FEEDING THE FEEDER

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PROBLEM AREAS

When handling non-free flowing and/or fluid-like powders, getting the material out of the hopper and to the relatively small inlet opening of the Weighfeeder creates a problem that many times negates good performance due to material hang-ups in the hopper or uncontrolled flushing when the material arch is broken.

To alleviate the problem of arching or no-flow, a flow-aid device is usually installed in or at the bottom of the hopper. If the material discharges from the flow-aid device (fixed vibration) directly to the feeder variable speed Weigh belt (Fig. 8) a mismatch of flow rates can occur especially when the Weighfeeder is set to deliver a lower flow rate than the bin-discharger is supplying. This causes the material to back up, or flush through the Weighfeeder if the material is floodable in nature. Cycling the bin-discharger (on-off) for lower flow rates sometimes solves the problem but not when the material is fluid-like...which can result in flooding and uncontrolled feed.

To prevent flooding, rotary type vane feeders are usually installed, between the bin-discharger and weighfeeder which have at times solved the problem notwithstanding the maintenance involved.

If the bin-discharger utilizes a variable spe screw or auger to feed the Weighfeeder (Fig. 9), flooding may also be prevented providing the screw or auger does not run empty, otherwise the system will be subject to the same conditions previously mentioned.

A constant speed weigh-belt (Fig. 10) utilizing an adjustable gate to increase or decrease the material throughput per unit of time, is also subject to the same problems when handling highly cohesive, or floodable type powders. The gate will not prevent flushing, and cohesive powders could plug at the gate opening. If the constant speed weighfeeder control gate is eliminated and is fed by a variable speed screw or auger as shown in (Fig. [illegible]) the problem of feeding the screw or auger prefeeders still exists because the bin-discharger is supplying a relatively constant flow rate and the excess material has no where to go when low flow rates are required to satisfy process requirements. If the material is highly floodable, it will find its natural outlet and flush through the prefeeder and flood the Weighfeeder.

SOLUTIONS

Weighfeeders operate best when a relatively constant head of material is maintained on the weigh section. When the Weighfeeder increases its speed to deliver more material to satisfy the process (set-point) the bin-discharger must supply this demand by increasing its flow rate accordingly (Fig. 11).... and visa versa.

CAUSES OF FLOW PROBLEMS

Scores of technical papers have been written on this subject and to elaborate further would not serve any benficial purpose beyond what has already bee established; simply that the problems exist...and how to solve them without creating more problems.

It is further generally recognized that the cause of flow problems is related to two (2) major basic areas:

A) Material flow characteristics.
B) Bin/hopper design.
} Fig. 1

MATERIAL FLOW CHARACTERISTICS

So as not to over simplify the multitude of catagories of flow characteristics and their relation to flow problems, it can be concluded, for the sake of brevity and better understanding,that flow characteristics can be classified as either cohesive, floodable, or a combination of both.

The flow problems caused when discharging and feeding cohesive or floodable type powders needs no elaboration. However, what may clarify the crux of the problem is to consider and understand how a material can be both cohesive and floodable in nature at the same time.(Refer to Fig. 2)

In short, a cohesive powder becomes floodable in nature when the degree of areation permeates every particle comprising the mass...regardless the particle size. When this occurs, cohesiveness is either non-existant or not enough to cause arching, ratholing or spasmodic flow. It can actually flow like water!

On the other hand, when a highly floodable type powder is allowed time to deaerate, i.e., allow the air to escape or free itself from each particle comprising the mass, the particles, regardless their size, tend to adhere to eachother thus causing an adhesive/cohesive characteristic. Needless to say, it is this type of combination situation that merits the most consideration regarding flow problem solutions.

The answer is obvious and possibly over-simplistic. The material should be allowed time in the storage tank to free itself of air (deaerate) thus eliminating the drastic results of flooding potential. In otherwords, a highly floodable powder can be made relatively cohesive by allowing ample retention time in the storage tank. The flow problems now to be solved deals only with a cohesive type powder.

Cohesive powders can be made to flow from a storage tank by utilizing one or more of the myriad of devices available on the market today. The trick that the Process Engineer must "pull" is picking the right one.

To simplify this chore, it would pay to consider the design of the storage tank in relation to the material flow characteristics.

