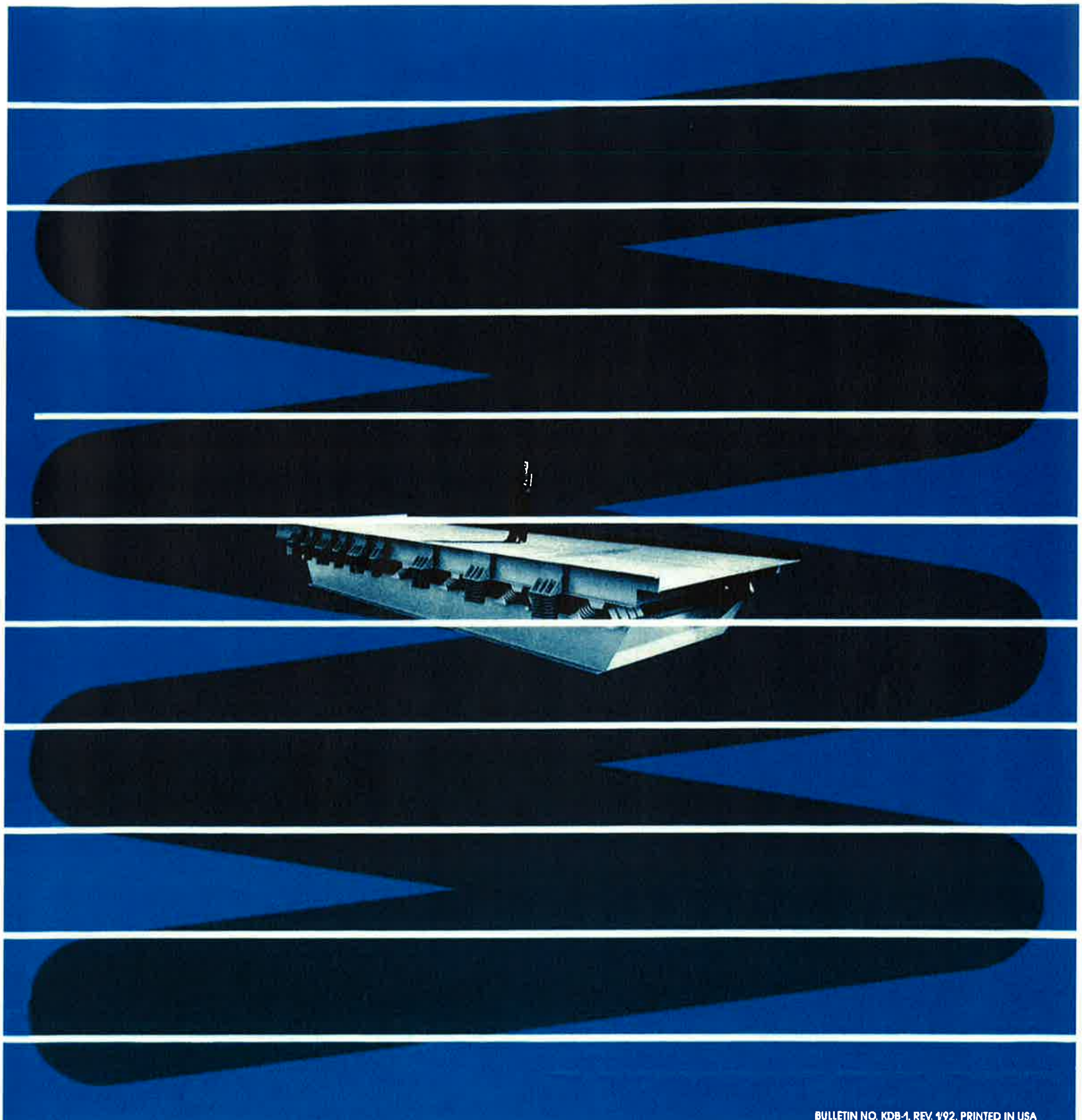
nduced
Conveying

Moving and Processing Bulk Solids by The Kinergy Drive System

Kinergy
Corporation



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How the Kinergy Drive System Was Developed

The Kinergy Drive System combines a "Free Force" input from an A-C type electric motor with the output of "Sub-Resonant" tuned springs. When the applied load increases, these springs inherently drive harder. This type of vibratory drive system lends itself to a simple method of electrical control.

Stated differently, rotating eccentric weights installed on the extended shafts of a motor sustain the vibratory motion of reactive power-producing drive springs. Their output can be electrically controlled over a broad range.

For powering "Induced Conveying" machines, it has proven to be the most versatile and "energy efficient" vibratory drive system known.

Preface

In 1960, probably the most agonizing problem confronting material handling engineers was: "How do you make bulk solids flow from storage?"

Since equipment and their controls had been steadily improving over the years, production lines were gradually increasing their degree of automation. As they did, material flow stoppages became less tolerable. More progress in automation finally made these interruptions virtually intolerable because they would temporarily render the sophisticated process line nearly useless. When this happened, workers had to manually prompt the bulk solid to flow from storage. For example, they physicially poked to break wide-spanning "bridges" or to collapse gaping "rat-holes." The concern for personal safety grew as bizarre and sometimes, fatal accidents occurred.

