SPIROL WHITE PAPER

Vibratory Feeder Noise Reduction

Christie L. Jones, Market Development Manager
SPIROL International Corporation, Danielson, CT

INTRODUCTION

The past century has been witness to unprecedented changes in industrial manufacturing technology. Advancements in materials, methods, and control systems have led to higher quality, tighter tolerances and increased production speeds. All of these lead to lower costs, lower prices, and subsequently, increased demand. The increased demand drives the pursuit of ever-increasing speeds and the cycle repeats. As production machinery is pressed for faster and faster speed, machine cycle rates increase, vibration increases, and there is a corresponding increase in noise levels.

Vibratory feeders are not immune to this exponential rise in speed requirements. As one of the fundamental building blocks of automated assembly systems, ever-larger feeders are being pressed to run ever faster to keep up with ever increasing production rates. Additionally, as the use of automated assembly systems proliferates, so does the absolute number of feeders at a given facility. Increasing quantities and increasing rates of feeders lead to increased noise levels in the workplace.

Noise—any sound in excessive volume—has long been identified as a major cause of hearing loss. It is ***the major cause*** of preventable hearing loss. In addition to putting employees at risk for hearing loss, excessive noise levels have been linked to increased accident rates, decreased quality, and low worker productivity. Hence, any opportunity to reduce noise levels should be viewed as an opportunity to improve company profitability.

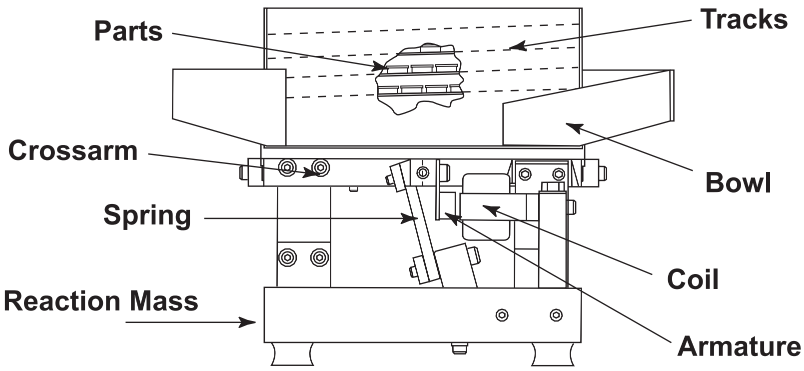
THE EFFECTS OF NOISE

The mechanics of why intense sound power damages hearing are now well understood. The nerves of hearing known as cilia in the inner ear are damaged very slowly over time by persistent exposures to high sound power. Eventually these nerves die. The worsening of hearing from noise exposure is insidious, slow, persistent and painless. Usually the earliest warning sign is tinnitus, ringing in the ears (or humming, buzzing or clicking sounds) when nerve damage first develops. As hearing loss increases, friends and relatives notice that they must repeat conversation frequently, radio and television are turned abnormally loud and those with hearing problems begin to lose interest in socialization (a form of personality change).

Other associated problems have been found among those who work in noise. One major issue is worker safety. Workers are put at risk when there is noise in the workplace. Noise effects the ability to hear warning signals. Clarity of verbal conversation such as instruction and directions is diminished. Speech discrimination becomes impaired as does sound localization. Noise restricts social interactions and serves to mask out useful and necessary auditory information. For workers with hearing loss, these auditory disadvantages increase the risks. Noise in the environment can create mistakes and sometimes accidents. In noisy production facilities, hearing loss affects between 40 and 80 percent of the work force versus an estimated 18 percent in the general population

There are several other negative effects of working in noise on a regular basis. Those who are regularly exposed to noise on the job have a higher rate of emotional health problems including anxiety, sleep disorders, emotional discord with their spouse and children, and blood pressure hypertension. In a study conducted in China, young adult females were found to develop several reproductive problems when subjected to a noisy work environment. 1) Menstrual cycles changed and became less regular. 2) Initial pregnancy was difficult to achieve. 3) Those who became pregnant had an abnormally high rate of miscarriage. 4) Those who became pregnant had an abnormally high risk of premature delivery. 5) Babies delivered live had an abnormally high rate of birth defects.

Illustration 1: Conventional Vibratory Feeder



Clearly the effects of noise can have damaging consequences and efforts should be made to minimize noise exposure. Reduction of noise produced by vibratory feeders is one area that can significantly reduce noise exposure in the workplace.