BIN/HOPPER DESIGN

Too often, and many times with reasonable justification, the storage tank is designed for capacity requirements and available space...without too much, if any consideration for the material flow characteristics. The end result of actual and potential flow problems needs no elaboration.

If the tank is not properly designed, material hang-ups will occur in the form of arching over the hopper outlet, rat-holing, uncontrolled funnel flow or unpredictable spasmodic flow...each of which can cause results totally unacceptable to efficient operation.

Further, even though ample retention time basically eliminates the flooding nature of the material, once the arch or rathole has been broken, the material cascading down and through the hopper outlet becomes highly aerated (each particle entrapped with air) defying any device to stop the "flood".

It is evident that in order to prevent this phenomena, the hopper opening must be made large enough to avoid a stable arch to form. Also; to avoid funnel flow which in essence can lead to stable ratholes, the slopes of the hopper should be relatively steep to assure flow throughput without material clinging to its sides.

Conical shaped tanks instead of square or rectangular avoid valley angles where the material can build up to a degree that would eventually lead to a completely plugged tank.

Materials of construction and inside "finish" must be taken into consideration to prevent hang-ups due to the inherent sliding friction between the material and the wall it slides on.

One of the most important factors in bin design is the consideration of the POTENTIAL CHEMICAL REACTION of the material. Should the material be hygroscopic in nature (tendency to absorb moisture) and allowed to sit in the tank for prolonged periods of time, the end result would be a tank filled with a "solid" that would defy dynamite to break loose. Needless to say, materials of this nature should be stored in reasonably sized tanks and with the caution of not allowing the material to turn to an unmovable mass, or have its flow characteristics radically change.

Although many Process Engineers have means to consider and avoid the various potential flow problems by utilizing shear-test and other material testing devices for proper bin design, the magnitude and seriousness of the problems caused by improper bin design merits and justifies the services of a Bin design Consultant whose efforts in the past years has proven that storage tanks can be properly designed.

CAUSES OF FEEDING PROBLEMS

If material does not flow properly from a storage tank or cannot be made to flow properly with whatever flow-aid device is used, there is no Feeder on the market that will do an efficient job.

One of the major problems in efficiently feeding powdery materials from a hopper is caused by selecting a Feeder based on volumetric throughput requirements without consideration for the material flow characteristics.

A case in point for example is the selection of a 10" dia. screw feeder (or any similar sized feeding device) which will adequately feed the required flow rates to process. (Refer to Fig. 3) However, should a cohesive material have a tendency to arch over a 10" hopper-bottom opening, the Feeder is useless. If a flow-aid device of sorts is utilized in breaking the arch, material flow to the Feeder (more chances than not) would be inconsistant thereby causing erratic feed, hence erratic accuracy.

Another case in point is that even if the hopper opening is large enough to prevent arching, and gravity flow to the Feeder is not interrupted, the total cross-section of the material in the hopper-bottom must be "kept alive", i.e., discharged at the same time, otherwise dead areas of material are likely to form above the Feeder due to the inherent mass resistance in cohesive powders. (Refer to Fig. 4) Once this situation occurs, density stability in the lower hopper section becomes erratic thereby negating acceptable accuracy. In other words, although volumetic accuracy may be maintained, accuracy by weight would vary erratically due to extreme density variations.

In either case mentioned, and similarly in many others, it becomes evident that a mismatch exists between the Bin and the Feeder.

It can be concluded thus far that a poorly designed bin will be a deterent to good operation regardless the Feeder design...and a poorly designed Feeder cannot enhance the operation even if the Bin design is compatible to the material flow characteristics.

SOLUTIONS

Countless experiments and field experiences corraborate the conclusion that large hopper-bottom openings are required to facilitate uninterrupted flow. The problem that this elimentary conclusion creates is to select and apply a compatible Feeder that can be installed under the hopper yet have the design features to "choke" down the large hopper-opening to a practical sized discharge means. (Refer to Fig. 5)

Another "must" in the Feeder design is to have the ability to "keep alive" (Fig. 5) and discharge every square inch of material in the hopper-bottom (directly over the Feeder) to avoid "dead" areas and excessive compaction.

Conventional bin-dischargers which are designed for installation directly under the bin/hopper bottom utilize the principle of vibration throughout the entire cross-section of the hopper-bottom (and well up into the bin) but the discharging flow pattern is around the periphery of the vibrating (gyrating) element and not throughout the entire cross-section of the hopper-bottom. Further, the majority of these devices do not have the capability to directly vary the flow rates therefore cannot be considered Feeders. Variable speed "take-away" devices are normally used to satisfy the feeding requirement.