This repeated and emphatic outcry from Industry brought attention to a rather embarrassing reality. That reality was that there was very little known about the material flow peculiarities of Bins, Silos, Piles, or anything similar. Somehow this field of professional endeavor had gone almost completely overlooked. Therefore, this near desperate situation prompted a concerted effort to study this vertical flow phenomenon in a dedicated fashion and to derive some corrective measures for eliminating this nagging difficulty.

From a research grant awarded to the University of Utah came the engineering basis for the formulation of "Modern Bin and Silo Designs." For stored bulk solids that favorably respond to the forces of gravity, this "Static Design" approach was a welcomed solution.

Concurrently, and also in response to the need, the vibrating Bin Activator came into being. It is usually applied when the stored material is more obstinate to gravity flow. Its introduction successfully initiated the complementary concept of "Induced Vertical Flow." The necessary field follow to learn more about this new field unfolded some unique insights into important factors relating to the engineering of vibratory drives. These teachings were eventually applied to a group of vibratory machines that are far removed from those used to discharge bulk solids from storage.

At the time, the principle of "Induced Conveying" had long been established. The many Vibrating Feeders, Conveyors, Screens, and the like that already existed confirms this. However, the means to drive all these different types of "Induced Conveying" machines was going to change.

This outline explains how and why it happened.

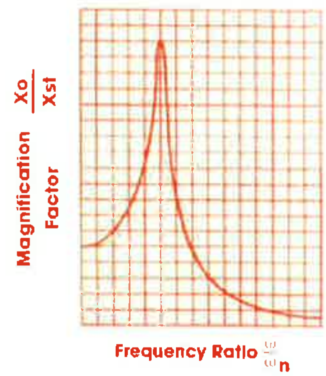
The field follow of the Bin Activator instigated the "Drive vs. Load" analysis. In turn, it prompted advancements in vibratory drive systems.

It began with the Bin Activator

The knowledge that led to the development of the Kinergy Drive System began to emerge shortly after the Bin Activator was introduced in 1962. Since it was a very unusual type of vibratory machine, its associated technology was not fully understood. Therefore, some of the earlier applications brought about challenging and often frustrating situations.

Input Vs. Output Power

A significant predicament occurred in September of 1963. It was to question how much vibratory power could be produced by a 5′ diameter Bin Activator being driven by a ¾ HP motor. This unit was accused of damaging the massive structural supports of a large coke furnace located in Wyoming. It was installed under the outlet of this heated oven. Supposedly, the Bin Activator transmitted excessive vibrations to the furnace supports and caused the structural failures. In the proceedings that followed, the basic equation of "Power In" equals "Power Out" became the center of discussion. After it was reasoned the small motor driving the Bin Activator was incapable of doing the damage, all the attention turned to the classic Resonance Curve. This well known graphic plots "Frequency Ratios" against the corresponding "Magnification Factors" for vibratory strokes or forces. If the forces coming from the Bin Activator were being magnified or markedly increased, then they could become large enough to do the harm. However, when this idea was subsequently related to a power output, it ultimately led to stating "Energy was being magnified," which was dubious at best. That's because it inferred energy was being created by the Bin Activator's vibratory action. The debate continued, but reached a stalemate on this issue. In any further review of power, it was very difficult to justify a greater output from the vibratory unit other than its 0.75 HP input. Consequently, the Bin Activator was eventually relieved of the cited claims.



The well known "Resonance Curve" which plots "Frequency Ratios" against the corresponding "Magnification Factors." It is shown with some degree of damping. This curve is typical of the classic theory dedicated to either the elimination of vibrations or their isolation. Applying this logic to purposely produced vibratory power to drive "loads" proved to be cumbersome.

This controversy among learned and highly experienced engineers revealed there wasn't any acceptable expression for describing the full extent of vibratory power.

The Available References

The available text books used in this ordeal were an excellent reference for the basic theory of "Mechanical Vibrations." This included "Forced Vibrations." However, when the books applied all this theory to actual practice, the focus was essentially dedicated to either eliminating vibrations or achieving their proper level of isolation.

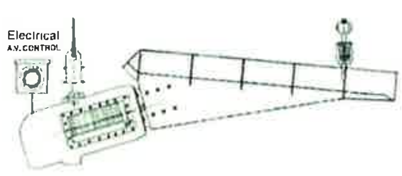
The Kinergy Drive System "To Save Energy, Use Kinergy"

They didn't discuss "Loads" and there were no guidelines for understanding the performance characteristics of a purposely vibrated machine. For some reason, the published information did not explain how to evaluate the different types of drive methods used to intentionally produce mechanical vibrations. This is probably why most of the contemporary vibratory machine designers used this same classic Resonance Curve to explain a given unit's operating characteristics when it utilized the principle of "Natural Frequency." In short, there seemed to be a lack of a logical method for analyzing machines that were "intentionally" vibrated and for expressing the "total amount of power" that could be produced in order to accomplish some useful function.

