is 32 ft. long with full length attenuation.



To unload half of a 100 ton car, the car contacting face is normally reduced to 22 ft. in length. The Discharger shown has explosion proof enclosures for the electrical controls.



When only a section of a compartment is to be unloaded, smaller size Dischargers are available. This unit's car contacting member is only 11 ft. long.

Available Designs

Since standard cars with a "net loading" of 100 tons are very common in North America, the Rail Car Discharger designed to unload them in this region is the most popular. Its contact face usually has a length of 32'-0", so it can properly engage both end slopes. The power consumed is less than 8 HP. The dynamic, vibratory force capability is up to 80,000 lbs at 684 CPM. It typically initiates vertical flow from the entire rail car with an air pressure of 50 to 60 PSI. When the car is about half empty, the air pressure in the linear actuators is reduced to 30 to 40 PSI. Consequently, the rail car is not excessively tilted to one side as it is unloaded.

If a 100 ton car is to be unloaded in two positionings, then the contact face is normally reduced to a 22'-0" length, with a power consumption of about 4 HP. The dynamic, vibratory force capability is up to 40,000 lbs. Half the car is discharged, and then repositioned to enable the unloading of the other portion. An exception is the large volume wood chip cars that are almost 70 ft. in length. The unit applied would have the longer contact face member even though the cars are unloaded with two positionings.

Dischargers are available for other rail cars of different dimensions and "net loadings." The car contacting face is usually shorter in length and the dynamic, vibratory force output will most likely be reduced. The same applies when only one compartment is to be emptied, and the car is repositioned to discharge each of the others.