O-15

O-15

#22

1966 SURVEY OF CONTINUOUS AMMONIATOR-GRANULATOR

Presented at Meeting of
Fertilizer Industry Round Table
Washington, D. C.

November 2 - 4, 1966

By
Frank P. Achorn, Head,
Process and Product Improvement Section
And
J. S. Lewis, Jr.,
Chemical Engineer

Division of Agricultural Development
Tennessee Valley Authority
Muscle Shoals, Alabama

1966 SURVEY OF CONTINUOUS AMMONIATOR-GRANULATOR

Introduction

At the annual meeting of the Fertilizer Industry Round Table in 1961, A. B. Phillips presented and discussed the results of a survey concerning the TVA continuous ammoniator-granulator. Last fall it was decided that TVA should make another survey to determine the changes that have occurred in ammoniator-granulator practices in the past five years. Questionnaires were sent to 142 companies that were licensed by TVA to use the continuous ammoniator-granulator. We have received replies from 57 companies concerning 122 ammoniator-granulators. I hope that those of you who operate continuous ammoniator-granulators will be interested in seeing where your operation fits into the overall picture.

One major trend that has occurred is that the size of the ammoniator-granulator has increased. Also, in 1961, the ammoniator-granulators were primarily used for the ammoniation of superphosphate base grades and now a significant number of them are being used for granulation of ammonium phosphates, ammonium phosphate nitrates, and granular superphosphates. Of the ammoniator-granulators included in the report, 46 percent were used to produce ammoniated superphosphate grades, 26 percent were used to produce ammonium phosphate grades, and 28 percent were used to produce both.

Table 1 shows the ten most frequently mentioned grades and five most frequently mentioned ratios which were reported for those plants that ammoniate superphosphate. The 1966 survey is compared with the 1961 survey. These results indicate that plants which ammoniated superphosphate produce about the same grades and ratios now as they did in 1961. The average plant food concentration in all grades reported remained at about 34 units; however, there was some tendency to drop some low analysis grades, such as 6-20-0 and 3-12-12.

The ten most frequently mentioned ammonium phosphate grades and five most frequently mentioned ratios are shown in Table 2. These data show that, as would be expected, the plants which produce ammonium phosphate grades usually produce higher analysis grades. The average plant food concentration for the ammonium phosphate grades which were reported was 50 units of plant food--about 47 percent higher than the plant food concentration of the ammoniated superphosphate grades. As can be seen in the table, the five ammonium phosphate grades, in the order most frequently reported, were 6-24-24, 8-32-16, 10-20-20, 8-24-24, and 18-46-0. This is not to imply that the tonnage movement of these grades was in this order. Other data indicate that over 50 percent of the ammonium phosphate produced in this country was produced as the 18-46-0 grade. The survey simply shows that of those reporting using the ammoniator-granulator to produce ammonium phosphate, more of them reported that they produced the 6-24-24 grade than any other.

Ammoniator Detail

There was quite a variety of sizes reported ranging from 4.5 ft. to 12 ft. in diameter and 6 ft. to 25 ft. in length. The maximum sizes reported are considerably larger than the maximum sizes reported in 1961, when the maximum diameter reported was 8 feet and the maximum length was 16 feet. Table 3 shows the ten most frequently mentioned sizes. They were 8 ft. x 16 ft., 7 ft. x 14 ft., 7 ft. x 12 ft., 7 ft. x 10 ft., 6 ft. x 12 ft., 6 ft. x 10 ft., 7 ft. x 16 ft., etc. They account for about 80 percent of all those reported. The most popular sizes were the 8 ft. x 16 ft. and 7 ft. x 14 ft. ammoniator-granulators. However, the survey shows that in the new installations the 10 ft. x 20 ft. ammoniator-granulators are showing some prominence.

Figure 1 shows two bar graphs. The one on the left gives the distribution of diameters and the one on the right, length-to-diameter ratios. As you see, the 7-foot diameter and a length-to-diameter ratio of 2:1 is the most popular.

The reported speed of the ammoniator-granulators varied from 6 to 16 rpm; however, the average was about 28 percent of critical speed. The critical speed is that at which material in the ammoniator-granulator would be carried around the drum by centrifugal force. It is calculated by dividing 76.5 by the square root of the diameter of the drum in feet.