THE "SILETTA" LIVE-BOTTOM triple purpose FEEDER (Refer to Fig. 6)

Since its introduction to the market place in 1976, the Siletta LIVE-BOTTOM triple purpose FEEDER has been accepted as a new device offering design features which are compatible to the solution of flow problems when discharging and feeding difficult to handle powdery materials.

Extensive testing and subsequent successful field-installations verify its applicability and performance.

PRINCIPLE OF OPERATION

The unit operates on the principle of controlled vibration. A feed-tray component, consisting of narrow slots and sloping plates (similar to a louver) is activated by a high-frequency, low-amplitude precision-tuned vibrator. When stationary ("OFF" position) the material inside the bin/hopper arches over the narrow slots of the sloping plates stopping all flow. Under vibration ("ON" position) the arch is broken and material will flow through the slots with controlled consistancy.

By varying the amplitude (1.5 mm max.) of the feed-tray component (manually, remotely or via an input signal from a process controller) a predictable feed-rate change occurs when necessary to satisfy varying process requirements. Turn-down rates up to 10:1 are possible for many materials thus eliminating the need for a variable speed "take-away" means or any other transfer device, by feeding directly into process.

In short, the Siletta Live-Bottom triple-purpose Feeder not only serves as a bin-discharger but also performs the functions of an accurate volumetric Feeder and a non-movable cut-off gate...all in one compact machine.

FEEDING THE FEEDER APPLICATIONS

Due to its inherent design features, the Siletta can be applied as a volumetric feeder in lieu of practically any volumetric feeder on the market today...by virtue of its capability to vary the flow rates. However its utilization as a prefeeder makes it ideally suited for those applications requiring extremely high accuracies that only gravimetric feeders can guarentee. (Refer to Fig. 7)

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In short, predictable flow rate capabilities should be incorporated in the bin-discharger design to assure controlled flow throughput out of the hopper without bridging, rat-holing, flushing or spasmodic flow and at the same time provide the Weighfeeder with the approximate flow rate it requires.

Once this condition prevails, the instantaneous response capabilities of the Weighfeeder to varying material densities and set-point changes will then assure the precise flow rates that it is capable of delivering.

The Siletta Live Bottom triple-function Feeder has been specifically designed to provide predictable flow rates while still having the capabilities to serve as a bin discharger flow-aid device. Its instantaneous "no-flow" feature (non-movable cut-off gate) when the unit is in the "OFF" position, also makes it ideally suited for batching or bag-filling applications.

CONCLUSION

As mentioned in the Abstract, equipment design in many cases, has not kept up with advanced technological concepts of fine powder handling. Although many devices on the market today are "holding their own" regarding performance, it is the combination or sum total of the related equipment in the process line that causes the problems. In other words, the more devices involved, the more chance of problems.

Eliminating the possible "weak-links" in the process train with equipment whose design incorporates the "triple-function" approach merits consideration for its applicability in material flow-feeding systems...which can result in considerable savings in costs, elimination of downtime and time-consuming maintenance.

SOLIDS FLOW CONTROL
CORPORATION

MATERIAL FLOW CHARACTERISTICS

- SLUGGISH:
  - COHESIVE
  - DAMP
  - HYGROSCOPIC
- FLOODABLE
- INTERLOCKS or MATS:
  - FIBERGLASS
  - ASBESTOS, ETC.
- PACKS UNDER PRESSURE
- LIGHT & FLUFFY
- COHESIVE & FLOODABLE