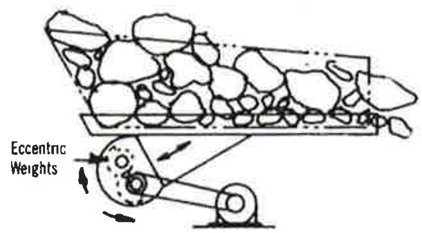
Drive Vs. Load Analysis
In an attempt to fill this academic void, the vectorial "Drive vs. Load" analysis was conceived in 1964. It utilizes "heat" and "non-heat" energy quantities. The new theory came to introduce the term "Kinergy," which is the kinetic energy developed by a spring's motion during the drive portion of its cycle. Although Kinergy has a net power output of zero, its effective use directly affects "Energy Efficiency."

We had all of this in mind when we joined all the other manufacturers in the long standing quest for a better Vibrating Feeder. Trying to improve upon this type of machine had been a dedicated effort since the mid-1950's.

A New Feeder Emerges
The first practical benefit of this revised thinking was the discovery of a full range output adjustment for mechanical type Feeders by a simple method of electrical control. This was done in July of 1965. It made the so-called Electro-mechanical type of Vibrating Feeder much more practical. Sub-Resonant tuned springs produced the wanted "Non-Heat" energy. A "Free Force" input developed by rotating



The Electromagnetic Driven Feeder – 1928
It was the original drive to have the enviable asset of "simple electrical control" for output adjustment.



A "Brute Force" driven Feeder – 1930's
This was previously the best for "Load Abuse" capability.

The initial concept of a Kinergy Driven Feeder – 1965
This Electro-Mechanical type of Feeder easily outperformed its conceptual competitors.

eccentric weights mounted on the shafts of an A.C. motor provided the needed "Heat Energy." These two power components combined to make a "Drive System." Although it had been in use for many years, it marked the first time a standard A.C. squirrel cage type motor could successfully have its running speed adjusted by simply varying the applied three phase voltages.

This was only seen to be a new type of feeder, with a short trough length, because that's what it was intended to be. As the record clearly shows, it achieved total success as it easily outperformed its conceptual competitors. Namely, the Electromagnetic type of Vibrating Feeder which had been the prevailing leader for more than 35 years. The other was the Feeder design driven solely by so-called "Brute Force."

In time, other benefits were noticed such as easier counterbalancing, common components, smooth starts and stops, and minimal maintenance. As more years passed, it gradually became evident that a beneficial "drive system" had really been advanced by this innovation, and not just a better Vibrating Feeder.

To Save Energy, Use Kinergy
The need to further expand the use of this drive system didn't occur until the late 1970's. The reason was the "Energy Crisis." Previously, "Energy Efficiency" had not been a serious factor. This incentive, plus all the other benefits, caused us to deliberately consider using it to power more types of vibratory machines.

Consequently in November of 1978, we announced the adaptation of this drive system to all the other "Induced Conveying" machines. This included Vibrating Conveyors, Screens, Spiral Elevators, Heat Transferring units, Mold Shakeouts, Sand Reclaimers, and the like. By now, we had realized it maximized the use of Kinergy, so it was commonly called the "Kinergy Drive System." This is why all these machines are sometimes said to be "Kinergy Driven."

At the same time, we formally revealed the "Drive vs. Load" analysis we had been using to analyze vibratory machines. It has given the mechanical version of the "Free Force" input combined with Sub-Resonant tuned springs type of vibratory drive system the final engineering link it needed – just as the "cycle type" of operation did for "Induced Vertical Flow" units many years before.

The result of this sequence of engineering thought is revealed in the reality of our broad line of modern machines. The story is on-going as we continually strive to update our technology even more.

The Difference:
"We learned from Induced Vertical Flow"
Unlike other engineers who began their careers by studying the established technology that was being used to explain the existing "Induced Conveying" units, such as Electromagnetic Feeders, "Natural Frequency" Conveyors, or solely "Brute Force" driven Screens, our vibratory intuition evolved from the teachings learned from initially pursuing the "Induced Vertical Flow" concept. In other words, by sheer circumstance, we had a fresh start. It gave us a new outlook which inspired originality. Therefore, our professional path of engineering progress was different. This is the primary reason we had the opportunity to be the first to contribute these significant technical improvements.

Without the advanced Kinergy Drive System technology, this gigantic Feeder would not have been possible. It was built in 1979, and it still is the world's largest.

The "Drive versus Load" Analysis

The purpose of this "Drive vs. Load" analysis is to provide a more appropriate method for analyzing machines that are "intentionally" vibrated. It should be thought of as a "supplement" to any previously published analytics concerning Mechanical Vibrations and the theory that applies to either their elimination or degree of isolation.

Identifying the "Load" and the "Drive"
A vibratory machine will be considered as any unit "intentionally" vibrated in order for it to perform some useful task or beneficial function.