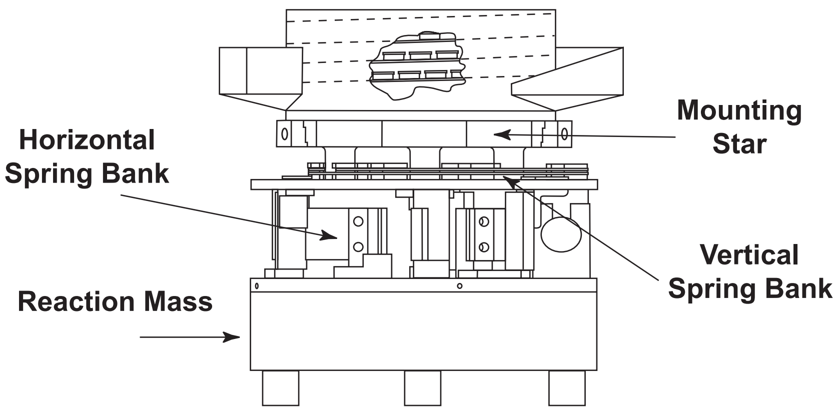
VIBRATORY FEEDER NOISE

Conventional vibratory feeders utilize an electromagnetic coil, a corresponding armature, and a spring in combination to provide the necessary motion. (See Illustration 1.) The coil is mounted on a reaction mass to counterbalance the vibrating bowl. As the coil is energized, the armature is drawn towards it. The armature and spring are connected through the crossarm, which is the mounting surface for the bowl. Because of the mounting angle of the spring, as the armature is drawn horizontally toward the coil, the crossarm moves both horizontally and vertically. The resultant vector represents the angled plane on which the bowl moves back and forth. The angled plane of motion, in conjunction with the angled track of the bowl, incrementally "feeds" the parts up the helical track towards the bowl discharge.

Noise is generated from the electrical pulses that draw the armature in towards the coil. These pulses occur at a frequency of either 60 or 120 Hz, corresponding to half wave and full wave line frequencies (in some countries these frequencies are 50 and 100 Hz). Noise is also generated from the parts in the bowl contacting the track. With each pulse of the coil, as the bowl is drawn along the resultant vector, the parts are "thrown" up the track to a spot slightly further along. Every time the part is thrown up and contacts the track on its way back down, noise is generated. With thousands of parts in the bowl, this contribution to noise can be substantial. The type of part has an impact on the noise level as well. Lightweight plastic parts will produce less noise than heavy metal parts. Feeding speed is controlled by varying the amount of power to the coils. An increase in power will create an increase in amplitude, the distance that the bowl travels with each pulse. Because the horizontal and vertical components of the motion are mechanically linked through the spring, any increase in power to increase the horizontal component (the major contributor to feed rate), will automatically increase the vertical. In addition to the extra noise generated by the coils, the increased vertical component causes the parts to bounce more, therefore creating more noise, as well as potentially causing mis-oriented parts.

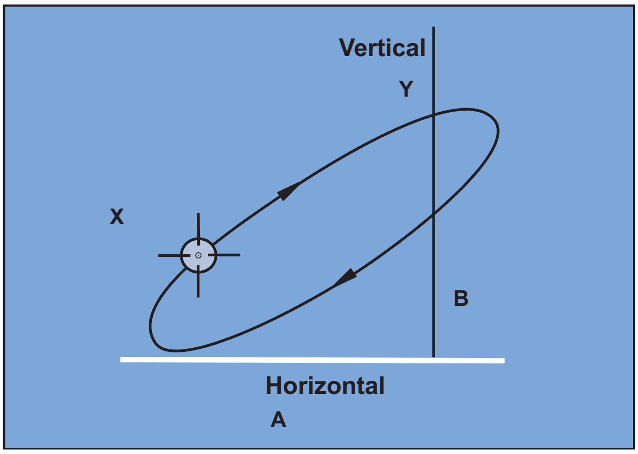
The Series 2000 dual-axis feeder achieves the vibratory motion in a different manner. Rather than having a set of springs mounted at a fixed angle, the dual-axis drive has one set of springs/coils that control the horizontal motion and another set controlling the vertical motion. (See Illustration 2.) These two motions are combined electronically, through the use of a microprocessor-based controller, to create a resultant vector. The controller senses the natural frequency of the feed system, and drives it at or near this frequency, typically 25-35 Hz. These lower frequencies are perceived by the human ear as being less noisy than the higher frequencies of the conventional feeder. Also, because the electromagnetic pulses are now working with, rather than fighting against, the natural motion of the bowl, less energy is consumed.

Illustration 2: Series 2000 Vibratory Feeder



Independent control of the horizontal and vertical motions of the bowl allows an increase in horizontal amplitude without a corresponding increase in vertical amplitude. This increases the feed rate without an increase in noise level and without causing mis-oriented parts. In addition to the horizontal and vertical components, the relationship between them, or phase angle, can also be optimized. By adjusting the timing between a horizontal and vertical pulse, an elliptical path is created (See Illustration 3.) With this motion, the bowl drops away from the part, travels backward, and then gradually picks the part up and carries it forward. Contrasted with the throwing action of the conventional bowl, this provides for much quieter and gentler parts handling.