BIN / HOPPER DESIGN

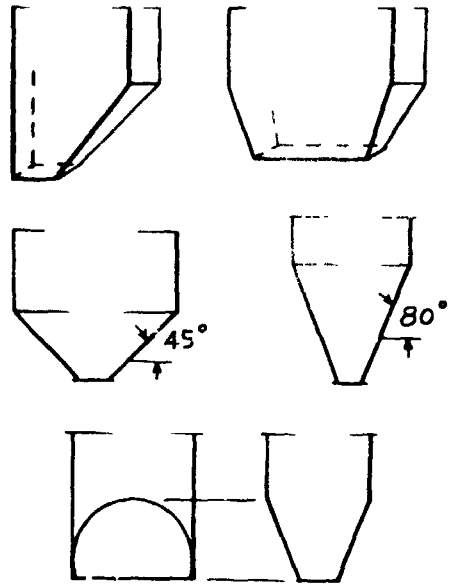

FIG. 1

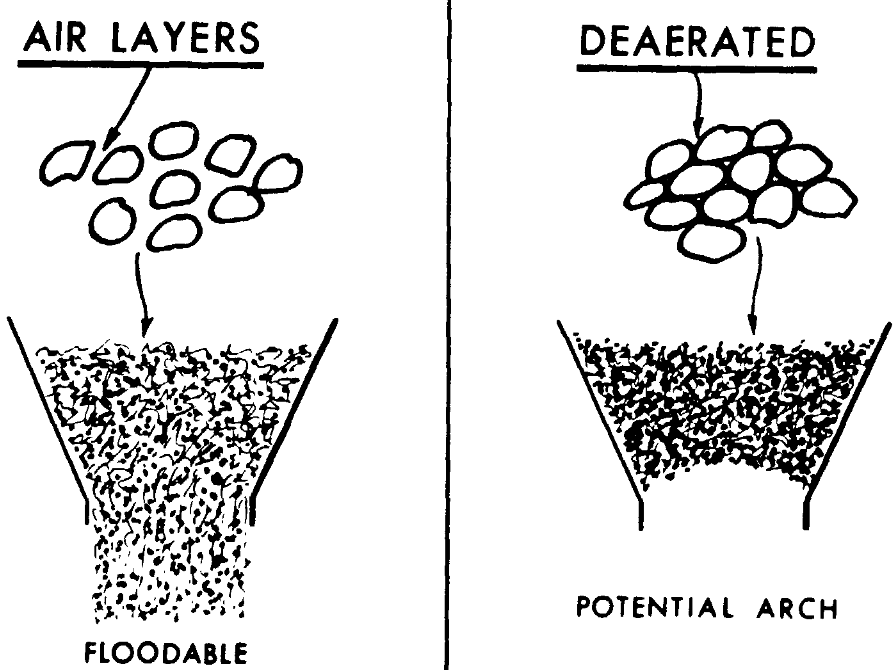

FIG. 2

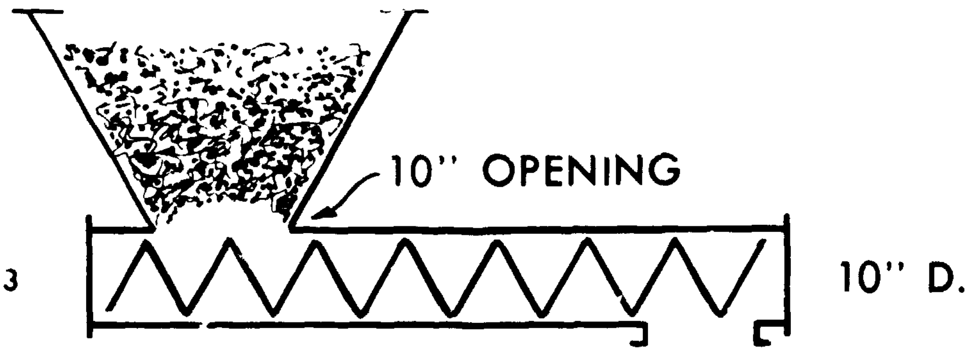

FIG. 3

DEAD AREA

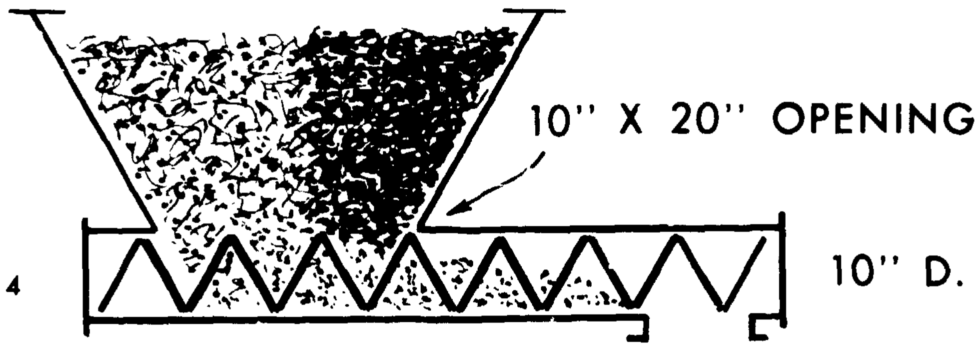

FIG. 4

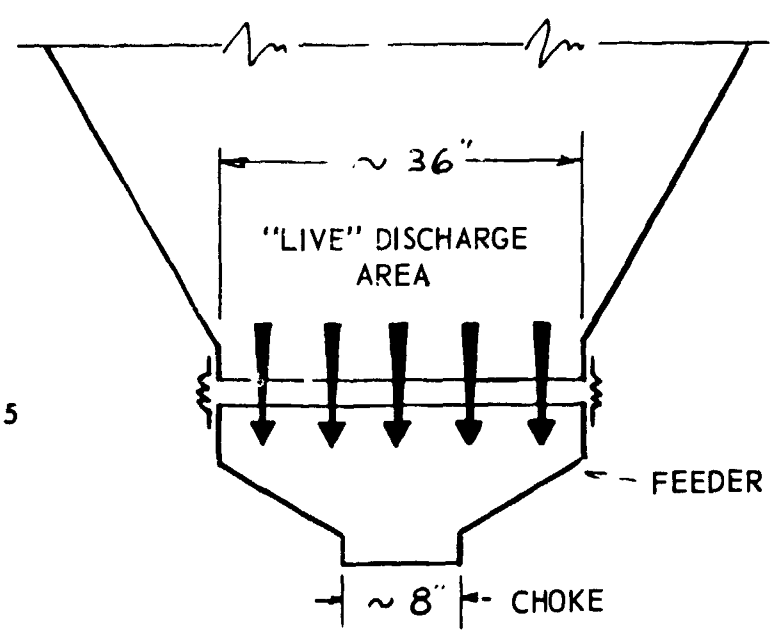

