One Simple "Common" Drive for Foundry Vibrating Equipment

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ABSTRACT

The capabilities and characteristics of the vibratory equipment used in foundries are directly related to the specific type of drive system the unit employs. This determines the machine's width and length limits, type of loading, ease of adjustable output, energy efficiency, component complexity, maintenance requirements, or the like.

This presentation describes, evaluates, and compares the four popularly available vibratory drives. By using the "drive vs. load" analysis, it respectfully shows how and why one of these drive methods has all the advantages of the other three, but avoids their respective disadvantages. For the first time in the history of vibrating equipment, one common vibratory drive system has emerged that can be universally applied.

Foundries are benefiting from this development. For example, power consumption for these needed units is reduced by as much as 75%; the electrical control for output adjustment is greatly simplified; load abuse is tolerated; the few interchangeable drive components are a relief to maintenance, and the cost is at least competitive with units equipped with alternate drives.

Cupola feeders, sand and casting conveyors, screens, sand coolers or dryers, lumpbreakers and shakeouts are among the units available with this "common" drive. This makes the operating and maintenance "logic" the same for all these different machines of various functions.

Academically, this text also explains "mechanical impedance," the "heat vs. non-heat" energy concept for driving vibratory mass inertia loads, and indicates a practical method of obtaining "mechanical power factor" correction.

INTRODUCTION

The capabilities of any vibratory machine used in foundries are directly related to the specific type of drive system it employs. For example, this determines the machine's width and length limits, type of loading, ease of adjustable output, energy efficiency, component complexity, and maintenance.

Virtually all the vibratory units utilized by industry are powered by one of four different types of drive systems. They are: 1) electromagnetic, 2) single input (brute force), 3) natural frequency tuned springs combined with an eccentric crankarm input, or 4) the free force input combined with sub-resonant tuned springs.

By using the "drive vs. load" analysis, this presentation describes, evaluates, and compares these popularly available vibratory drives, and it respectfully shows how and why only one of these drive methods has all the primary advantages of each of the others, while avoiding their disadvantages. It has far more universal adaptability than any of the others. Further, this drive can probably be used to power other machines such as pumps, fans, or the like. Finally, it could be the first practical means of accomplishing mechanical power factor correction.

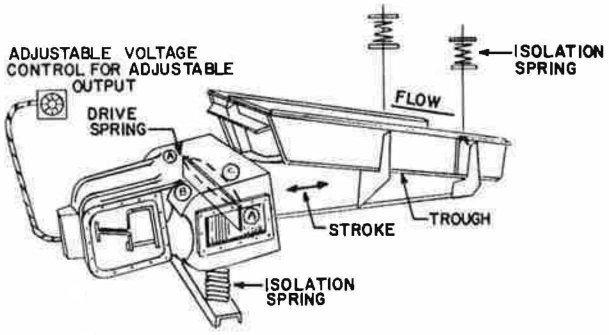


Fig. 1. The electromagnetic type of drive system. Introduced in about 1928, it showed the conveyability of bulk solids solely by a vibratory action. Because of the simple electrical control feature for a zero to maximum adjustable output (TPH), this drive method was very popular for feeders for many years. But, it was limited by the electrical power supply to a buzzing type of vibratory impulse.

TYPES OF DRIVE SYSTEMS

Electromagnetic

Because electromagnets have an inherent "back and forth" action, they have an innate linear stroke, or uni-directional output. By mounting the electromagnet so its output force was displaced 20 to 30 degrees from the trough surface, good particle conveying action was obtained. Further, because a magnet can have its field strength varied by altering the applied voltage, the amount of stroke could be changed. Flat bar-type drive springs, which are vibrated near their reasonant point, can be uniquely used to reduce energy consumption. This drive system is illustrated in Figure 1.

Electromagnets were the original drive system for vibratory feeders. They are commonly called *electromagnetic feeders*. For many years, they were the only practical type available. Using a simple voltage control, they obtained a full range, zero to max., adjustable output (TPH).

This drive system was also successfully applied to steep, downhill-sloped screening units, particularly when intense surface action on the screening media was required.

They are usually limited to only a "high frequency-short stroke" or a "buzzing" type of vibratory impulse by the electrical power supply.

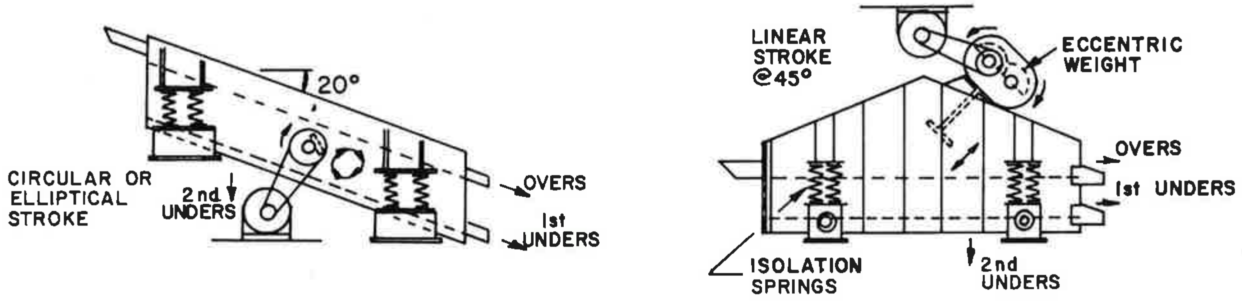
Single Input (Brute Force)

This drive method derives its name from all the power stemming from only one source: the input motor. Commonly known as a *brute force* drive, it usually uses motor speeds or vee-belts to rotate freewheeling eccentric weights that generate a relatively low frequency, long stroke action. This provides a more favorable capacity (TPH) per unit of trough width (as compared to higher frequencies and shorter strokes). This drive system, as applied to several different vibratory units, is illustrated in Figure 2.