Most ammoniator-granulators contain retaining rings equal in height to 6 to 30 percent of the diameter. Usually, as the diameter of the ammoniator-granulator is increased, the height of the retaining ring represents less of the total diameter. Therefore, it is not unusual to find 10 ft. x 20 ft. ammoniator-granulators which have 20-inch retaining rings and to also have a 6 ft. x 6 ft. ammoniator-granulator with the same size retaining ring.

Table 4 shows a tabulation of the types of shell cleaners reported. These data indicate that stationary scrapers and knockers, the two major types of shell cleaners used in 1961, are still the most popular cleaners. However, many new innovations have been introduced in shell cleaners. Typical examples of two of these innovations are shown in the next two figures. The use of rubber flaps, such as those shown in Figure 2, has become significant. The use of the oscillating scraper, Figure 3, has gained some prominence. Lately, some operators have reported considerable success using rubber liners. Contrary to the usual prediction concerning these liners, they do have a life longer than one year, and they do not tear easily.

The survey showed that the majority of operators used simple drilled pipe type spargers. A few use the block type sparger, and some use the slotted lip type that was the original TVA design.

Table 5 shows the materials used in construction of acid and ammonia spargers. The survey revealed that about 60 percent of those reporting are using Hastelloy C for the acid sparger. This is quite a change from the 39 percent reported in 1961. Those who reported they use Hastelloy C indicate that the longer sparger life they receive is well worth the additional cost. The survey also shows that most of those reporting use stainless steel or Hastelloy for ammonia spargers, whereas in the former survey, most were using carbon steel ammonia spargers, and only a few were using the higher priced metals.

Most of the ammoniator-granulators that revolve in a counter clockwise direction have the spargers located at the four o'clock position. Those that rotate in a clockwise direction usually have the spargers located at the eight o'clock position. The sulfuric acid sparger is usually located above and slightly to the side of the ammonia sparger. The usual practice is to bury the sparger about three-fourths of the bed depth. Phosphoric acid is usually added on top of the bed through a drilled pipe sparger.

Various size electric motors are used to drive the ammoniator-granulator depending on the size of the ammoniator-granulator. Usually the smaller sizes, such as the 7-ft. by 14-ft. are driven by a 30-50 h.p. motor, whereas the larger 10-ft. by 20-ft. ammoniator-granulators are driven by a 125-h.p. motor. Most of the ammoniator-granulators are driven by a pinion gear which drives a bull gear that is mounted on the ammoniator-granulator itself. The pinion is usually attached directly to the shaft from the speed reducer. Recently, many fabricators of ammoniator-granulators have used chain sprockets on both the pinion and shaft from the speed reducer. Therefore, the pinion is driven through a chain drive, and it is easy to align the drive. Also, in reversing the ammoniator-granulator for cleaning, less shock is transmitted to the drive gears because of slack in the chain drive. Many of the smaller ammoniator-granulators have a chain sprocket around the shell, and a direct chain drive from the speed reducer is used to revolve the ammoniator-granulator.

The survey showed that about 50 percent of those reporting do not have separate granulation sections in their ammoniator-granulators. Of those that do have granulating sections, about 55 percent have sections that are less than 5 feet in length. The smallest granulating section reported was 2 feet. It is interesting to note that only two companies now report that they use separate granulators. As you are probably aware, in the early days of granulation, it was felt that a separate ammoniator and granulator driven independently of each other were required.

The need to slope the ammoniator-granulator has often been questioned. The survey shows the maximum slope reported was 1.5 inches per foot and about 15 percent of those reporting indicate there is no slope to their ammoniator-granulators. Those who have level ammoniator-granulators indicated they operate smoothly, and the spargers are well covered throughout the length of the sparger.

Other Plant Equipment

Many of the plants which were used exclusively to produce ammoniated superphosphate grades when the previous survey was made have now been converted to permit the production of ammonium phosphate grades by the installation of a preneutralizer and an ammoniator-granulator scrubber to their existing granulation facilities. Also, all new plants which use the ammoniator-granulator to produce ammonium phosphate grades include a preneutralizer and a scrubber. To determine the trend toward the production of ammonium phosphate grades in the ammoniator-granulator, our questionnaire asked if a preneutralizer was used in the plant. More than 25 percent of those reporting had preneutralizers. Several of the companies indicated they were using the preneutralizer in the production of ammonium sulfate and X-O-X grades. As you are probably aware, TVA now uses the preneutralizer and ammoniator-granulator in the demonstration scale plant for the production of nitric phosphates.