FIG. 5

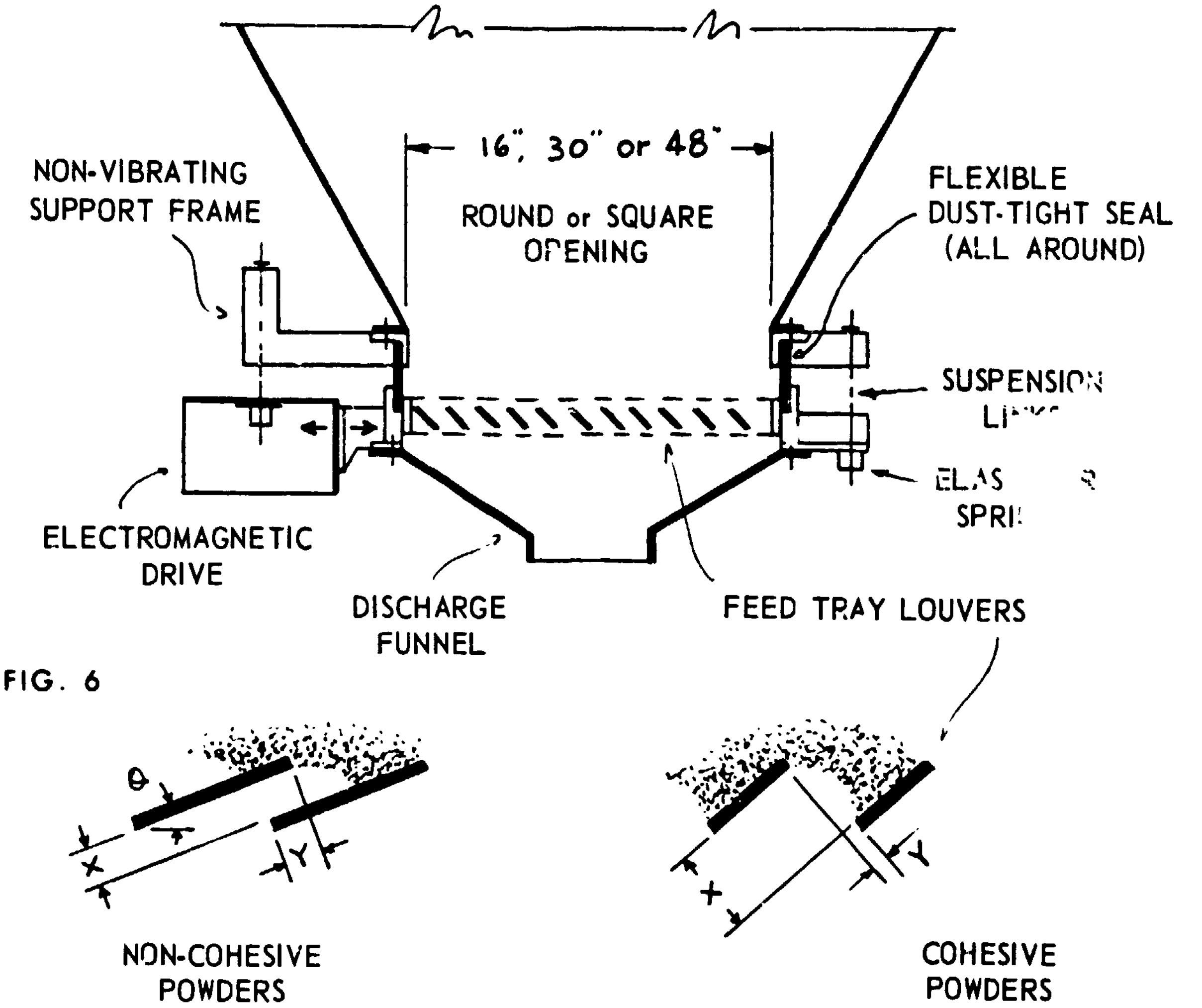
16", 30" or 48"
ROUND or SQUARE OPENING
NON-VIBRATING SUPPORT FRAME
FLEXIBLE DUST-TIGHT SEAL (ALL AROUND)
SUSPENSION
ELECTROMAGNETIC DRIVE
DISCHARGE FUNNEL
FEED TRAY LOUVERS
θ
X
Y
NON-COHESIVE POWDERS
COHESIVE POWDERS