It can have an erratic wobble-type motion when started or stopped. Isolation or mounting spring snubbers of various types have been developed over the years in an attempt to curtail this alarming motion. It does not lend itself to a simple means of adjustable output (TPH). However, variation can be obtained by the use of hydraulic motors, eddy current clutches, adjustble voltage D.C. drives, or adjustable mechanical sheaves with vee-belts.

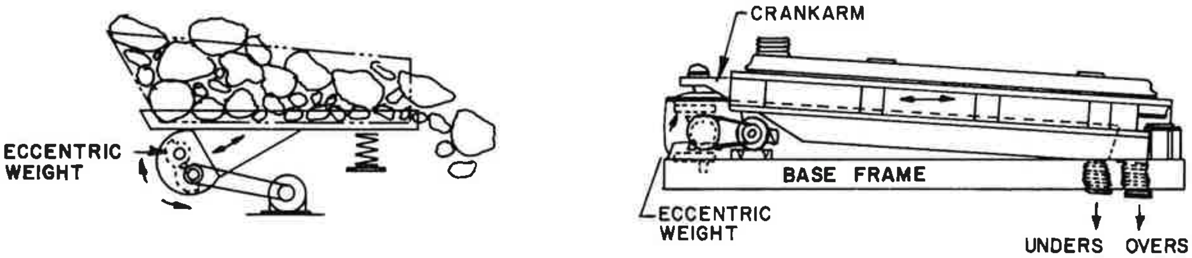
For many years, this was the only mechanical vibratory drive system capable of dealing with wide load swings, severe shock loads, and abusive loading applications. That's because it has a free force input. This is why it is still a favored drive system for powering heavy and extra heavy duty feeders, screening units, foundry shakeouts, or for any other marked load changing applications. Stroke patterns can be circular or elliptical, with so-called single shaft, two bearing drives, or unidirectional (straight-line), by using two shaft, four bearing drives.

In passing, the rotating eccentric weights can be replaced with an eccentric crankarm. It pushes and pulls the trough. In this design, the trough was usually supported by soft or easily bent flat bar springs which are similar to the stabilizers used on other vibratory drive systems. This is a second type, single input drive system. Because of its limited loading capability and width and length restrictions, it was usually only applied to relatively light duty applications.



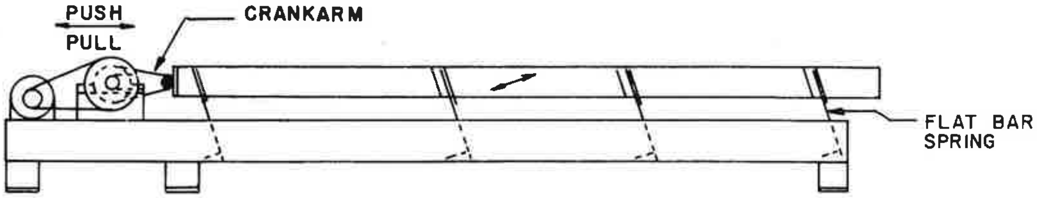
A. AN "INCLINED' SCREENING" UNIT. IT HAS A SINGLE SHAFT(WITH ECCENTRIC WEIGHT) THAT PASSES THROUGH THE SCREEN BODY. THEY ARE OFTEN CALLED "TWO BEARING" UNITS.

B. A "HORIZONTAL MOUNTED SCREENING" UNIT. THESE ARE SOMETIMES CALLED "FOUR BEARING" UNITS.



C. AN ABUSIVELY LOADED FEEDER OR SHAKEOUT. PREVIOUSLY, THIS WAS THE ONLY DRIVE METHOD CAPABLE OF WITHSTANDING SEVERE LOADING.

D. A "SIFTER STROKE" SCREENING UNIT. THEY ARE ALSO CALLED "GYRATORY SCREENS", GRAINCLEANERS, "SHAKERS", OR SEPARATORS. BECAUSE OF THE TYPE OF CRANKARM USED, ANY LOADING ON THIS UNIT IS LIMITED.



E. AN ECCENTRIC CRANKARM "PUSHING & PULLING" THE UNIT. EASILY BENT FLAT BAR LEAF SPRINGS SUPPORT THE TROUGH. EVEN THOUGH ROTATING ECCENTRIC WEIGHTS COULD REPLACE THE CRANKARM, THIS TYPE OF DRIVE IS LIMITED TO RELATIVELY LIGHT LOADING.

Fig. 2. Typical single input (brute force) driven vibratory units. The designs shown in A, B and C are the type that earned this drive system's reputation for tolerating severe, abusive loading. Because they were motor driven, they could be operated at a lower frequency and longer stroke for better capacity capability. Available from about 1900, this drive was made much more practical in the 1930s.

Natural Frequency Tuned Springs/Eccentric Crankarm

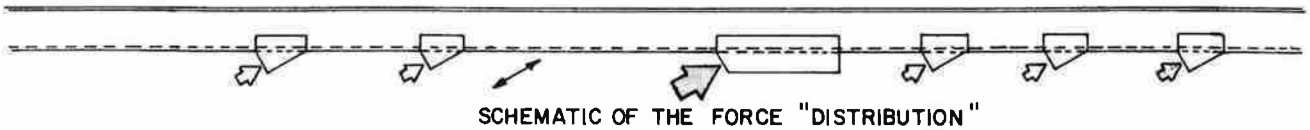
This drive system (Fig. 3) uses a motor driven, rubber-bushed, eccentric crankarm, which is usually coupled with a dashpot or shock absorber to enable it to be combined with stiff drive springs spread across the width and along the unit's trough length. By doing so, wide and long units can be constructed.

These machines are usually tuned to have the drive spring's natural frequency nearly agree with the speed of the eccentric crankarm when the unit is in the no-load state. When applied within proper load limits, it is a very smooth operating, quiet running, low power consuming, minimal maintenance drive system. Since the input forces generated by the drive springs are spread across the full width and along the length of the trough member, the structural stresses are considerably reduced. The stroke action is unidirectional, or a straight line.

