INDUCING FLOW IN STORAGE BINS
USING THAYER BRIDGE BREAKER™

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The problem of promoting flow from storage bins should not be taken lightly. While the use of flow aid devices is well established in all industries, their effectiveness in many situations has been less than desirable. Most bins are designed on the basis of storage capacity alone, with little consideration given to material properties and required flow rates. Consequently, it is not surprising to encounter such problems as arching, rat-holing and insufficiency of flow rate. When such problems are encountered, usually at the time of first use, the need for a quick solution is urgent. No wonder then that so many flow aid devices are sold – and prove of little value in solving the basic problem.

What is the basic problem? During recent years, great progress has been made in the study of gravity flow of bulk solids. We know today that material develops strength as pressure is imposed upon it. The pressure imposed on a bulk solid in a bin is a function of the geometry of the bin and, in general, varies at different points within the bin. At regions within the bin, where the pressure is such that the solid develops sufficient strength to support itself across its open flow channel below, flow ceases.
In general, the wall pressure profile in a bin with attached hopper section when filled with material is that shown in Fig. 1. Note that the greatest pressure occurs on the wall of the hopper section near its attachment to the bin. This is due to the fact that a good portion of the vertical load of the stored material is supported by wall forces in the upper third of the hopper. We might conclude from this that the material, owing to its high strength in this region, would tend to bridge at this point. Of greater importance however, is the ratio of the material strength to the open flow channel area directly below. Since the area for most hopper sections decreases faster than the diminution of material strength as it moves toward the outlet, bridging usually occurs in the lower regions.

Most flow aid devices are vibratory in nature and operate on the principle of imparting sufficient random motion to the particles to make it difficult for any group of them to come into sufficient juxtaposition to develop any serious strength. Such particles, being in a state of high mobility, have little difficulty converging to the small outlet of the hopper.

The most serious problem encountered with such devices if that this same particle motion, in the absence of complete freedom to discharge under the influence of gravity, upsets the initial wall pressure profile and hence material strength may increase to abnormally high values in the lower regions of the hopper. If the hopper gate is closed during periods of vibration, or if the duration and/or magnitude of vibration is too large for the quantity of flow per unit of time, the material will tend to compact. Getting the flow to start again may require considerable manual effort.

The most popular flow aid device is the bin vibrator. Its low cost and installation simplicity makes it a most appealing first choice when bin flow problems are encountered. Unfortunately, aside from these obvious advantages, the bin vibrator is a very inefficient device because of the way it is installed. Because the bin vibrator is mounted directly to the hopper wall, which, through design, is the important structural support of the material, most of the energy is consumed by the walls, not the material in the hopper. What vibration does reach the material cannot be focused to any particular region in the hopper and that which is available to the particular region of need is usually of insufficient intensity to do much good. On the other hand, sufficient vibration may be generated to the upper section of the hopper to upset the wall pressure profile in the bin, causing additional compaction of material in the lower region of the hopper.

The ideal flow device would have the following features:

1) It would provide a controlled amount of agitation of material in the lower regions of the hopper, but not provide agitation in the upper regions, which serve to support the bulk of the stored material above.

2) It would be efficient in the sense that all available energy would go into the material, not the hopper walls.

3) It would provide the correct quantity of vibration commensurate with the quantity of flow required per unit of time so as to provide sufficient particle mobility to assure flow but not enough to cause compaction.

4) It would be quiet in operation and its vibration would not affect surrounding equipment.

5) It would be serviceable from the outside of the hopper.

We believe that the Bridge Breaker, equipped with an adjustable cycle time program, is
unique in meeting all of these requirements.

The Bridge Breaker

The Bridge Breaker consists of eight parts (See Fig. 2, 3, 4 & 5)
1) Diamond-shaped expanded metal screen fitted in flat bar frame (note: triangular and rectangular models are also available.)
2) Shaker support frame.
3) Rigid interconnecting spacer and bolt assemblies.

