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RECENT DEVELOPMENTS IN GRANULATION

Presented at the Fertilizer Industry Round Table
Washington, D. C.

November 10 - 12, 1965

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Frank P. Achorn and J. S. Lewis, Jr.
Chemical Engineers

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Tennessee Valley Authority
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The number of granulation plants in this country continues to increase. Many companies with small plants that formerly produced pulverized mixtures have converted their batch ammoniators to batch granulation plants, and many producers with medium-size granulation plants have installed preneutralizers and scrubbers so that they now produce diammonium phosphate grades. Companies that have plants of the latter type now tend to have higher annual fertilizer production, and many of them are now marketing complete grades through bulk handling stations.

Producers that have converted their small pulverized-mix plants to granulation have accomplished this conversion by cutting away part of the flights in their batch mixers and installing ammonia and acid distributors below a rolling bed of material in the batch mixer. Figure 1 is a sketch of a typical batch mixer that has been converted to a batch granulator. The flights in the first half of the mixer have been removed, and a block sparger or drilled pipe-type spargers have been installed in this section. The flights in the latter half of the mixer are usually cut so that they are only about 6 inches deep. The material from the batch granulator is usually cooled in a rotary cooler. Coolers of this type vary in size from 6 by 12 feet to 7 by 50 feet. Producers with granulation plants of this type formerly sold unscreened products or they removed the oversize only and sold the product as "semigranular" fertilizer. However, since quality specifications of granular products have become more demanding, most of these companies have found it advisable to screen the product from the cooler and recirculate the fines from the screen to the batch granulator. Recently some companies have converted their batch ammoniators to granulators by enlarging the discharge opening from the ammoniator and operating it on a continuous basis. The operation would then be essentially the same as with a conventional ammoniator-granulator. Most companies that have converted their 1-ton mixers or batch ammoniators to ammoniator-granulators have found that their production rate is usually less than 10 tons per hour. Because of these production limitations and the demand for higher production rates, many of these companies now plan to construct conventional ammoniation-granulation plants.

The size of the conventional ammoniator-granulator has been increased in the past few years. The Croplife survey of 1961 indicated that the largest ammoniator-granulator at that time was 7 by 14 feet. Last year some companies installed ammoniator-granulators that were 12 by 24 feet. The larger ammoniator-granulators are usually found in those plants that use the TVA process for the production of granular diammonium phosphate. Most of the ammoniator-granulators are still constructed of mild steel. Many now have Hastelloy or stainless steel sparger pipes. Most operators have found that the extra cost of stainless steel or Hastelloy is worth the investment. They report that there is considerably less wear of the holes in the stainless steel distributor; therefore, the distribution of the ammonia and acid remains uniform in the bed of material in the ammoniator-granulator for longer periods of time. This uniform distribution in turn causes ammonia losses to be minimized and granulation efficiency to remain good. They report that the holes in the mild steel distributors become enlarged so that there are wet spots in the ammoniator-granulator that cause overgranulation and high ammonia losses.

Recent observations indicate that many operators are removing the retaining rings inside the ammoniator-granulator which eliminates the granulation section. Operators who have removed this dam in the granulator have found that its removal does not affect their granulation efficiency. They have found also that they can lengthen their distributors and that the longer distributors tend to lower the amount of nitrogen lost in granulation and to decrease the difficulties encountered with overgranulation of the higher nitrogen grades such as 13-13-13.

There are many new devices to prevent the caking of material on the walls of the ammoniator-granulator. Some companies use rubber-lined ammoniator-granulators to prevent this caking. Figure 2 is a sketch of this type of ammoniator-granulator. Strips of rubber about 3 feet wide are bolted to the walls of the ammoniator-granulator and are held in position with metal strips. As the ammoniator-granulator rotates, the rubber lining flexes and thus causes any buildup on the rubber to fall off. Other companies are now using ammoniator-granulators that have rubber flaps inside. Figure 3 is a sketch of an ammoniator-granulator of this type. These flaps are usually made of 24-inch rubber belting, and they are installed so that the belts overlap each other when they are laid on the walls of the ammoniator-granulator. As the ammoniator-granulator revolves, the loose ends of the flaps drop. Any material that collects on them will drop off, and the flaps will remain relatively clean. Other plant operators have found it advisable to use an oscillating scraper to prevent this caking of material on the walls of the ammoniator-granulator. Figure 4 is a sketch showing a scraper of this type. The scraper oscillates back and forth across the walls of the ammoniator-granulator, and its teeth dig the caked material away from the walls. This type of scraper tends to wear less than the normal stationary scraper bar. At TVA we have recently installed a spiral scraper in one of our new ammoniator-granulators. Figure 5 is a sketch showing a scraper of this type. This scraper is similar to a German design. It is driven by an electric motor through a speed reducer; as it revolves slowly its teeth dig away the caked material from the walls of the ammoniator-granulator. Most companies still use knockers to remove buildup from the walls of the ammoniator-granulator.