To better understand these machines, the vectorial "Drive vs. Load" analysis was conceived. It is based upon electrical analogies that utilize "Heat" and "Non-Heat" relationships combined with rotating "Phasors." It enables the separation of all the dynamic, vibratory "forces" into four basic vectors. By using the state of "Dynamic Equilibrium," these "forces" can be expressed in the form of an equation.

$$F_{\text{input force}} \leftrightarrow F_{\text{spring effect}} \leftrightarrow F_{\text{friction force}} \leftrightarrow F_{\text{mass inertia}} = 0$$

Re-arrange the terms:

$$F_{\text{input force}} \leftrightarrow F_{\text{spring effect}} = F_{\text{friction force}} \leftrightarrow F_{\text{mass inertia}}$$

An equation expressed in concise words would be:

DRIVE = LOAD

The right side of the equation identifies the "LOAD." As it shows, it is made up of the resistive frictional forces and the motion opposing inertia. These two load quantities will be present regardless of how a machine is applied. Therefore, any driving means must be able to at least satisfy both of these terms. The "LOAD Resultant" can be defined as the vectorial sum of all the frictional forces "Resisting" and all those "Opposing" the vibratory motion. Similar to its electrical counterpart, this "LOAD resultant" is called "MECHANICAL IMPEDANCE."

On the left side, the "DRIVE" is revealed. The equation indicates there are two choices for driving a vibratory machine.

One is to rely solely on the Finput vector. Consequently, this "Single Input" source must drive the two vectors on the "LOAD" side. This is commonly known as **"BRUTE FORCE."** Since the friction quantity is usually much less than the mass inertia load component, it accounts for this driving method being so "inefficient" when it is the primary material mover. It also sets aside the myth that once the large eccentric weights of this type of drive "get going," they only require a small amount of energy to sustain their rotation. Stated as an equation, it would be:

$$F_{\text{input force}} = F_{\text{friction force}} \leftrightarrow F_{\text{mass inertia}}$$

which basically describes a "Single Input" or **"BRUTE FORCE"** type of drive.

The other alternative for a drive is to utilize the Fspring effect component in combination with the one for Finput. The rest of this analysis is dedicated to achieving this.

The Energy Relationships
If each of these four "forces" were multiplied by their respective amplitude or distance moved, it would become an equation that expresses the energy relationships. In review, the four energy vectors would be:

A. Heat Loss: This includes all the internal friction which comes from any hysteresis loss in the machine itself, plus any external resistance and any damping effect from the moved material or the like. This quantity establishes the minimum amount of heat energy input needed.

B. The "Opposing" Load: This is essentially derived from the mass inertia of all the weight that "opposes" the vibratory motion. While strictly in the reactive mode, it is not a heat loss and it is thus labeled a "non-heat" component. The vibrating parts of the machine itself, plus most of the opposing weight of the material being moved, normally make up this term.
As explained below, any detrimental "spring effect" encountered will have to be added to this quantity because it will also "oppose" the vibratory motion.

C. Kinergy: The "spring effect" in a properly designed vibratory machine comes only from the purposeful use of relatively stiff springs to help drive the "LOAD." They are called "Drive Springs." Sub-Resonant tuning is always wanted because it enables these springs to drive harder under loaded conditions.

As long as this "spring effect" quantity is on the "DRIVE" side of the equation, it is beneficial. Unfortunately, this is not always the case. A good example is the added energy consumed by a conveyor's crank-arm forcibly "pushing and pulling" its drive springs at any speed other than their precise "Natural Frequency." Another would be the unwanted "flexing" of a member in a poorly designed counterbalance. When this happens, this portion of "spring effect" actually becomes part of the "Load" which tends to confuse this analysis.

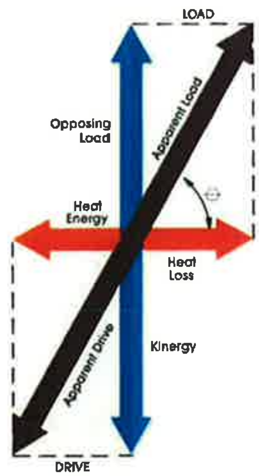


Figure 1
The four vectors are shown as they would appear in a Phasor Diagram. When the "Kinergy" vector equals the one for the "Opposing" Load, it is the specific ideal condition of Resonance. The upper quadrant reflects the "LOAD" and the lower left describes the "DRIVE."

Therefore, the "spring effect" quantity needs to have a specific name that identifies it only when it is gainfully part of the driving means. This necessity introduces the term "Kinergy." It stems from the letter "K" which is the long time symbol for "spring rate" or lbs./in. It is defined as the kinetic energy developed by a spring's motion during the drive portion of its "cycle." Since it has no "heat" value, it is a "non-heat" energy quantity, with a net power output of zero. However, the "effective" use of Kinergy will directly affect "energy efficiency." The minimal contribution of any "spring effect" from the unit's mounting on soft isolation springs is ignored in this analysis.

D. Heat Energy Input: This is the necessary "heat energy" that must be provided to the machine from an outside source to sustain the vibratory motion. It often takes the form of an electrc motor for more versatility, but it could also be a high frequency electromagnet or any other suitable means.