FIG. 6

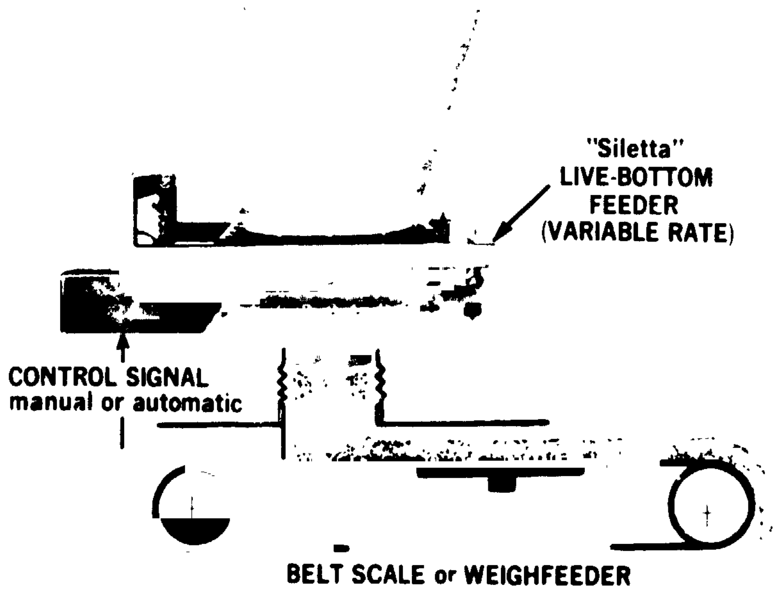
"Siletta" LIVE-BOTTOM FEEDER (VARIABLE RATE)
CONTROL SIGNAL manual or automatic
BELT SCALE or WEIGHFEEDER