4) Elastomer sealing mounts.
5) Material sealing gaskets.
6)Air-operated piston-type air shaker with air cushioned ends. Thrust of approximately 1200 lbs at 1200 cycles per minute.
7) Shear reaction spring.
8) Spring adjusting and support bar (mounted to hopper wall).

The expanded metal screen is mounted inside of and parallel to the hopper wall. The shaker support frame is rigidly mounted to the metal screen through the use of two interconnecting bolt and spacer assemblies. These latter assemblies pass through two holes in the hopper which are fitted with the two elastomer sealing mounts, permitting the shaker to operate external to the hopper. The shear reaction spring is adjusted so as to center the interconnecting spacer and bolt assemblies with respect to the elastomer mounts when material loading effects have been established. The shaker imparts a thrusting action to the screen assembly in a direction that is predominantly along the wall in an up and down fashion. The screen importantly does not move in and out from the wall surface and therefore does not tend to compact the material. Screen displacement is typically +/- 1/8", which is effective in shearing or undercutting, the base of any "bridge" formations within the hopper. The screen also imparts vibrations to the surrounding material, and the regions so affected within the hopper are designated zones of influence. The size of the zones of influence vary with the material being handled. The zones are larger for relatively hard materials and smaller for soft and "spongy" materials, which in turn do not offer good energy transmission qualities.

Because the screen is open to material passage, the hopper walls, and not the screen, provide the reaction forces to bin loading resulting in the efficient utilization of energy.

The screen extends from the outlet up to a third, and perhaps half, of the way up the sloping hopper wall, thereby leaving the material in the upper regions undisturbed. Disturbing this material would upset the wall pressure profile, thereby increasing the material strength in the more critical regions. Lower extensions to the screen, perhaps 4-6" in length, are oftentimes recommended to aid in the promotion of flow through the hopper outlet, particularly where the outlet is of small dimension.

Further in this regard, the diamond shape of the screen affords the means of supplying some vibration to questionable regions somewhat above the primary region of concern, but without overdoing it.
Various sizes and shapes of units are available to meet the requirements of most hoppers.

In many cases, a cycle programmer is recommended to provide just enough vibration to meet the discharge flow requirements. An interlock is also provided to discontinue all vibration when flow is intentionally stopped. (See Fig. 6 & Fig. 7) We believe that the combination of one or more Bridge Breakers and a cycle programmer can provide you with a most efficient and practical solution to your bin and hopper flow problems.

GENERAL GUIDELINES

1) Start with the fewest number of screens which are likely to do the job. Additional screens can always be added at a later date. See drawings of suggested arrangements for ideas. Oversized screens and/or the use of too many units are counter-productive. Not only are cost increased, but material is oftentimes over vibrated resulting in further compaction of the material.

2) At least one screen is required near the outlet of the hopper. This screen should have a length (M + 2.5) that is equal to or exceeds one third of the distance up the sloped wall. The best selection is usually accomplished by selecting the smallest available (M + 2.5) dimension that equals or exceeds one third of the distance up the sloped wall. Attempt to use a triangular unit by checking density limitations against screen area. If screen is too large, check to see if a diamond or rectangular shaped unit can be used. Always attempt to apply screens having an (M + 2.5) dimension of less than 42 inches. Units larger than this are only practical on very low density products and where the outlet is large and flow is not retarded by downstream equipment. If the outlet is smaller than ten inches, consider adding a few extra inches of extension to the bottom of the screen to aid flow through the outlet proper. In general, the smaller the outlet, the smaller the lower screen should be.