The shock absorber is used to help reduce the effect of the inherent force fight that occurs between the stiff drive springs and the input motor turning the eccentric crankarm shaft at starting and stopping. At times, stout stabilizing rocker arms are needed to provide added support to the load carrying trough to help prevent excessive overloads from developing in the input crankarm as the trough inherently tries to settle under load.

Counterbalancing (Fig. 4) is available and is usually a reasonably simple design. But, it can become complicated in order to be stable in force isolation from no-load to full load for units applied to relatively heavy loads.

This drive system is restricted to relatively steady state, constant rate loading applications such as vibrating conveyors. This is the reason it is commonly called the *natural frequency conveyor* drive.



SCHEMATIC OF THE FORCE "DISTRIBUTION"

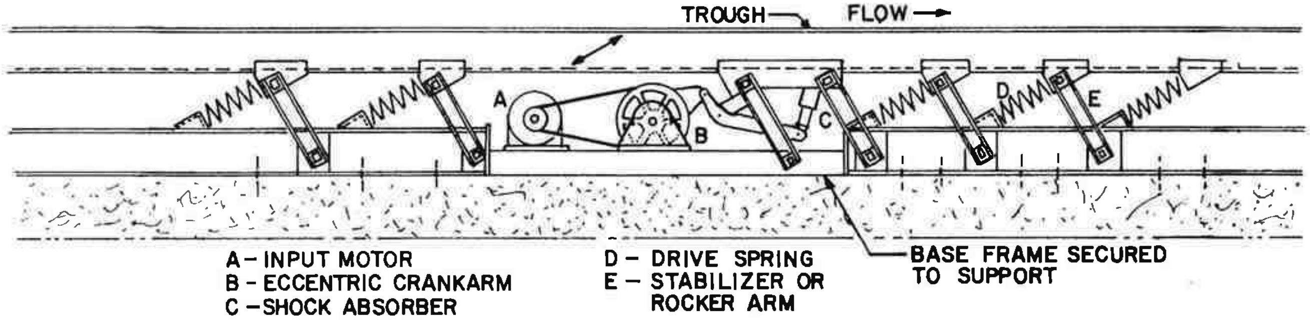


Fig. 3. Natural frequency tuned springs combined with an eccentric crankarm drive system. It is shown in the original non-balanced design that was introduced in about 1950.

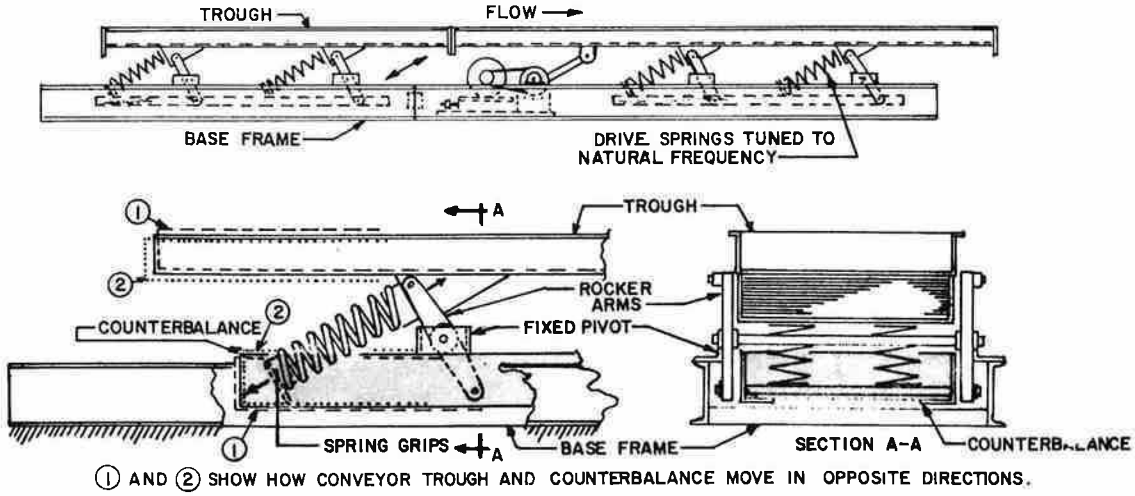


Fig. 4. Typical counterbalanced design for the drive shown in Figure 3. When the base frame is mounted on soft springs, it becomes the counter-balanced and isolated design. This development added more versatility to this conveyor's application.

Figs. 3.&4. Both the width and length restrictions were lifted from vibrating conveyors by this innovative drive in about 1950. That's because it distributed the driving forces. Probably more important, it boldly showed the deliberate use of natural frequency in a mechanical form without destructing the machine.

Free Force Input/Sub-Resonant Tuned Springs (Mechanical Type)

The discovery of an A.C. squirrel cage motor, rotating small eccentric weights, and coupled with sub-resonant tuned stiff drive springs to possess a full range, zero to max., adjustable output by only varying the applied voltage to the motor, caused a lot of attention to be given to this type of drive system.

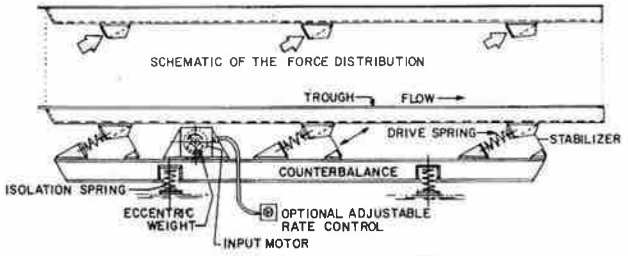
While this drive method takes advantage of the natural frequency principle, the difference is the drive springs are purposely sub-resonant tuned. This means their resonant frequency is significantly above the speed of the input motor's forces. *Sub* infers under. *Resonant* relates to the spring's natural frequency. *Sub-resonant* tuning means to always keep the maximum running speed of the input force "under" the drive spring's natural frequency or resonant speed—regardless of the load level in the trough or load member. For example, when the unit is empty, or in the no-load state, the natural frequency of the drive springs is considerably above the input force's top speed. As load is applied, this resonant point or speed inherently reduces and moves closer to the input force speed. Thus, the drive springs work harder with material load, because their preferred speed moves closer and is more in step with the input force (motor's) speed. Therefore, this drive has a "built-in" automatic adjustment in the power output developed by the driving springs in direct answer to changing load levels.