The average capacity of plants which use ammoniator-granulators has increased extensively in the past few years since the ammoniator-granulator has been widely adopted as the best equipment for the production of diammonium phosphate. The survey shows that some diammonium phosphate plants that utilize the ammoniator-granulator have a capacity in excess of 1,000 tons per day. One company reported they have total throughput capacity as high as 285 tons per hour. This plant has a 10 ft. by 20 ft. ammoniator-granulator. With the advent of larger throughput and the necessity for the removal of larger quantities of liquids, the dryers in the granulation plant necessarily have become larger. One plant had a dryer that measured 12 feet in diameter and 120 feet long. The largest cooler of which we have knowledge measures 12 feet by 70 feet.

Although the question of screen size used in the plants was not asked in this survey, other surveys and data obtained in plant visits indicate most companies try to screen their products so that at least 95 percent of the granules are in the 6 to 16 mesh size. Recently, there has been a definite trend to narrowing this size specification to minus 7 plus 14 mesh. One new producer of granular ammonium nitrate has set size specification at minus 8 plus 12 mesh. The information we have concerning screening area per ton of throughput indicates that the most frequent size is about one square foot per ton of throughput for both the oversize and product size screens. However, recent contacts with industry indicate that there is a trend toward increasing this size to at least 1.5 square feet per ton of throughput for the product size screen. The reason for this trend probably is the fact that the recent emphasis on narrowing the particle size distribution in the product stresses better size separation which is possible with the larger screening area.

Granulation Control

A very important consideration in the control of granulation is the ratio of liquids to solids--commonly referred to as "liquid phase"--in the ammoniator-granulator. A specific question with regard to means of controlling the liquid phase was not included in the survey. However, TVA field engineers who have visited granulation plants report the most common way of controlling liquid phase in the ammoniator-granulator is to vary the recycle rate by adding varying amounts of onsize product to the crushed oversize and fines which are recirculated to the ammoniator-granulator. The amount of product that is returned with the recycled fines is controlled in several ways. One way is to have a damper in the fines hopper of the screen. A sketch of this type of screen is shown in Figure 4. The product screen deck has several screens that have openings that are well within the product size range. Therefore, some product size material is continually passing through this screen and into the fines hopper. The damper is adjusted so that the proportion of product diverted into the fines hopper is controlled. Another method of controlling the amount of product being returned to recycle is to have a "split boot" from which a controlled amount of product is withdrawn by a gravimetric feeder. A sketch of this type of apparatus is shown in Figure 5. The product which is not withdrawn by the product feeder overflows through a chute to the recycle feeder. Of course, another popular method of controlling liquid phase in the granulator is to control the amount of liquids added by varying the production rate or by changing the formulation. Also, many times steam and/or water is added to promote granulation.

In conclusion, I would like to thank all of the plant personnel, many of whom are in this audience, for taking time to complete and return the questionnaire. Certainly the survey revealed much interesting information that would be difficult to obtain in any other manner.

TABLE 1

Ten Leading Grades and Five Leading Ratios For Those Plants That Ammoniate Superphosphate

Grades	Order of Popularity 1966	1961
5-20-20	(1)	(1)
5-10-10	(2)	(6)
16-20-0	(3)	-[a]
6-12-12	(4)	-[a]
3-9-9	(5)	-[a]
12-12-12	(6)	(2)
10-10-10	(7)	(3)
5-10-15	(8)	-[a]
4-12-12	(9)	-[a]
6-24-24	(10)	(5)
Average plant food concentration, units of plant food	34	35
Ratio		
1:2:2	(1)	(3)
1:4:4	(2)	(1)
1:1:1	(3)	(2)
1:3:3	(4)	-[b]
4:5:0	(5)	-[b]

a Not one of the 10 leading grades.

b Not one of the 5 leading ratios.