3) Consider a control system for the vibrators. Remember that too much vibration is just as serious as too little. The amount of vibration should relate to the discharge flow rate requirements. Never continuously vibrate the material when the discharge gate is closed or where discharge is limited by downstream hardware, such as a rotary feeder, conveyor or the like. Using a cycle programmer, the amount of vibration (the ratio of “on” time to “off” time) should directly relate to the discharge flow requirements. More “on” time is permissible if the hopper freely discharges to gravity – less “on” time if discharge is limited or regulated. Where groups of screens are employed those further from the outlet (those above the outlet screen) should have less “on” time and more “off” time than the discharging screen. In operation the lower screen should create a partial void of material in the lower sections. The upper screens re-supply the void during their cycle. In this way compaction cannot occur.

MATERIAL HANDLED WITH BRIDGE BREAKERS

Bridge Breakers will, in general, work well with most fine powders and granules, regardless of
their degree of sluggishness (lack of flowability). This applies even where the material packs due to either pressure or moisture.

Examples:

PVC Resin	Hydrated Lime
Zinc Oxide	Flour
Activated Carbon	Titanium Dioxide
Phenolic Resins	Calcium Carbonate
Dry Mild Powder	Ferric Trioxide
Fly Ash	Condiments
Powdered Sugar	Sulfur

A number of lumpy and irregular-shaped materials are suitable, providing they are not of high bulk density (more than 50 lb/cu ft), hard or abrasive. Examples of satisfactory materials:

Wood Chips	Asbestos
Sawdust	Hops
Plastic Chips	Plastic Packing Material

Bridge Breakers are not recommended for rock-like (over 1 inch) particles that are hard and have a high bulk density (over 50 lb/cu ft). Examples of materials to be avoided:

Crushed Limestone	Copper Ore
Stone	Bauxite
Steel Chips	Cement Clinker
Crushed Slate	Furnace Slag
Iron Ore	Crushed Marble

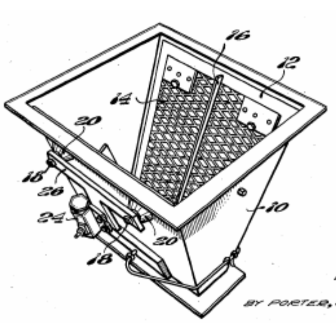

Fig. 2

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Covered by U.S. and Foreign Patents

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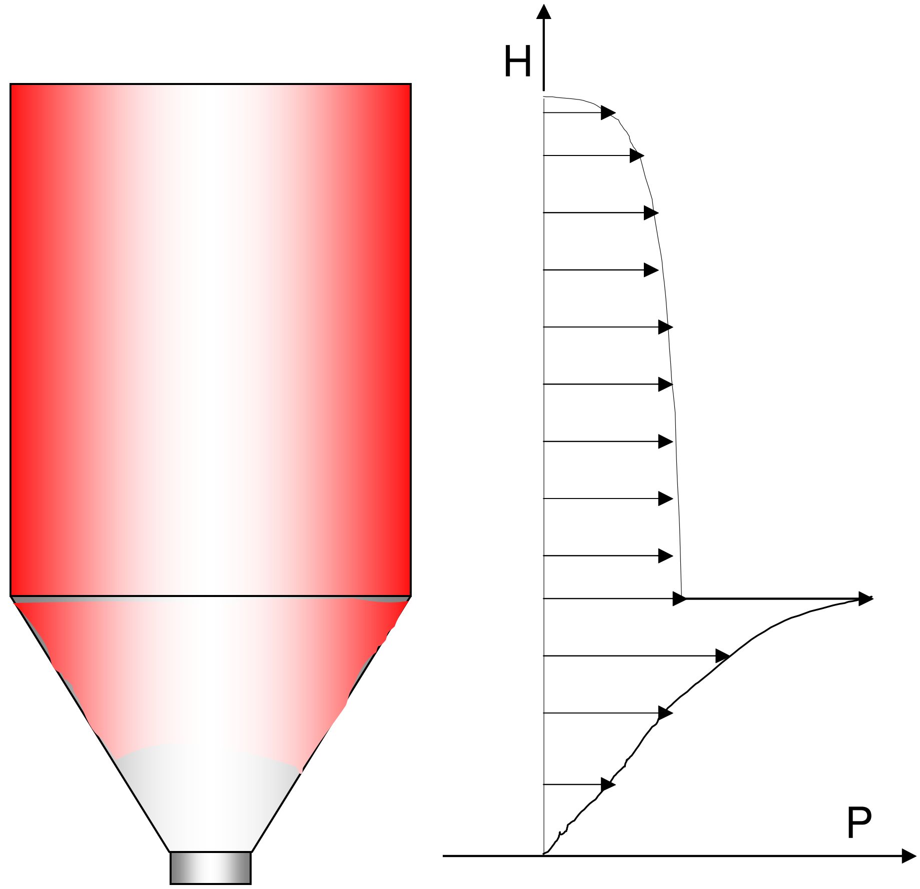