There is no mechanical linkage between the drive springs and the input motor. This permits the drive springs to continually alter their resonant speed in answer to changing load levels without demanding wasted power from the input motor. This gains more energy efficiency. Also, this drive can suffer a severe shock load without damage, because it has a freewheeling or yieldable input. Both the concentrated and the distributed drive spring arrangement for this drive system are shown in Figure 5.

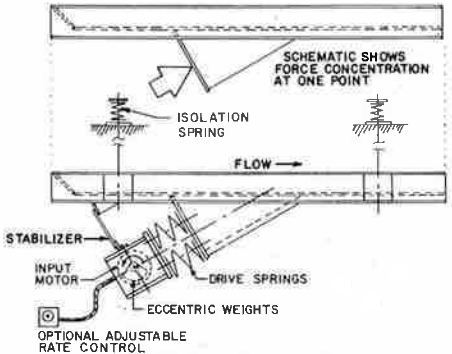
Counterbalancing is relatively simple and actually improves in percent force isolation with load. The output stroke is linear or unidirectional. Operating sound levels are surprisingly quiet. Commonly known as the *kinergy drive system*, it gets its name from *kinergy*, which is defined as the specific form of kinetic energy developed by a spring's motion during the drive portion of its cycle.

DRIVE VS. LOAD ANALYSIS FOR POWERING VIBRATORY MACHINES

Instead of using the classic resonance curve (Fig. 6) as a basis of analysis, the vibratory drive and load relationships can be more appropriately represented in a vectorial form. In so doing, some well-known textbook terms such as "magnification factor" are avoided. This skirts the need to say "energy is being magnified," which is dubious at best. The vectors reveal and define mechanical impedance. They allow the heat component of power to be separated and identified from the non-heat (reactive) power. Knowing the input power means, such as a crankarm or eccentric weights, it provides an insight for evaluating the machine's performance characteristics.



A. DISTRIBUTED DRIVE SPRINGS DESIGN FOR LONG LENGTHS



B. CONCENTRATED DRIVE SPRINGS DESIGN FOR SHORT LENGTHS

Fig. 5. The free force input, combined with sub-resonant tuned springs drive system (shown counterbalanced and with both concentrated and distributed springs). It is commonly known as the kinergy drive system. Because it has simple electrical control (1965), abusive loading capabiity, and the ability to build wide and long units, it emerged as the first vibratory drive system that could be universally applied, as was announced in 1978.

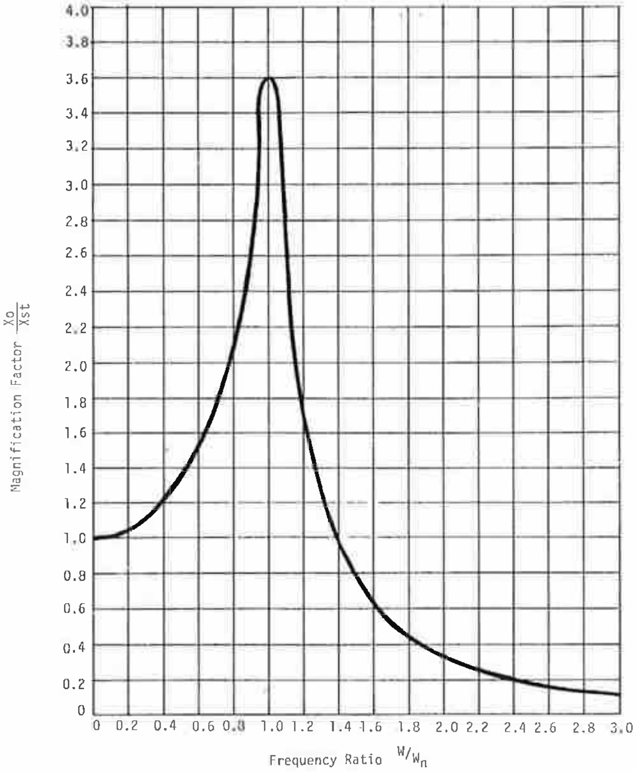


Fig. 6. Shows a well-known resonance curve of magnification factor vs. frequency ratio (combined with some degree of damping). This curve is typical of the classic theory dedicated to either the elimination of vibrations or their isolation. Applying this logic to purposeful, generated vibratory power proved to be cumbersome.

General Equations

Any vibratory machine can have its vectorial force equation analyzed by taking advantage of the law of dynamic equilibrium as demonstrated by the equations and vector diagrams shown in Figure 7.

The two terms on the right of Equation 2, which are ^{F}(mass inertia) and ^{F}(friction) represent the *load requirements*. The two terms on the left ^{F}(spring effect) and ^{F}(input) represent the *drive*. This gives a basis to analyze the vibratory machine as a "drive vs. load." Equation 3 shows the energy relationships. Equation 4 shows the realistic components. If these force terms were multiplied by velocity, it would represent the equation of power.

The analysis clearly shows the need to drive any vibratory mass inertia load with two separate input drive components of force, or power as compared to a single input drive source. Or, provide heat energy to that portion of the load that resists motion, but only supply non-heat energy to that portion of the load that opposes the vibratory motion.

The non-heat energy component of the load can be satisfied by the spring effect vector, which is called the kinergy component when it is on the drive side of the equation. The drive springs and the mass inertia load are actually exchanging their respective energy values in keeping with the law of conservation of energy. And, their net power output is zero. Each is reacting to the other. Thus, it is sometimes called *reactive power*.