Recently a company applied for a patent for a unique method of cleaning and positioning their sparger bars in the ammoniator-granulator. Figure 6 is a sketch illustrating this device. This mechanism will rotate the distributor bars that are normally used in the ammoniator-granulator. Many operators have reported difficulty with buildup and the positioning of the distributor bars in the ammoniation-granulation equipment. This rotating device provides a means whereby the distributor bars can be rotated out of the bed of material in the ammoniator-granulator so that they can be cleaned without shutting down the equipment. It also provides a means of positioning the distributor while the ammoniator-granulator is in operation. The rotating mechanism consists of an electric motor that drives a chain that causes the distributors to be rotated clockwise or counterclockwise. A brake drum is installed on one end of the distributor support bar, and this drum is used to lock the distributor at a desired position.

Many manufacturers with the larger granulation plants are now installing preneutralizers and scrubbers so that they can use large quantities of phosphoric acid and ammonia to produce diammonium phosphate grades. Most of these companies are using the TVA process for the production of diammonium phosphate grades. Figure 7 is a flow diagram of this process. The process involves the partial ammoniation of phosphoric acid in a preneutralizer and the complete ammoniation to diammonium phosphate in the ammoniator-granulator. The phosphoric acid is ammoniated in the preneutralizer to a mole ratio of 1.4 to 1.5. At this mole ratio there is a maximum solubility of the ammonium phosphate. Therefore, it is possible to obtain a concentrated slurry and a satisfactory fluidity for the proper distribution of the slurry in the ammoniator-granulator. Further ammoniation of this slurry to diammonium phosphate in the ammoniator-granulator decreases the solubility of the salts, and this in turn results in a relatively low liquid phase in the ammoniator-granulator. These conditions are conducive to low recycle rates and high production rates.

Many manufacturers have found that by converting their conventional granulation plant to this process they can use over 900 pounds of phosphoric acid per ton of product. This quantity is far in excess of the usual 200 pounds of phosphoric acid per ton of product that was formerly used in the conventional plant.

When this process is used, a high degree of ammoniation of the phosphoric acid can be used--9.6 pounds of ammonia per unit of P_2O_5. This degree of ammoniation of phosphoric acid is 33 percent higher than the 7.2 pounds of ammonia per unit of P_2O_5 that has been used in a conventional plant with an ammoniator-granulator. Because of this high degree of ammoniation, the economics of producing fertilizers in conventional granulation plants can be improved.

Some companies now produce high-analysis grades such as 8-24-24, 10-20-30, 12-24-24, and 20-10-10 by this process. Some of these companies are marketing their high-analysis grades through bulk handling stations. They have found that by producing high-analysis grades they decrease their transportation cost, and they can market their products farther from their plants. A typical granulation plant of this type produces more than 70,000 tons per year, and these products are marketed through bulk handling stations.

A typical bulk handling station is shown in Figure 8. At this station there is a 6-bin storage building. Each bin is about 12 feet wide and 30 feet long, and usually holds about 75 tons. The total capacity of the bins, therefore, is about 450 tons for all grades. These bins are usually used to store superphosphate, ammonium nitrate, potash, and three mixed fertilizer grades. The materials are usually transported to the bulk handling station by hopper-bottom railroad cars. A belt conveyor that fits under a hopper-bottom car is used to unload the materials. This belt conveyor empties into a portable conveyor that conveys the material to each of the storage bins. Materials are removed from the storage bins by means of a front-end loader. They are weighed in a scale hopper that is mounted above an inclined portable belt conveyor that empties into the bulk truck.

Other types of bulk handling stations use elevated storage tanks. Figure 9 is a sketch of a typical station of this type. Such a station usually has six tanks, each of which holds about 50 tons. Materials are removed from the railway car by a belt conveyor and are elevated to the storage tanks. The materials from the storage tanks are weighed in a hopper scale that discharges into the same elevator that is used to load the tanks. This elevator is used to convey the materials to the bulk truck.