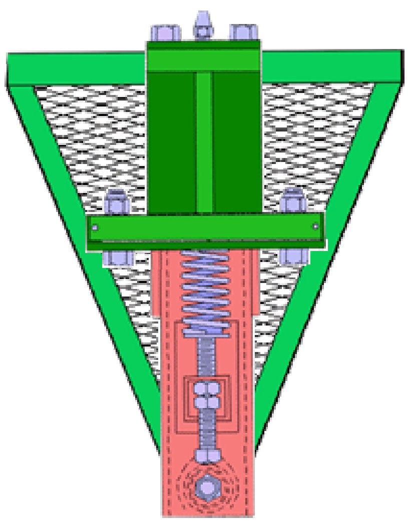


Fig. 2 & 3
Expanded Metal Screen and Shaker

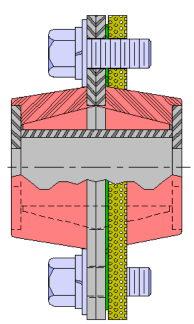


Fig. 4
Elastomer Sealing Mounts

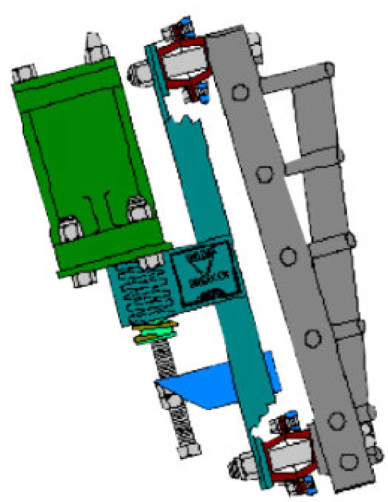


Fig. 5
Shaker support frame & air shaker

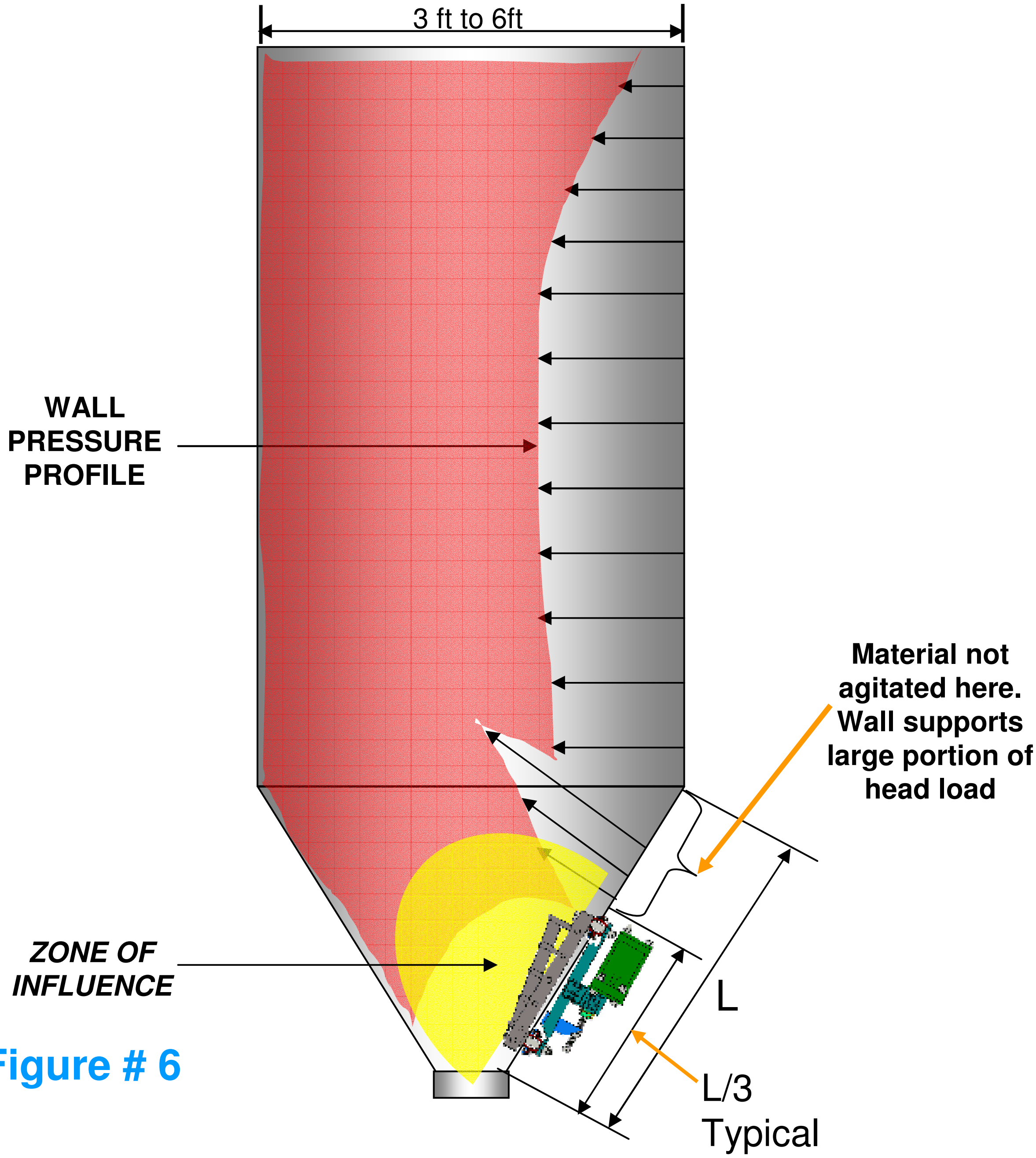
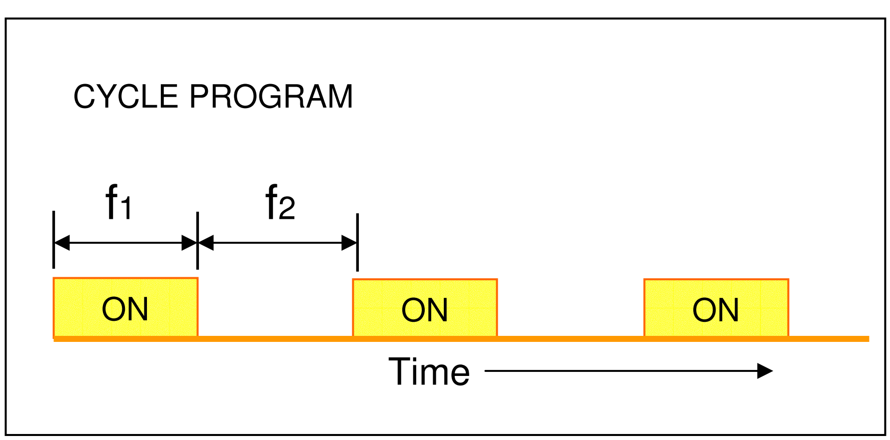