It is important to realize the machine will always vibrate at the speed or frequency of its "Input Power Source." This is so even if the resonant spring principle is used in conjunction with it.

Plotting the Vectors
A plot of these vectors is relatively easy to make. The "Heat Loss" and "Heat Energy" can be laid horizontal and colored red to denote their "heat" value. The "Opposing" Load and Kinergy are 90° displaced from the other pair. Therefore, they are plotted vertically and the cool color blue is used to symbolize they are "non-heat" quantities. The "LOAD" vectors are seen in the upper right and those for the "DRIVE" in the lower left in Fig. 1 above.

The "Drive versus Load" Analysis
(Continued)

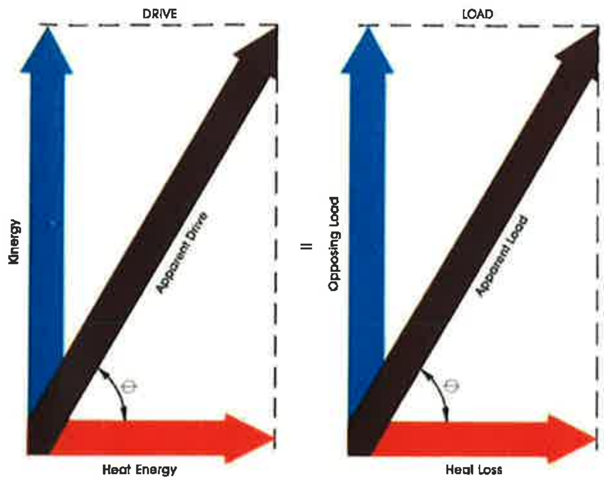


Figure 2

The "Drive vs. Load" analysis for any Vibratory Machine. It uses vectorial equations to express Forces, Energy Components, and the Total Apparent Power or LOAD. It reveals and defines Mechanical Impedance and it allows the reasoning of the effects of how the input power is applied to a unit. It also permits the evaluation of Energy Efficiency. In short, it appears to give vibratory machine designers a more appropriate line of analytics.

Vectorial "Resonance"

Instead of the familiar "peak" of a curve, this analysis depicts the critical point of Resonance or Natural Frequency to occur when the "Opposing" Load vector equals the one for Kinergy. At this precise point, Kinergy is solely driving that portion of the load that is "opposing" the vibratory motion for one half of each cycle. Then this same load pushes the drive springs back in the other half. They are smoothly "reacting" to one another and moving "back and forth" in perfect unison. In the energy equation, they cancel one another and these two terms drop out. This leaves the "Heat Energy" input to drive only the Heat Loss vector. For powering any vibratory machine, this is the "perfect" condition. While it may be impractical for one reason or another to fully achieve this "ideal" situation, it represents a goal for designers to pursue.

Saying this in the form of an equation:

DRIVE = LOAD
Heat Energy ↔ Kinergy = Heat Loss ↔ Opposing Load

If the Kinergy vector = the "Opposing" Load quantity, then they cancel one another. This leaves:

"Heat Energy In" = "Heat Energy Out"

which is the ideal condition for "Energy Efficiency."

Vibratory Power

Multiplying the original "force" equation by their velocity changes the terms to vibratory power. A vectorial "Power Triangle" can be constructed to reflect the "Total Apparent Power" provided by the driving means. The same can be done for what is being driven, which is the "Total Apparent Load." As a four component equation, it would be:

DRIVE = LOAD
Real Power ↔ Reactive Power = Heat Loss Load ↔ Opposition Load

Converting the Theory into Reality

For a drive to take full advantage of the principle of "Natural Frequency" these vectors indicate a "Free Force" type of input power means is wanted in place of a "Crankarm" because:

1. When it is necessary, the drive can innately "yield" to marked changes in the load's Mechanical Impedance. This reads out as "load abuse" capability.
2. In maximizes the "effective" use of Kinergy, which is essential for energy efficiency.
3. An adjustable output is possible, because the heat energy input will "peak" at the point of resonance instead of being at a minimum. However, any change in the operating frequency would have to be below the point of resonance. Otherwise, the mass inertia load quantity would become excessive.
4. The input power means can accelerate independently of the stiff drive springs. This eliminates detrimental "force fights" within the machine itself during starting or stopping.

Original Achievement

The first practical benefit of this "Drive vs. Load" analysis was the discovery of a full range output adjustment for a mechanical type of Vibrating Feeder by a simple method of electrical control. Since its introduction years ago, its position of leadership has remained unchallenged.

Sub-Resonant tuned steel coil springs produce the wanted Kinergy or "Non-Heat" energy. A "Free Force" input, developed by relatively small rotating eccentric weights mounted on the shafts of an A-C motor, provides the needed "Heat Energy." It is a two component "drive system" whereby Kinergy is driving most of the segment of the load that "opposes" the vibratory motion and the motor is essentially driving the other portion that "resists" it.