TABLE 2

Ten Leading Grades and Five Leading Ratios for Those Plants That Produce Ammonium Phosphate Grades

Grades:	(1) 6-24-24
	(2) 8-32-16
	(3) 10-20-20
	(4) 8-24-24
	(5) 18-46-0
	(6) 5-20-20
	(7) 16-20-0
	(8) 7-28-14
	(9) 8-22-11
	(10) 6-28-10
Average plant food concentration, units of plant food	50
Ratios:	(1) 1:4:4
	(2) 1:4:2
	(3) 1:2:2
	(4) 1:3:3
	(5) 9:23:0 (18-46-0)

TABLE 3

SIZE OF AMMONIATORS

Diameter x Length, Ft.	% of Those Reported
8 x 16	18
7 x 14	13
7 x 12	12
7 x 10	9
6 x 12	7
6 x 10	5
10 x 20	5
7 x 16	4
8 x 14	3
7 x 15	3

TABLE 4

SHELL CLEANERS

Type of Cleaner	% of Those Reported
Stationary scrapers	24
Knockers	22
Rubber flaps	13
Knockers and stationary scrapers	11
Moving scrapers	10
Manual	8
Rubber liners	2
Two flexible panels	1

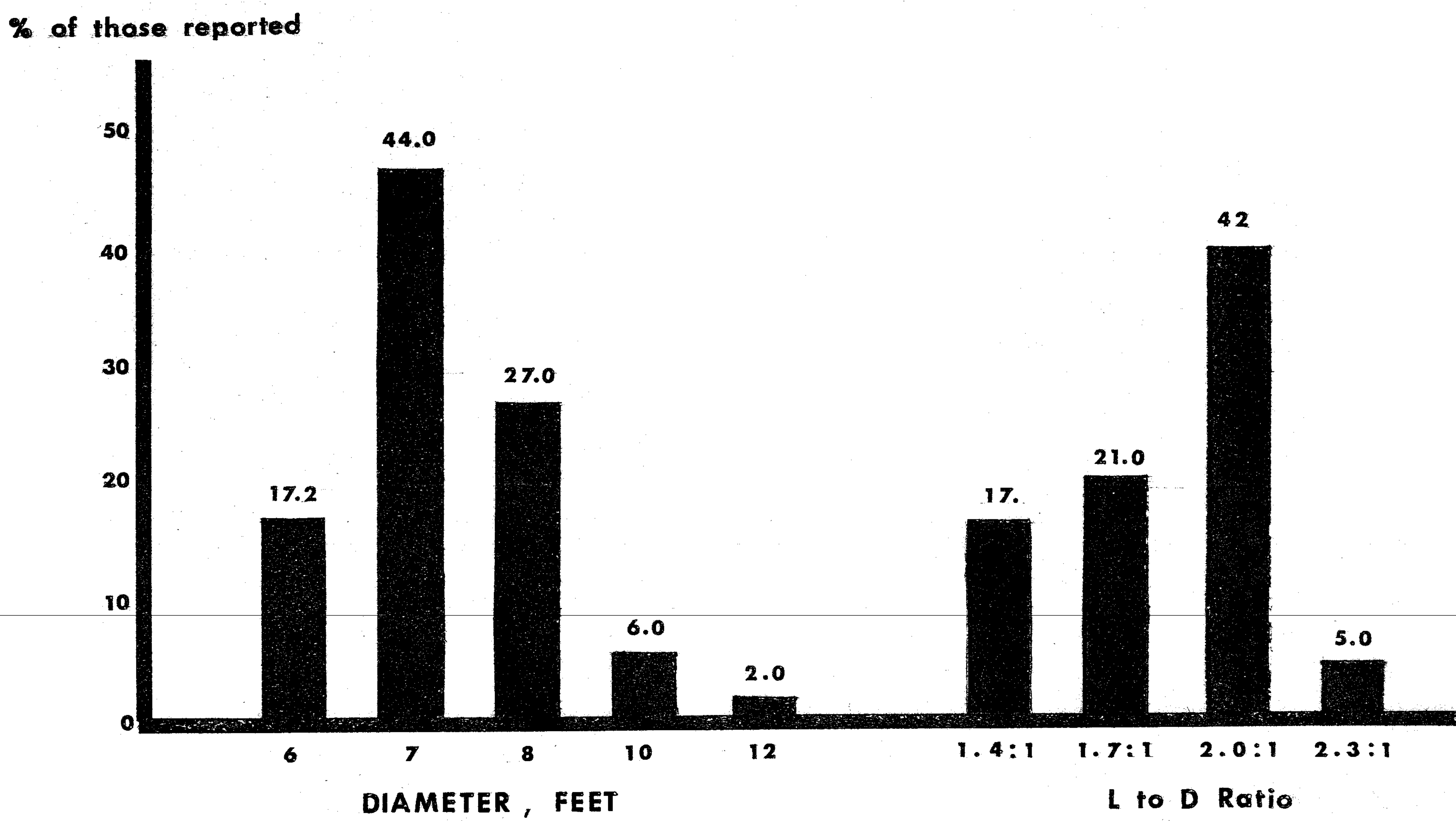
TABLE 5

Materials of Construction of Acid and Ammonia Spargers

Metal	% of those Reported	
	Acid	Ammonia
Hastelloy C	57	11
Black iron or mild steel	25	44
Stainless steel	18	45