Figure # 6

SMALL and MEDIUM BINS



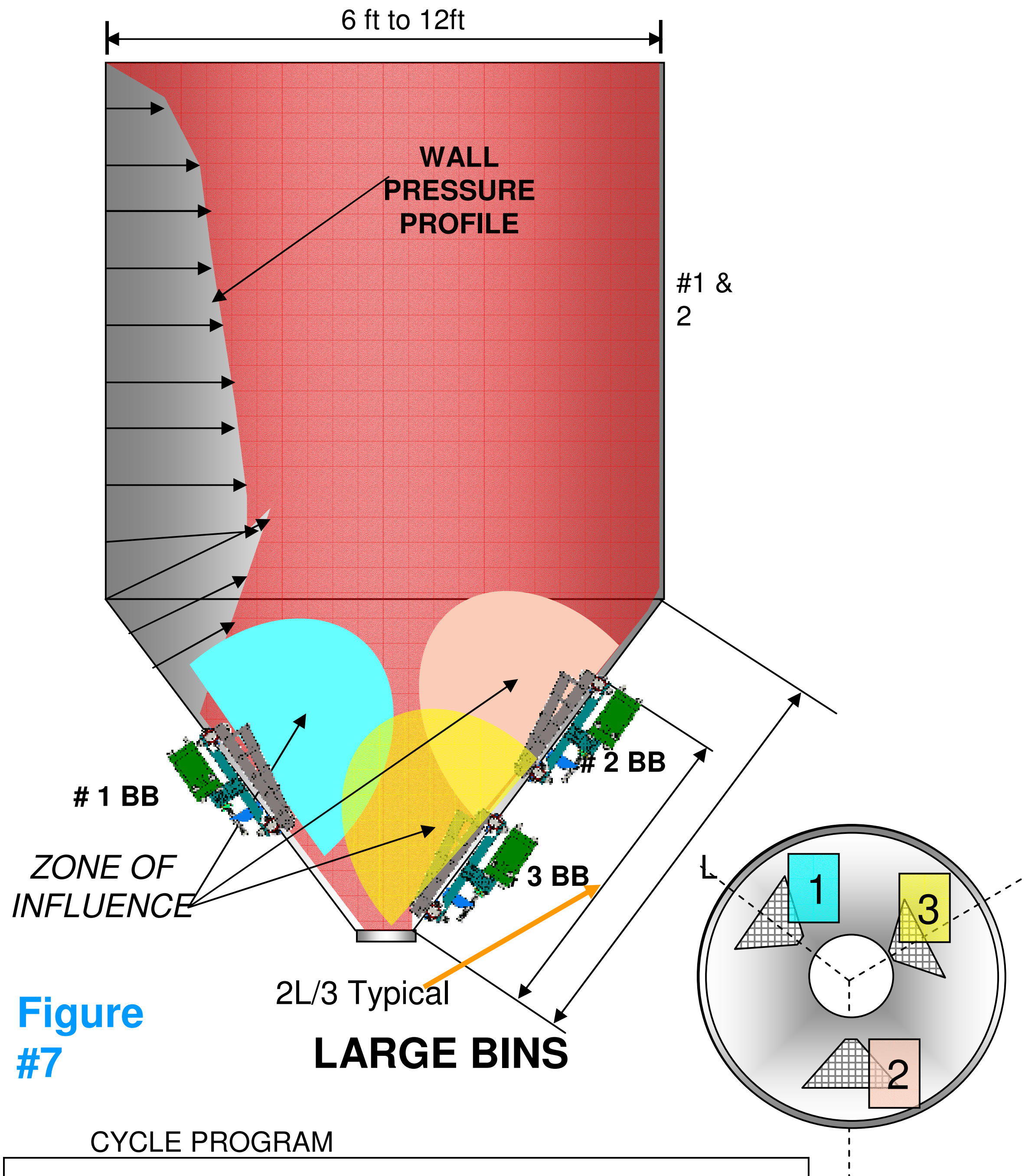


Figure #7

CYCLE PROGRAM