It appears to still be the only electrical drive known that allows a standard A-C squirrel cage type motor to successfully have its running speed adjusted by simply varying the applied three phase voltages. This is possible because both the vibratory load demand and the drive system's total power capability are near perfectly matched, at any point, in the machine's zero to maximum range of output adjustment. This established a new "Load Curve." It amended the three already known, which were "Constant Torque," "Variable Torque," and "Constant HP" as they related to changes in speed. The unit's maximum operating frequency, which is absolutely essential for the drive's stability, is the motor's "synchronous speed." It can't be exceeded with this type of control because of the motor's inherent "regenerative braking" characteristic.

Uniquely, the operating "stroke and frequency" of a driven unit are simultaneously changed with the adjustment in voltage.

The "Universal" Conclusion

In time, it was eventually realized a unique "drive system" had been advanced by this innovation and not just a better Vibrating Feeder. By "distributing" the drive springs across the width and along the length, wide and long units can be built. They can also be concentrated in a single nest for short lengths. Therefore, the driven machines don't have dimensional limitations.

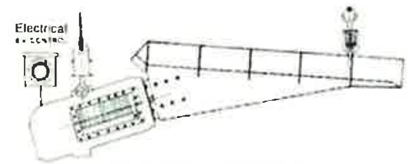
The stroke output is "linear" or a straight line which is preferred for accomplishing "Induced Conveying" functions. Its driving line can be designed for any stroke angle from zero to 90°.

The benefits of this type of vibratory drive system are many. They include the ability to tolerate load abuse, better capacity capability, allows repetitive starts and stops, an adjustable output, and the best energy efficiency.

These are the reasons why the "Free Force" input combined with Sub-Resonant tuned springs or what is commonly called the Kinergy Drive System has qualified for the "Universal" adaptation to all the machines that depend upon the vibratory action to move bulk solids or unit pieces. Historically, it was the first one to be able to do this.

For powering these various types of "Induced Conveying" machines, it has proven to be the most versatile and "energy efficient" vibratory drive system known.

Comparing Vibratory Drive Systems Used to Power "Induced Conveying Machines"

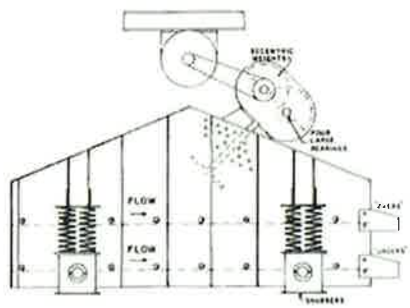


Electro-Magnetic Drive

1928

Electro-Magnetic

This was the first drive to have the enviable asset of "simple electrical control" for output adjustment.

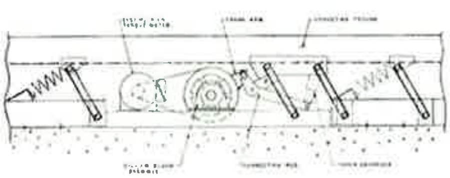


Single Input Drive

1930's

Single Input (Brute Force) "Free Force" Input Type

This drive was previously the best for "load abuse" capability.

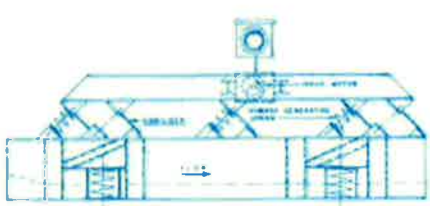


Natural Frequency Drive

1950

"Natural Frequency" Springs with Eccentric Crank Arm

This drive method was the first to permit "long" conveying units to be built.



"Distributed" Top Drive

1978

A Typical Kinergy Drive Configuration

Since the Kinergy System has (1) "full range output adjustment by simple electrical control" (2) "severe load abuse" capability, (3) the ability to make wide and "long" length units, (4) the best "energy efficiency," and (5) higher capacity capability, it has emerged as the only "universal" vibratory drive system to power "Induced Conveying" machines.