(1) $F_{\text{SPRING}} + F_{\text{INPUT FORCE}} + F_{\text{MASS INERTIA}} + F_{\text{FRICTION}} = 0$

RE-ARRANGING THE TERMS, THE FOLLOWING CAN BE DERIVED:

DRIVE = LOAD

(2) $F_{\text{SPRING EFFECT}} + F_{\text{INPUT FORCE}} = F_{\text{MASS INERTIA}} + F_{\text{FRICTION}}$

(3) KINERGY + HEAT ENERGY = NON-HEAT ENERGY + HEAT LOSS

(4) DRIVE SPRINGS (KINERGY) + INPUT MOTOR = TOTAL MASS INERTIA LOAD + TOTAL FRICTION LOSS

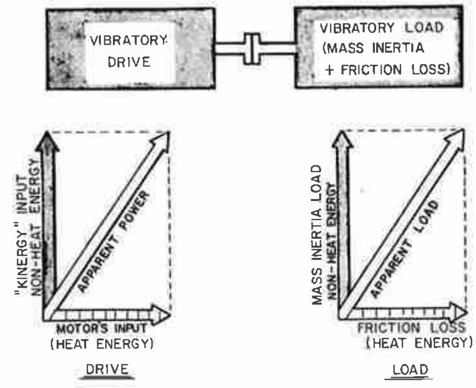


Fig. 7. The drive vs. load analysis for any vibratory machine. It uses vectorial equations to express forces, energy components, and the total power or load. It reveals and defines mechanical impedance and allows the reasoning of its effects on how the input power is applied to a unit. It also permits the evaluation of energy efficiency. In short, it gave vibrating equipment designers their own line of analytics.

Efficiency

The most energy efficient drive calls for the input power to only answer the needs of all the frictional losses (heat energy) of the loaded machine. Any additional load demand decreases the drive's efficiency.

Friction should be minimized by using drive springs that have a low hysteresis loss. If, for example, rubber-type drive springs were used instead of steel coil springs, the input power requirements of the unit would be at least double to overcome their higher friction loss. And, more power is needlessly consumed.

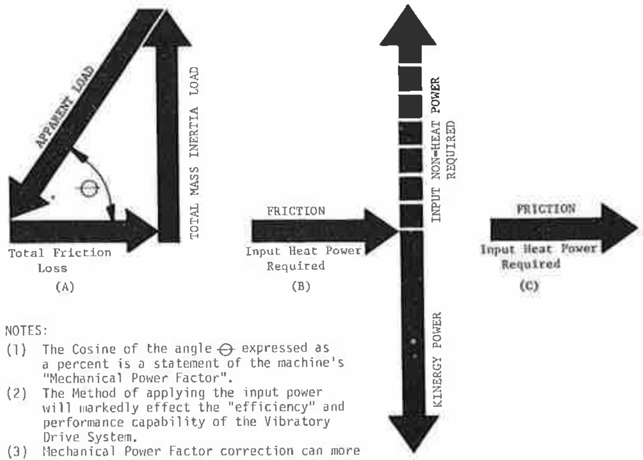
Mechanical Impedance

When the needed total frictional force of the loaded unit is vectorially combined with any opposing force, the resultant is an expression of the mechanical impedance of the load. Since it represents forces of both resistance (heat) and opposition (non-heat) to the input drive source, any drive system that tries to overcome mechanical impedance has a portion of its power consumption unnecessarily wasted.

Effect of the Input Power Means

The specific method used to supply the necessary input power (heat energy) to the unit must also be taken into account. This determines whether the drive system will either yield or try to overcome the impedance to its motion. It will also reflect the unit's flexibility in application and its performance capabilities.

For example, electromagnets or motor driven eccentric weights will *yield* to changes in the mechanical impedance of the load because they have a free force input. This is the reason they can be effectively sub-resonant tuned, and why they may have a full range zero to maximum output adjustment by simple electrical control. It is also why they tolerate abusive loading.



NOTES:

(1) The Cosine of the angle θ expressed as a percent is a statement of the machine's "Mechanical Power Factor".

(2) The Method of applying the input power will markedly effect the "efficiency" and performance capability of the Vibratory Drive System.

(3) Mechanical Power Factor correction can more easily be accomplished with a "free force" type of input power means.

Fig. 8. The total power required to drive a load is shown in (A). This is a power triangle. It represents the power input required to drive a machine that does not have a kinergy drive component. If an adequate kinergy drive component is provided, it effectively drives the non-heat required vector (B). Then, all that remains is the input heat power vector shown in (C).

Conversely, if the input power is by means of an eccentric crankarm, it will try to *overcome* the mechanical impedance of the load. This is why the power consumption of a vibratory conveyor rises markedly as the natural frequency of the drive springs departs from the crankarm's running speed even though it is empty, or in a non-productive state. It is also the reason it cannot be made easily adjustable in output by simple electrical control, and why it cannot tolerate abusive loading.

Therefore, a yieldable input power means to the load's mechanical impedance is almost always a better performing drive system than one which tries to overcome it. And, it is the only type that can be easily corrected for mechanical power factor.

The Power Triangle

If the total frictional load is plotted horizontally as a vectorial quantity, then the total vibratory mass inertia load would be plotted vectorially upward, 90 degrees displaced as shown in Figure 8. Their resultant is the *apparent load* the drive will need to satisfy.

The ratio of the total frictional loss to the apparent load is called the *mechanical power factor*. This is a statement of the drive's mechanical efficiency. It is often expressed as a percent by multiplying the cosine of the angle Θ by 100. The ideal mechanical power factor is unity or 100%. This would be obtained when the kinergy drive vector (plotted vertically downward) is exactly equal (but opposite) to the total mass inertia load vector. And, only the total friction losses remain to be provided from the input power source.

As a practical matter mechanical power factor correction should be accomplished with a free force input because it will yield to the mechanical impedance of the load.

SUMMARY OF THE ANALYSIS

By using this analytical approach, the vibratory equipment design engineer has a logical, predictable means of evaluating the purposeful, total power generated by either one or two input drive components. The characteristics of the unit can be derived from the specific method used to impart the input power. In short, it represents the analytics for the *power generation, efficiency*, and *performance of vibratory machines* as compared to the analytics used for the elimination of vibratory forces, or their isolation.