FIG. I

DIMENSIONS OF AMMONIATOR



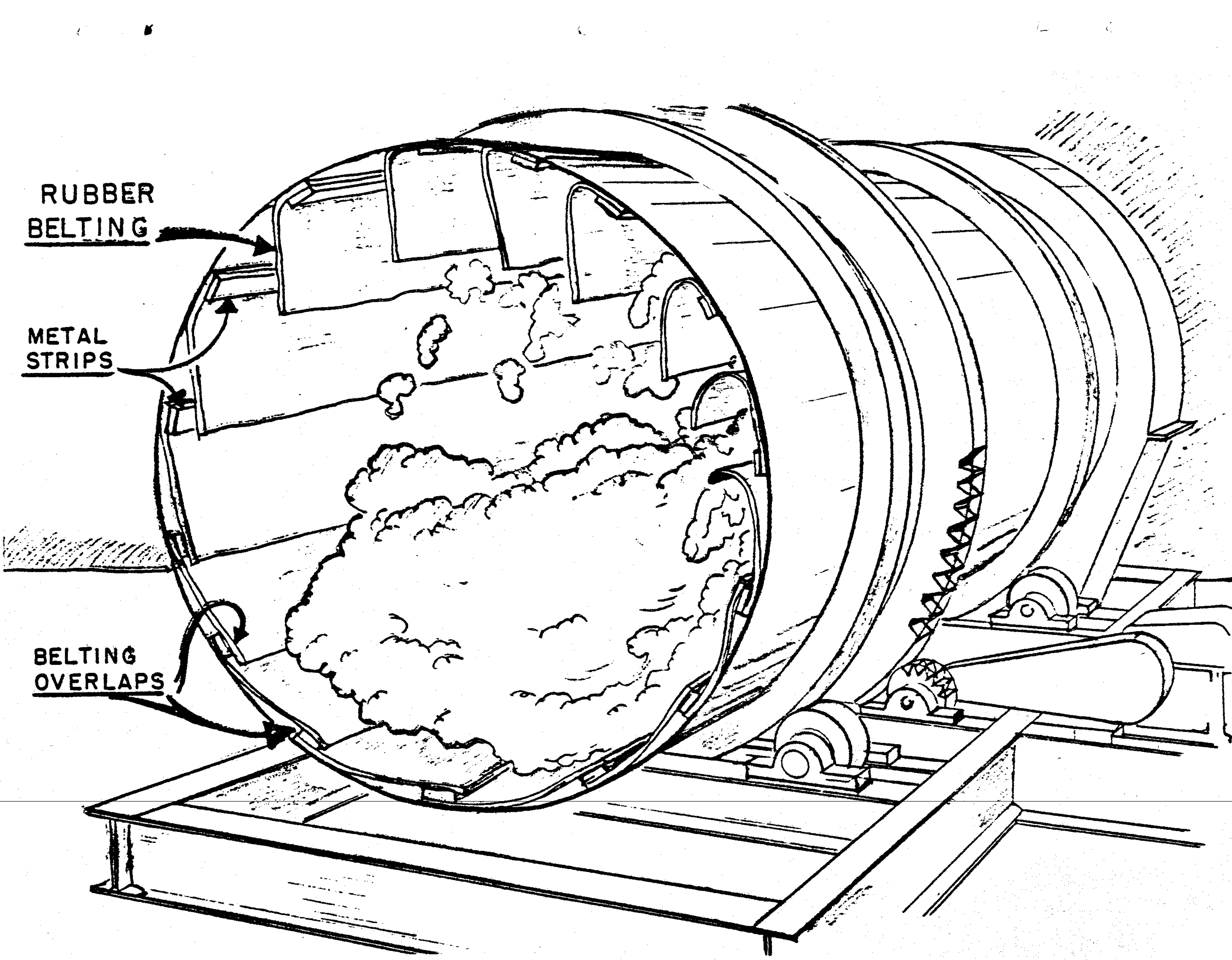


FIG. 2
AMMONIATOR GRANULATOR