Illustration 3: Series 2000 Phase Control



NOISE LEVEL COMPARISON TESTING

Empirical data to support the claims made above were gathered by conducting comparison testing between a conventional square drive and a SPIROL Series 2000 drive. The same bowl was used for testing on each drive. Noise readings were taken with an empty bowl, plastic bottle caps and metal coiled pins. Consistent feed rates were maintained between the Series 2000 and the square drive for both the caps and the pins.

Four measurements around each vibratory feeder were taken and averaged in order to compare the square drive to the Series 2000.

Measurements and analyses were performed by Noise Control Engineering (NCE) of Billerica, Massachusetts. Noise levels were measured using a Larson-Davis Model 2900B acoustic analyzer. The instrument was field calibrated by a Larson-Davis CAL200 acoustic calibrator at 94 and 114dB (re// 20 μPa) at 1,000 Hz.

Octave band and overall A-Weighted noise measurements were taken by NCE. Octave band sound levels provide information on the frequency character of the noise. The overall A-Weighted noise level provides a measure of the total sound amplitude, as perceived by the human ear. The A-Weighted scale is used by OSHA to set acceptable noise levels. All measurements were conducted in an interior room with HVAC systems turned off. The background noise levels (feeders not operating) were at least 20 decibels below the feeders' noise levels. Noise measurements were taken in four positions around the perimeter of the feeders, all at a distance of 3 feet. Three different conditions were tested: (1) an empty bowl; (2) plastic bottle caps; and (3) metal coiled pins.

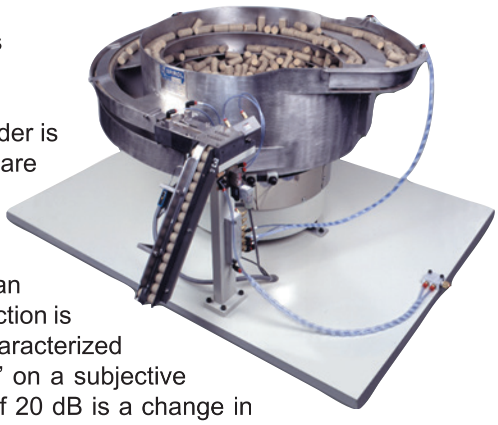
In order to make a comparison between the square drive and Series 2000 units, NCE averaged all the measurement locations for each feeder and each condition. The sound levels as a function of octave band are given in Table 1. The "Delta" columns present the average sound levels for empty bin, plastic caps and metal pins, respectively. "Average Delta" presents the difference between the square drive and Series 2000 units.

TABLE 1: Octave Band Noise Levels, Averaged of Four Locations. (All values in dB re 20 μPa.)

Octave Band	Empty Bin			Plastic Caps			Metal Pins			Average Delta
	Sq. Drive	2000	Delta	Sq. Drive	2000	Delta	Sq. Drive	2000	Delta	
31.5	50	59	-9	51	59	-8	51	61	-11	-9
63	55	55	0	55	55	0	54	56	-2	0
125	87	58	29	87	58	29	89	63	26	28
250	96	78	18	96	77	19	96	80	16	18
500	87	65	22	83	64	19	84	68	17	19
1000	75	53	22	81	63	18	80	66	15	18
2000	64	44	20	80	61	19	81	65	16	18
4000	63	34	29	81	59	22	85	70	15	22
8000	54	31	23	68	45	23	84	69	15	20
16000	39	27	12	50	34	16	78	64	15	14
dB(A)	89	70	19	91	72	19	93	77	16	18

TEST RESULTS

NCE made the following conclusions as a result of their testing:

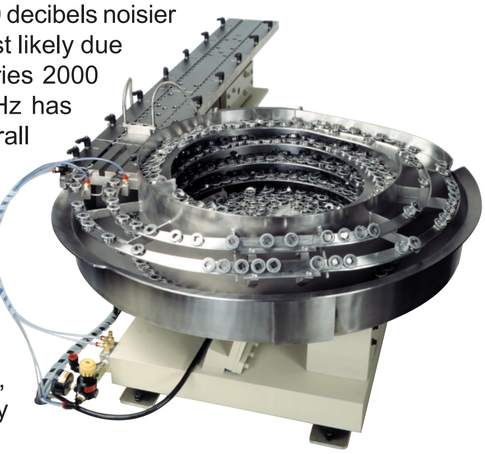


- The Series 2000 Vibratory Feeder is 15 – 22 dB quieter than the square drive unit in 125 to 16,000 Hz octave bands. On an overall A-weighted basis the Series 2000 is 18 dB quieter than the standard device. This reduction is a very significant and can be characterized as a "striking, fourfold change" on a subjective response basis. A reduction of 20 dB is a change in sound energy of one hundred times (100x).