COMPARATIVE EVALUATION

From this discussion, the following criteria for a vibratory drive system can be concluded:

1) For *output adjustment*, simple electrical control is the preferred method. It should be linear, and of full range from zero to maximum rate output. (This is the feature that made electromagnets popular in the earlier years.)
2) For *load abuse capability*, a free force (eccentric weights) type of input power method is needed (as compared to a crankarm type).
3) To enable *wide and long units* to be constructed, the input forces must be distributed across the width and along the length of the machine.
4) For the best *energy efficiency*, the total drive power must be provided by two separate drive components. One is the input power source (heat energy) and the other is springs tuned to a resonant principle. Added efficiency will be obtained by using drive springs that have a low hysteresis loss. And, the input power method should be of the free force type. (A crankarm would not be as efficient.)
5) For better *capacity capability* (TPH), the generated vibratory action should be linear and of a relatively long stroke, low frequency type (as compared to a high frequency, short stroke).

With these guidelines in mind, the four available vibratory drive systems can be comparatively evaluated. This is reflected in Figure 9.

Any unit that utilizes an eccentric crankarm as the sole power means shows the least merit. Combining it with natural frequency tuned drive springs gains the advantage of being able to construct wide and long units; and these units can have good capacity capability. But, they cannot tolerate load abuse, nor can they be made adjustable in output by simple electrical control. They also lack energy efficiency with any increase in material load over a limited amount.

The motor driven, free force type, single input (brute force) drive system has load abuse and capacity capability. But, it is not easy to make it adjustable in output, and it can have poor energy efficiency. It also has width and length limitations, plus maintenance peculiarities.

If the electromagnetic drive system could be made to have capacity capability, plus eliminate the width and length limits, and it could be of rugged construction when needed, it would be rated as one of the best vibratory drive systems. However, this has not been accomplished over its fifty or so years of availability; and chances are, it will not be.

As can be seen, the free force input combined with sub-resonant tuned springs, or what is commonly called the kinergy drive system, has an integration of each of the advantages of the other three drives, but avoids their disadvantages. Namely, it has 1) simple, full range, electrical control, 2) load abuse capability, 3) the ability to build wide and long units, 4) the best energy efficiency, and 5) high capacity (TPH) type vibratory action. For these reasons, plus simplicity in design with only three components, it has emerged as the first vibratory drive system that can be universally applied. That is, it can be adapted to many different types of vibratory units of various functions; such as feeders, conveyors, screens, fluid bed cooler or dryers, shakeouts, lumpbreakers, sand reclaimers, or the like. Fortunately, this drive system compares favorably in cost, particularly, for those machines which require a linear stroke output to perform their function.

This does not mean the other three types of vibratory drive systems should no longer be used. It does mean vibratory equipment designers, purchasers, operators, or users now have a potentially better alternate drive system to consider.

BENEFITS TO FOUNDRIES

Foundries are benefiting from this development. For example, power consumption for these needed units is reduced by as much as 75%; the electrical control for output adjustment is greatly simplified; load abuse is tolerated; the few, interchangeable drive components are a relief to maintenance; and the cost is at least competitive with units equipped with alternate drives.

	Vibratory drive systems				
Technical Name	Electro-Magnetic	Single Input		"N. F." Springs Combined w/Ecc. Crank Arm	"Free Force" Input, Combined w/Sub-Resonant Springs
		Crank Arm	Free Force		
General Type ①	Electro-Magnetic	Mechanical	Mechanical	Mechanical	Electro-Mechanical
Typical Application	Feeder or Screen	Conveyor	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 ②
"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
Uses Drive Springs	Yes	No	No	Yes	Yes
Operational Tuning	Sub-Resonant	—	—	Natural Frequency	Sub-Resonant
Power Factor ③ Correction	Practical	—	—	Difficult	Practical
Mechanical ④ 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 ⑤	Smooth
Repetitive Starts & Stops	Yes	No	No	No ⑤	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 150 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

①"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).

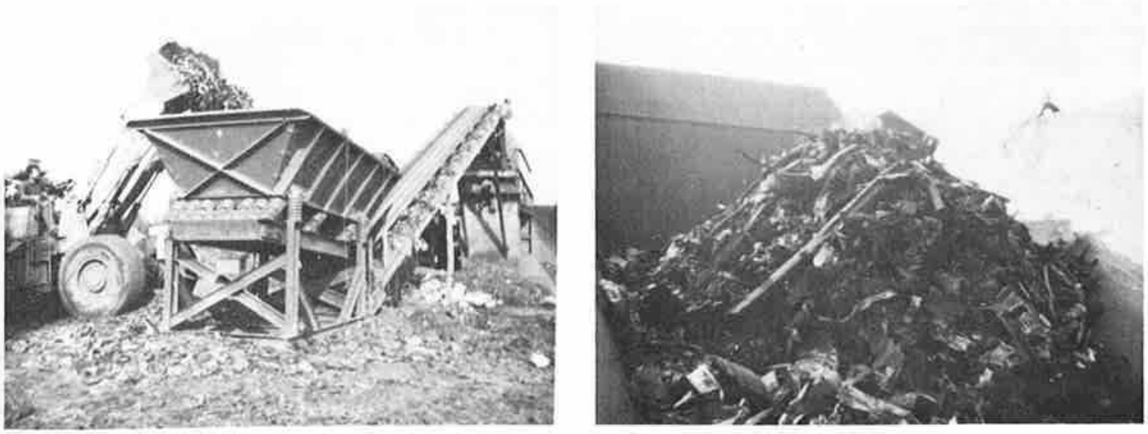
②"Kinergy" is defined as the specific Kinetic Energy developed by a spring's motion during the drive portion of its cycle. It provides the "Reactive" power component of the drive system.

③The ratio of the total frictional loss to the actual apparent load is called the "Mechanical Power Factor".

④"Mechanical Impedance" is the resultant or vectorial sum of all the forces "resisting" (friction) and all those "opposing" the vibratory motion.

⑤An internal "force fight" innately occurs between the crank arm and the drive springs at each start or stop.