LINED WITH RUBBER BELTING

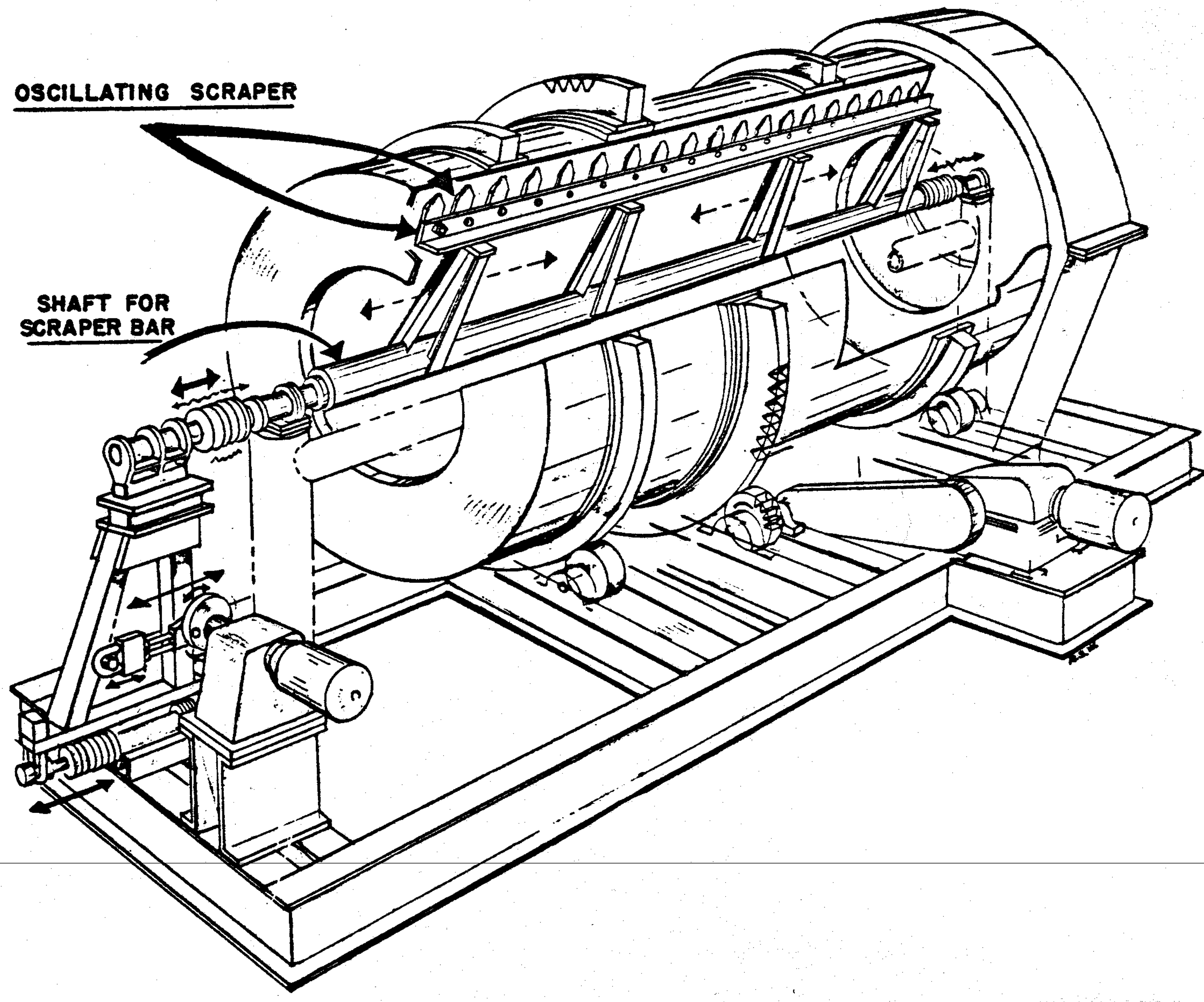


FIG. 3
AMMONIATOR-GRANULATOR WITH