FIG.7

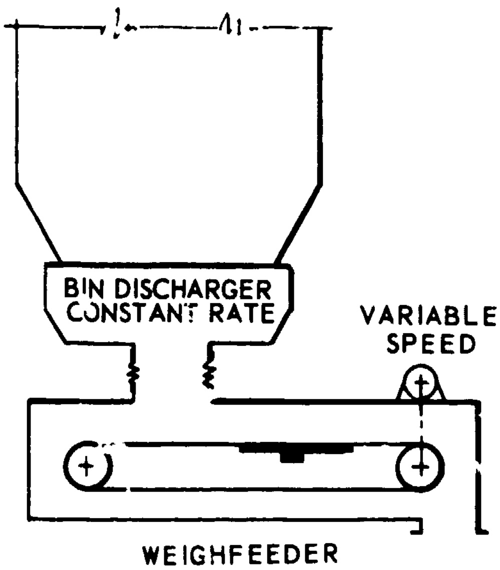

FIG. 8

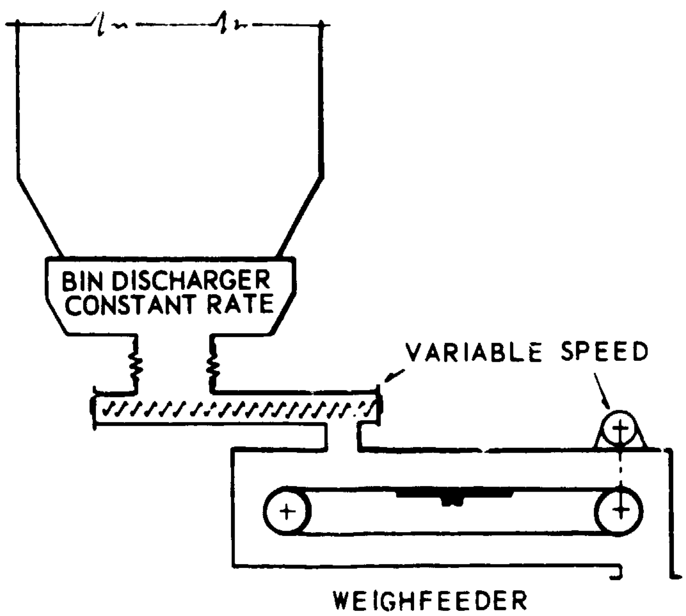

FIG. 9

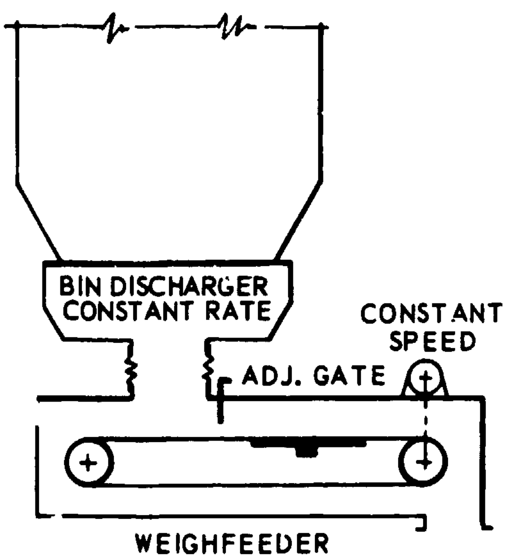

FIG. 10

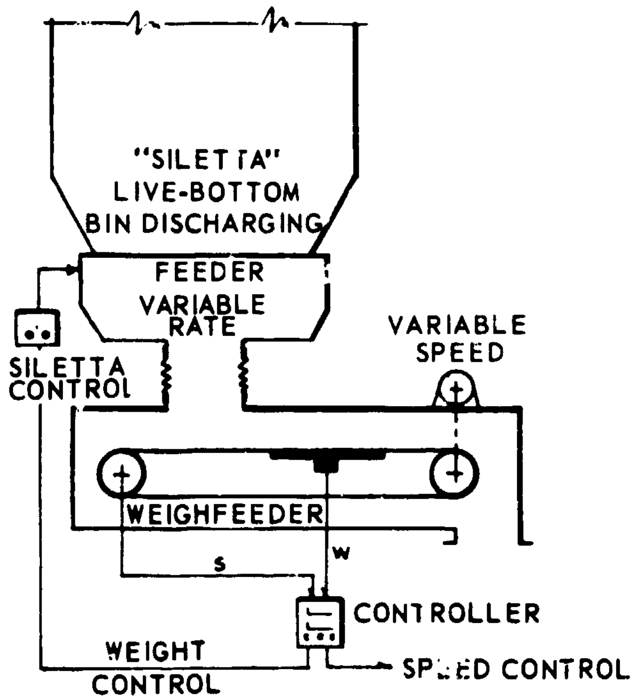

FIG. 11