Fig. 9. A comparison of the four types of available vibratory drive systems.



Front end loader dumping

A close up of the intertwined pieces

Abusive crane bucket loading is routine

Feeding with zero to maximum rate control

Fig. 10. Shows a 48-in. wide, flaring to 96-in. wide, by 16-ft. long kinergy driven feeder handling scrap metal. It consumes less than 2 HP. Cupola feeders are in service that handle loads to 25 tons of scrap metal.

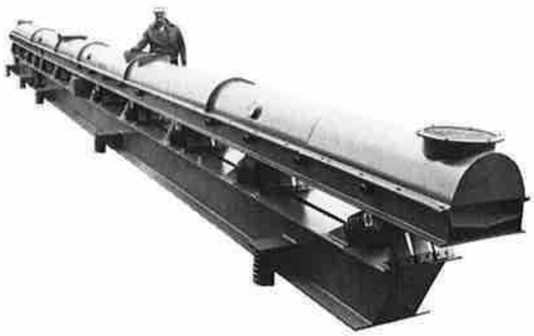


Fig. 11. A typical casting cooling conveyor. This 24-in. wide by 65-ft. long unit consumes less than 2 HP and is fully adjustable in its output.

Fig. 12. This lumpbreaking conveyor consumes less than 1.4 HP.

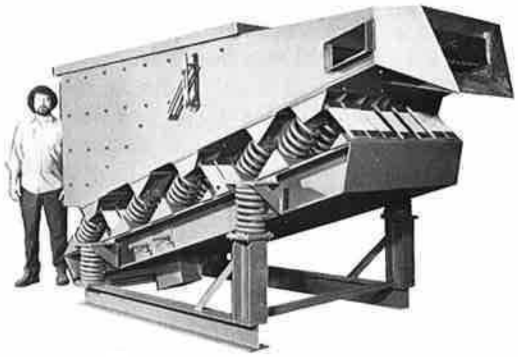


Fig. 13. This attrition mill for nobake sand is equipped with the same common kinergy drive system.

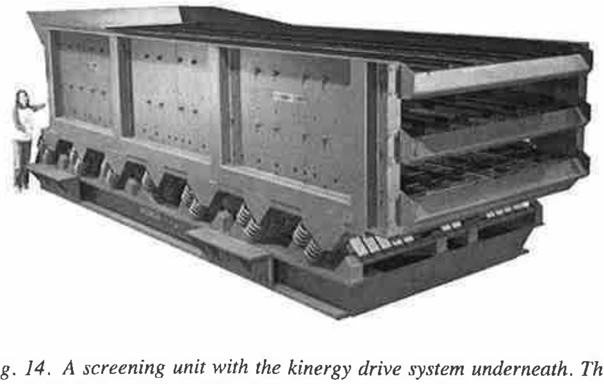


Fig. 14. A screening unit with the kinergy drive system underneath. This four deck, 8-ft. wide by 27-ft. long unit consumes 10 HP.

Cupola feeders, sand and casting conveyors, screens, sand coolers or dryers, lumpbreakers and shakeouts are among the units available with this common drive. This makes the operating and maintenance logic the same for all these different machines of various functions.

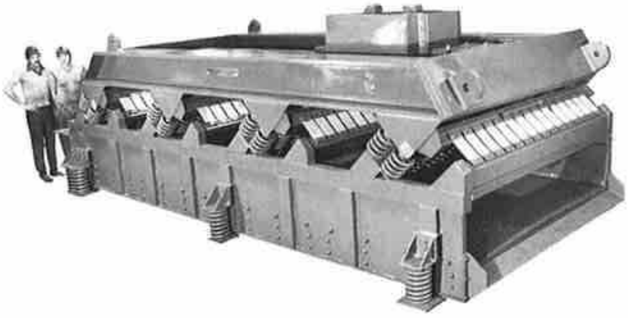


Fig. 15. This 8-ft. wide by 22-ft. long top drive screening unit is in service separating core butts and lumps from shakeout sand at an automotive foundry. It is rated 350 TPH, is horizontal mounted, and consumes 10 HP. It replaced an existing single input (brute force) driven, inclined screen that consumed 40 HP.

Examples of the reduction of this modern drive technology to actual practice are illustrated in Figures 10–19. Each unit is energy efficient, fully adjustable in output by simple electrical control, and by practical design has common, interchangeable components. Also, they can tolerate load abuse such as severe shock loads and head loads. Wide and long units can be built, operating sound levels are low; they are simple, and of easy maintenance; and they are all competitively priced.

For the first time in the history of vibrating equipment for use in foundries, one common, simple drive can now be used to power the needed units even though their respective application functions are different.

Fig. 16. This 60-in. wide by 42-ft. long sand cooler needs only 10 HP. The adjustable conveying speed is a true benefit.