OSCILLATING SCRAPER

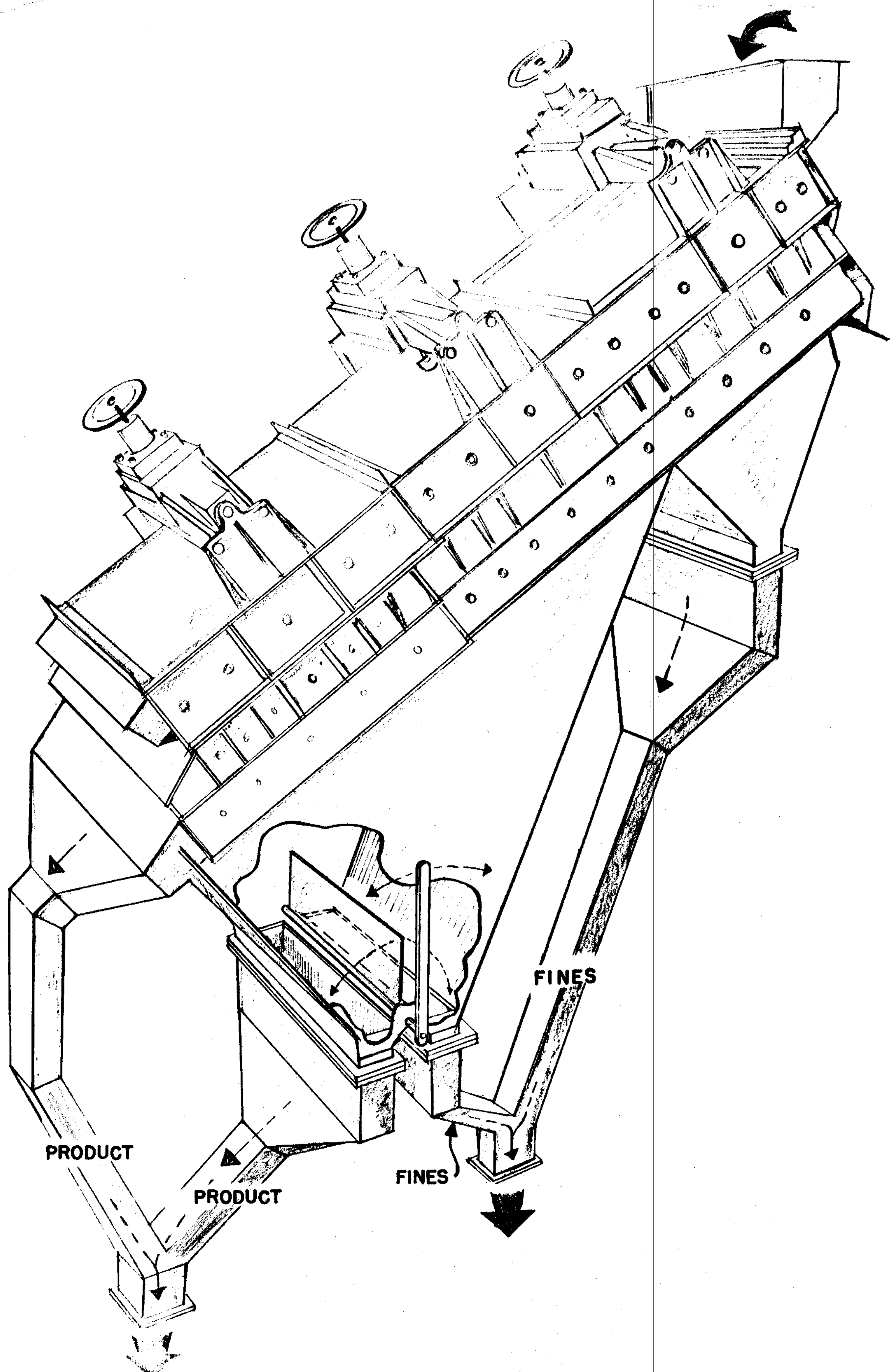


FIG. 4

SCREEN WITH DAMPER TO CONTROL