	Vibratory drive systems				
Technical Name	Electro-Magnetic (free force)	Single Input		N F Springs Combined w Ecc Crank Arm	Free Force Input Combined w Sub Resonant Springs
		Crank Arm	Free Force		
General Type ❶	Electro-Magnetic	Mechanical	Mechanical	Mechanical	Electro-Mechanical
Typical Application	Feeder or Screen	Conveyor	IVF Units Feeder, Screen or Shake-out	Conveyor or Spiral Elevator	Universal (i.e. many different units)
Common Name	Electro-Magnetic	Brute Force	Brute Force	Natural Frequency Conveyor	The Kinergy Drive System ❷
Input Power Method	Electro-Magnet	Eccentric Crank Arm	Eccentric Weight	Eccentric Crank Arm	Eccentric Weight
Stroke Pattern	Linear	Linear	Circular, Elliptical, or Linear	Linear	Linear
Adjustable Output (Elec.)	Simple 0 to Max	Not Simple	Not Simple	Not Simple	Simple 0 to Max
Multi-Unit Control (Elec.)	Simple 0 to Max	Not Simple	Not Simple	Not Simple	Simple 0 to Max
Stroke & Freq. Choices	Limited	Wide Range	Wide Range	Wide Range	Wide Range
Use of Kinergy	Excellent	None	None	Good	Excellent
Operational Tuning	Sub-Resonant	-	-	Natural Frequency	Sub-Resonant
Power Factor ❸ Correction	Practical	-	-	Difficult	Practical
Mechanical ❹ Impedance	Yields	Tries to Overcome	Yields	Tries to Overcome	Yields
Input Power at Resonance	Maximum	-	-	Minimum	Maximum
Input Power Below Reson.	Decreases	-	-	Increases	Decreases
"No Load" Noise Level	Noisy	Quiet	Noisy	Quiet	Quiet
Starting & Stopping	Smooth	Smooth	Erratic Wobble	Smooth ❺	Smooth
Repetitive Starts & Stops	Yes	No	No	No ❺	Yes
Start Under Head Load	Yes	No	Yes	No	Yes
Maintenance	Dust in Electro-Magnet	Many Parts in Crank Arm Assembly	Large, Special Brgs & Their Lubrication	Many Parts in Crank Arm Assembly	Only Three Components
Vibratory Force Isolation	Good	Good, if Counter-Balanced	Not Good Particularly at Start & Stop	Good, if Counter-Balanced	Good, if Counter-Balanced
Typical Std. Widths	1" to 72 (Limited)	8" to 72" (Limited)	8" to 120" (Limited)	6" to 144" (Not Limited)	6" to 144" (Not Limited)
Typical Std. Lengths	To 10 ft (Limited)	To 20 ft (Limited)	To 20 ft (Limited)	To 300 ft (Not Limited)	To 300 ft (Not Limited)
Load Capability	Fair	Fair	Excellent	Fair	Excellent
Head Load	Limited	Limited	High	Limited	High
Impact	Fair	Mild	Severe	Mild	Severe
Shock	Fair	Mild	Severe	Mild	Severe
Abusive	Fair	Mild	Severe	Mild	Severe
Energy Efficiency	Good	Poor	Poor	Good, if near resonance	Excellent

❶ "Mechanical" means an electric motor (or its equal) is used to provide either part or all of the total driving power required by the vibratory unit (as compared to an electro-magnet)

❷ "Kinergy" is defined as the specific Kinetic Energy developed by a spring's motion during the drive portion of its cycle. It provides the "Reactive" power component of the drive system

❸ The ratio of the total frictional loss to the actual apparent load is called the "Mechanical Power Factor"

❹ "Mechanical Impedance" is the resultant or vectorial sum of all the forces "resisting" (friction) and all those "opposing" the vibratory motion

❺ An internal "force fight" innately occurs between the crank arm and the drive springs at each start or stop

Induced Vertical Flow Versus Induced Conveying

"INDUCED VERTICAL FLOW" COMPARED TO "INDUCED CONVEYING" MACHINES

VIBRATORY MACHINES

	"INDUCED VERTICAL FLOW"		"INDUCED CONVEYING" ❹
	Discharging	**Densifying**	**Circular or Unidirectional**
Typical Machines	Bin Activators, Activated Bins, Container Activators,Storage Pile Dischargers, and Rail Car Dischargers	Tables, Activators, and Vertical Faces for densifying containers and Rail Car Densifiers.	Feeders, Conveyors, Screens, Mixers, Heat Transferring Units, Spiral Elevators, Sand Reclaimers, or the like.
Function ❶ ❷ ❸	To "induce" (not force) the stored material to have a uniformly Expanded Vertical Flow Pattern in a steady stream until the storage means is either empty or withdrawn to its maximum practical limit.	To "induce" (not force) the contained material to orient its individual particles so they can fill every void. The result is densification by means of packing the particles.	To "induce" (not force) the movement of the bulk solid or unit piece so the machine can accomplish its intended purpose, such as feeding, conveying, screening, heat transfer, shakeout, or the like.
Material Mover	Primarily the force of gravity	Primarily the force of gravity	The applied vibratory action
Material Flow Direction	Vertical	Vertical	Essentially horizontal or elevating.
Material Characteristics	The "vertical flow" properties of the stored bulk solid which includes its degree of "set".	The ability of the contained particles to be repositioned and deaerated.	The conveyability of the material in response to the applied vibratory action.
Vibratory Drive System	Usually, the Single Input (Brute Force) type.	Usually, the Single Input (Brute Force) type.	Usually a "Free Force" Input combined with subresonant tuned springs.
Effect of The Vibratory Action	Reduces the stored material's "inter-particle" friction, combined particle shear strength, and wall friction; shatters fused "set" or the "interlocking" of the material's particles.	By reducing "inter-particle" friction, the particles realign with respect to one another in their attempt to flow down in response to gravity. Consequently, voids are filled and any trapped air is released.	Conveys the material with an action that helps to accomplish the specific application. "Inter-particle" friction is reduced and the material "stratifies" into layers by particle size. Liquids "implode."
Operation	Activate in accordance with the material's "natural" vertical flow pattern as it develops while being discharged from storage. Or, must be able to be "cycle type" operated when needed to prevent the excessive densification or packing of a temporarily dormant column or sector of stored material.	Overly vibrate the contained bulk solid while it is essentially in a dormant or non-flowable condition.	Since the applied vibratory action is moving the material, the machines must be energized to perform their respective function.
Unit "Size" Selection	Directly related to the dimensions of the particular storage means. The TPH output capacity is a secondary consideration.	Determined by the physical size and the loaded weight of the container. The "output" is the amount of densification achieved.	Primarily governed by the required TPH capacity.
Loading	With "set," some shock or impact, and usually high head loads.	Can be very heavy loads, but all will be the "steady state" type.	Except for feeders or mold shakeouts, the loading is normally uniform.