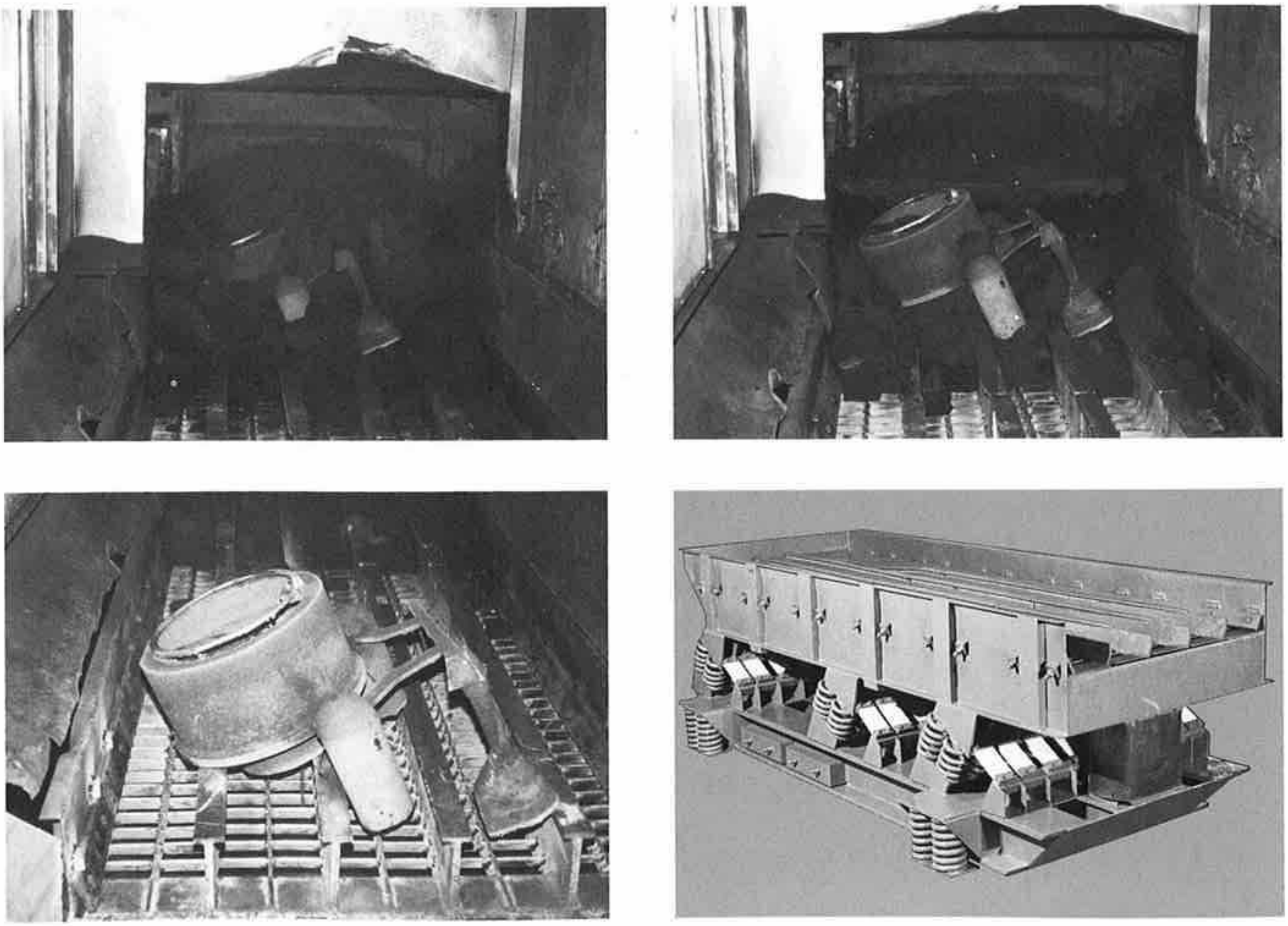


Fig. 17. Continuous shakeout feeders have been improved by the use of the kinergy drive system. Longer lengths are now practical, and the easy change in stroke and frequency for preventing casting damage is a real advantage.

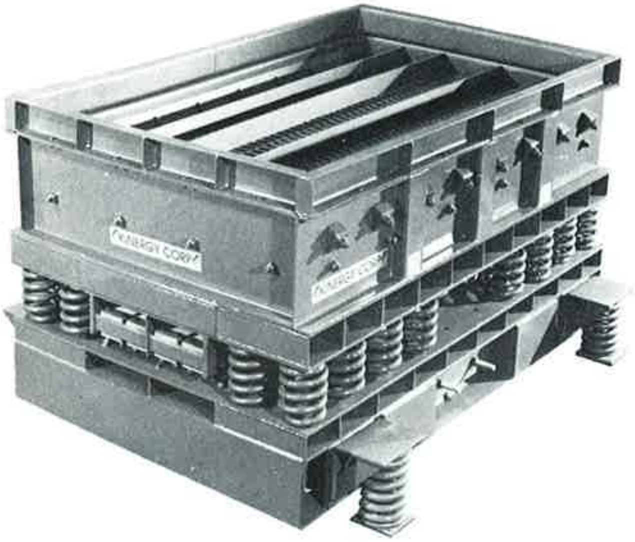


Fig. 18. A 6-ft. by 8-ft. shakeout table for either green or nobake type molds. It consumes 4 HP.

RETROSPECT

The advance of vibratory drive systems over the years was probably due to more "perspiration" than mental "meditation." During this time, the equipment designers had to persistently forge forward to gradually set aside deterrents in their path. Eventually, they calmed the fear of resonance; they pin-pointed the proper endurance limits for the component parts and the materials used in the unit's construction; they deviated from published theory when necessary and went on to formulate their own; and they eventually taught themselves how to logically reason vibratory drive systems.

Chances are, they had to do most of this progressive work while continually responding to their daily responsibilities. And, if all the facts were known, most of their gainful development work was probably done "on the run."

In closing, it is surprising for many to learn that all this advanced vibratory drive engineering technology initially came from the pursuits of the abstracts encountered with the "Induced Vertical Flow" of bulk solids from storage bins and piles. Said more simply, it all came from the digging out of many plugged storage bins!

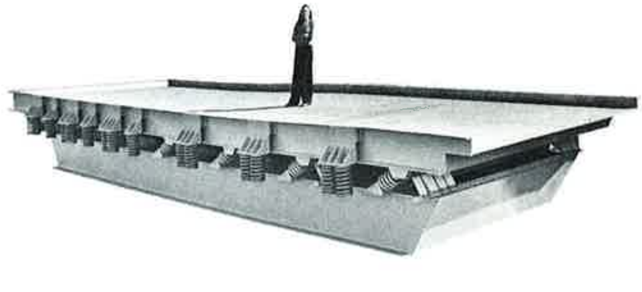


Fig. 19. This mammoth conveyor takes a 20-ton load dropped 14 ft. in a non-foundry application. It conveys reclaimed batteries uphill. Measuring 12-ft. wide by 38-ft. long, it is the largest unit ever built. It consumes less than 10 HP. This unit would not have been possible without the modern kinergy drive technology.

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