PRODUCT DELIVERY TO RECYCLE

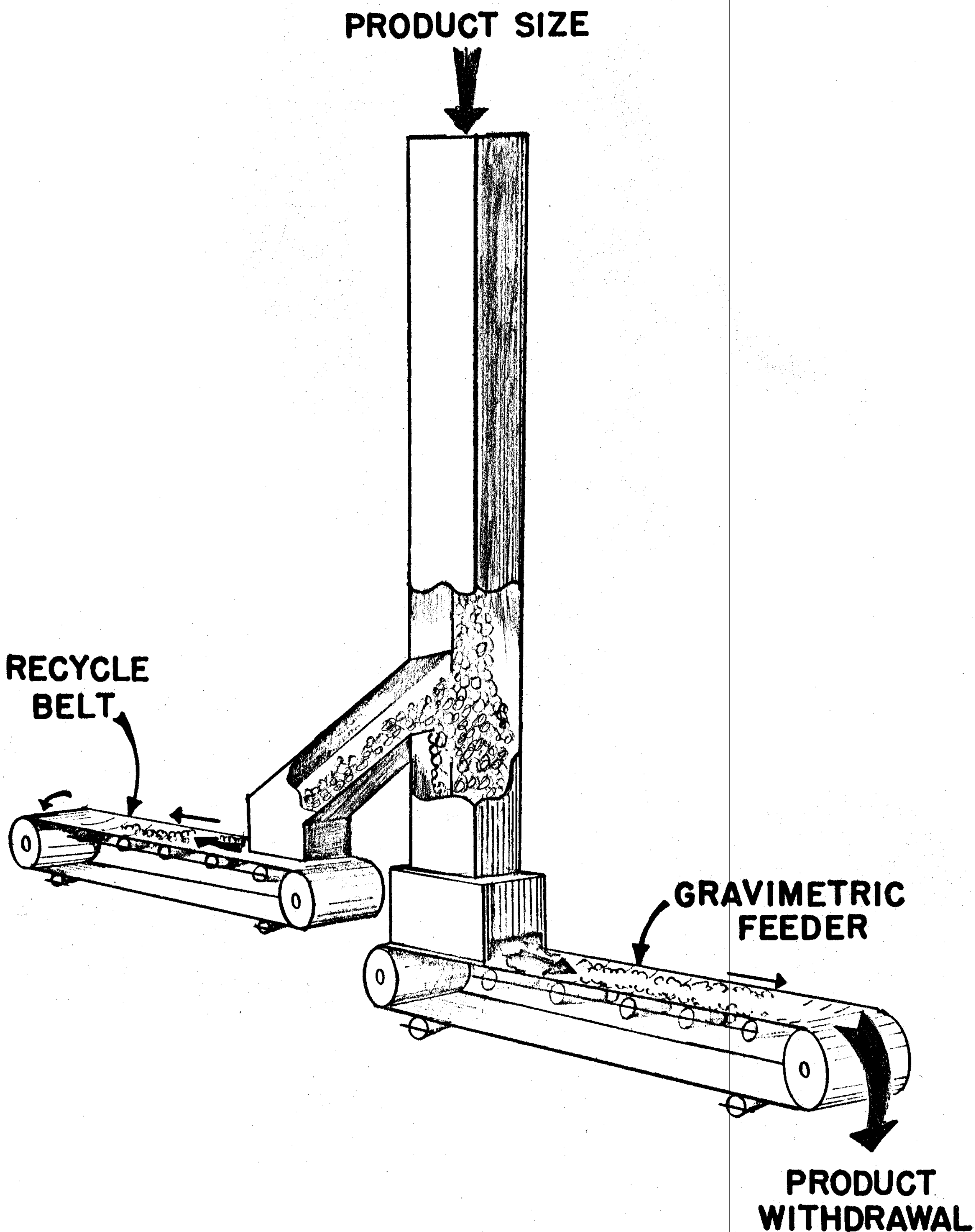


Fig. 5

SPLIT-BOOT RECYCLE CONTROL