❶ Vibratory machines for "Impelled Retrieving" are available. An example would be large feed-conveyors which can provide a flat floor for dump hoppers, bins, ship compartments, or the like. Another is accumulating conveyors.

❷ "Low-profile" type Bin Activators or Activated Bins are Induced Vertical Flow machines. This is so even though they convey a portion of the stored material to the outlet.

❸ "Densifying" is a form of Induced Vertical Flow. The difference is the storage means is excessively vibrated and it does not have an outlet.

❹ When a vibratory machine moves the material load primarily by vibration, it is utilizing the principle of "Induced Conveying."

Fig. 18

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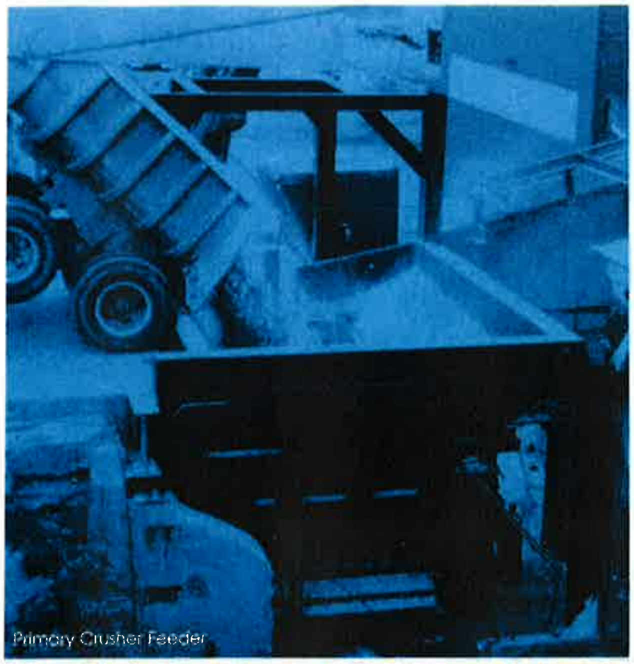
Kinergy Driven "Induced Conveying" Machines at Work

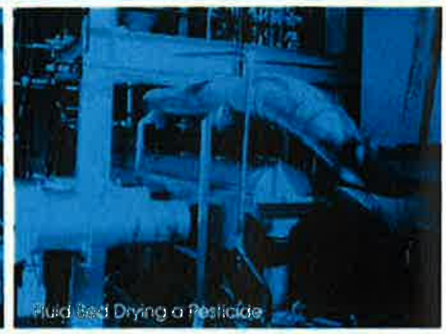
Save Energy use Kinergy

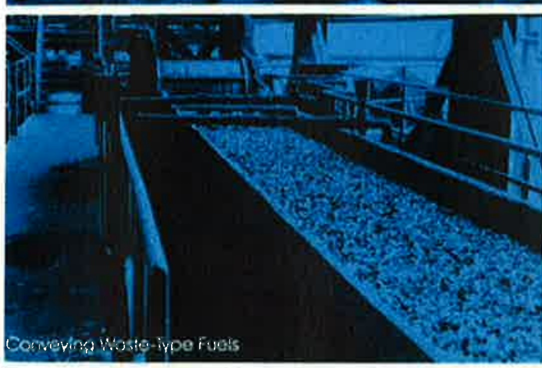

Primary Crusher Feeder

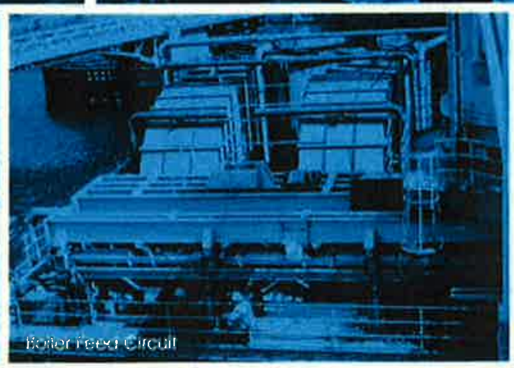

Conveying Hot Incinerator Ash


Vibratory Screen Grade-Sizing Coal


Feeding Aggregate


Fluid Bed Drying a Pesticide


Conveying Waste-Type Fuels


Boiler Feed Circuit


Tire Singulator


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