- At a distance of 3 feet, the square drive feeder sound levels exceed OSHA's 90 dB(A) noise limits for 8 hour exposure. It may be unlikely for an operator to be within 3 feet of the feeder for 8 hours. However, as a reference, the Series 2000 unit is well below these OSHA limits. Based on the OSHA methodology, the Series 2000 would have zero contribution to an operator's sound exposure during a single work day.

- A comparison of 1/3 octave band data shows that the Square Drive has two tones at the 125 and 250 Hz 1/3 octave bands. The elimination of the 125 Hz tone in the Series 2000 contributes to a less harsh sound.

- The Series 2000 Vibratory Feeder is a 10 decibels noisier in the 31.5 Hz octave band. This is most likely due to the lower drive frequency of the Series 2000 unit. The higher sound level at 31.5 Hz has very little to zero contribution to the overall A-Weighted sound levels.



- In the 31.5 through 500 Hz octave bands, the sound levels are roughly the same for the empty bowl plastic caps or metal pins. For 1000 Hz octave band and higher, the metal pins produce the highest sound levels, followed by the plastic caps and lastly the empty bowl.

CONCLUSION

Factory noise level reduction should be a top priority in any manufacturing facility. Successful programs will lead to reduced accident rates, reduced worker compensation claims, higher productivity, and increased employee morale. All of these benefits combine to lower overall costs, allowing companies to be more competitive and/or profitable. The dual-axis design of the Series 2000 Vibratory Feed System allows for increased feed rates in a given bowl size, operation at the natural frequency of the system, and an elliptical, gentler, motion. These features contribute to a 100 times reduction in sound energy over a conventional feeder drive, or, in other words a fourfold human perceived noise reduction. The Series 2000 therefore should be a major component of noise reduction programs in facilities that use, or are planning to use, vibratory feeders in their manufacturing process.

Technical Centres

Europe

SPIROL United Kingdom
17 Princewood Road
Corby, Northants
NN17 4ET United Kingdom
Tel. +44 1536 444800
Fax. +44 1536 203415

SPIROL France
Cité de l'Automobile ZAC Croix Blandin
18 Rue Léna Bernstein
51100 Reims, France
Tel. +33 3 26 36 31 42
Fax. +33 3 26 09 19 76

SPIROL Germany
Ottostr. 4
80333 Munich, Germany
Tel. +49 89 4 111 905 71
Fax. +49 89 4 111 905 72

SPIROL Spain
08940 Cornellà de Llobregat
Barcelona, Spain
Tel. +34 93 669 31 78
Fax. +34 93 193 25 43

SPIROL Czech Republic
Sokola Tůmy 743/16
Ostrava-Mariánské Hory 70900
Czech Republic
Tel. +420 417 537 979

SPIROL Poland
Aleja 3 Maja 12
00-391 Warszawa, Poland
Tel. +48 510 039 345

Americas

SPIROL International Corporation
30 Rock Avenue
Danielson, Connecticut 06239 U.S.A.
Tel. +1 860 774 8571
Fax. +1 860 774 2048

SPIROL Shim Division
321 Remington Road
Stow, Ohio 44224 U.S.A.
Tel. +1 330 920 3655
Fax. +1 330 920 3659

SPIROL Canada
3103 St. Etienne Boulevard
Windsor, Ontario N8W 5B1 Canada
Tel. +1 519 974 3334
Fax. +1 519 974 6550

SPIROL Mexico
Avenida Avante #250
Parque Industrial Avante Apodaca
Apodaca, N.L. 66607 Mexico
Tel. +52 81 8385 4390
Fax. +52 81 8385 4391

SPIROL Brazil
Rua Mafalda Barnabé Soliane, 134
Comercial Vitória Martini, Distrito Industrial
CEP 13347-610, Indaiatuba, SP, Brazil
Tel. +55 19 3936 2701
Fax. +55 19 3936 7121

Asia Pacific

SPIROL Asia Headquarters
1st Floor, Building 22, Plot D9, District D
No. 122 HeDan Road
Wai Gao Qiao Free Trade Zone
Shanghai, China 200131
Tel. +86 21 5046 1451
Fax. +86 21 5046 1540

SPIROL Korea
160-5 Seokchon-Dong
Songpa-gu, Seoul, 138-844, Korea
Tel. +86 21 5046-1451
Fax. +86 21 5046-1540

email: info-uk@spirol.com

SPIROL.co.uk