Cost studies indicate that a bulk handling station of this type can be constructed for a cost between $10,000 and $15,000. Cost studies indicate also that the high-analysis grades such as 10-20-30 can be marketed through a granulation plant with bulk handling stations at costs that are competitive with the cost of bulk blending. If a bulk handling system is to be competitive, however, it is imperative that the total movement from the granulation plant be as high as possible. Previous cost studies have shown that a granulation plant operating in conjunction with bulk handling stations cannot be competitive with bulk blending when only 30,000 tons of material is moved through these stations. Other calculations indicate, however, that with a 70,000-ton movement considered, the economics of this production and marketing system may very closely approximate those of bulk blending.

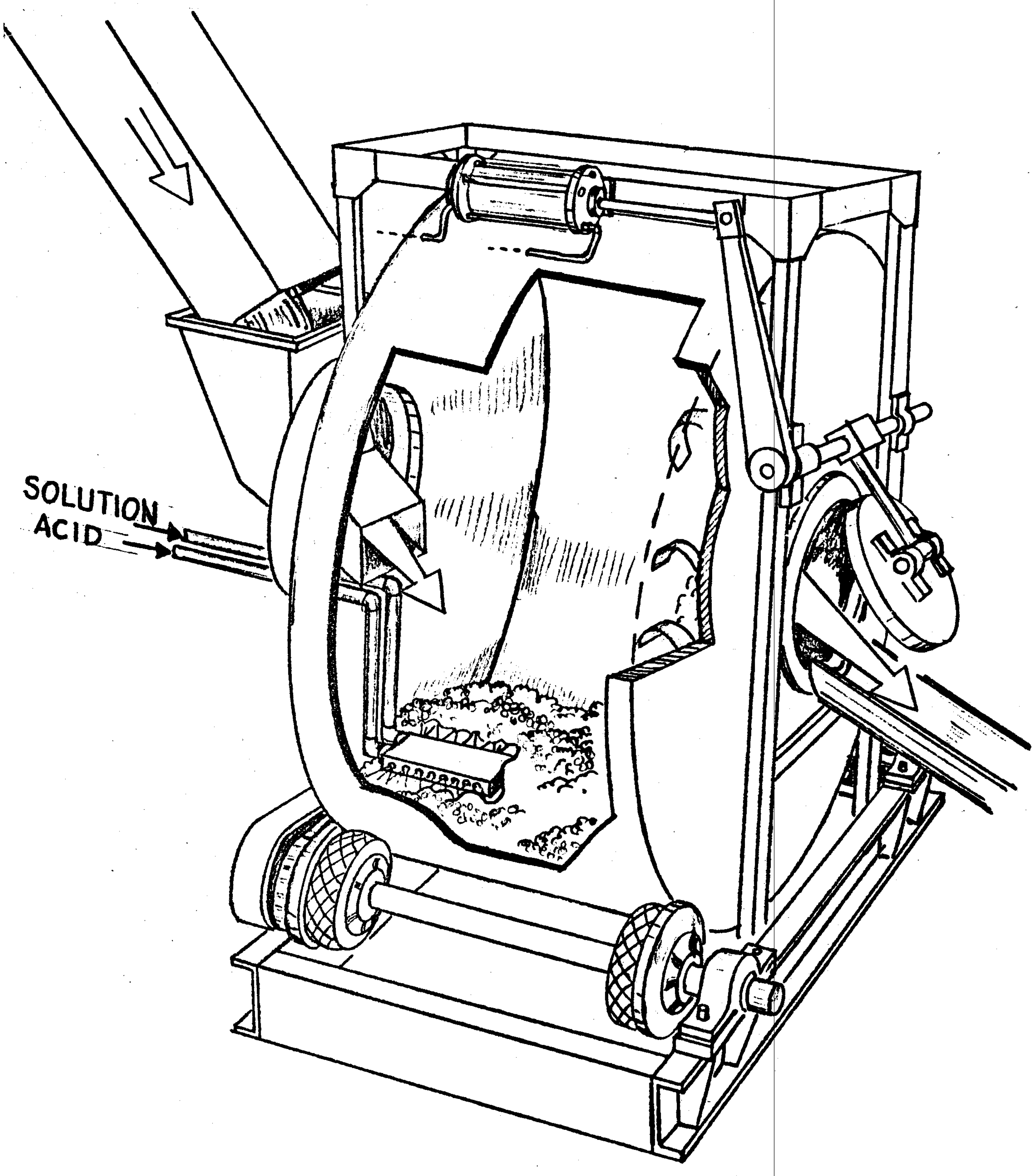

FIG. 1
BATCH GRANULATOR

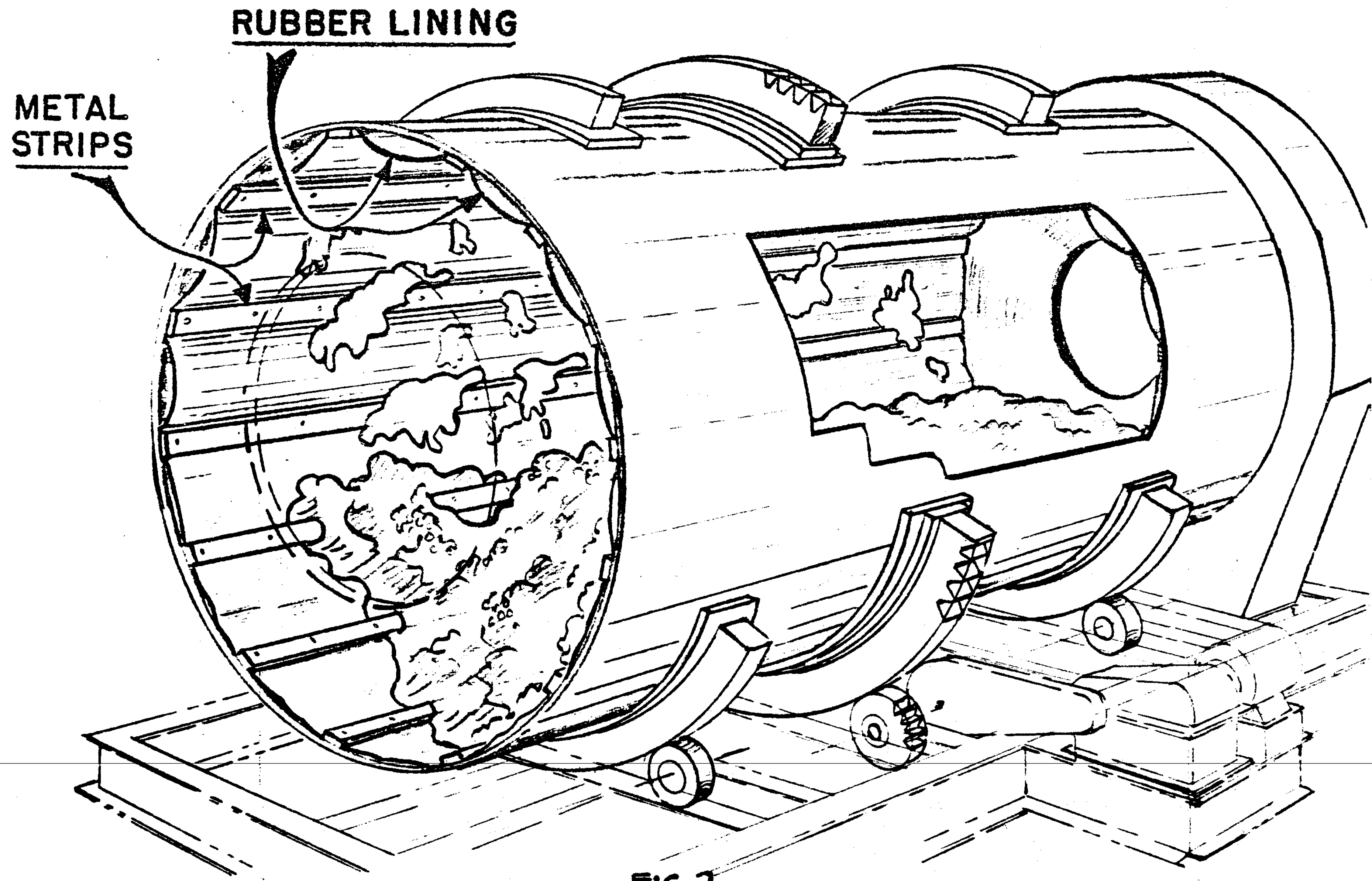

FIG. 2
A RUBBER LINED AMMONIATOR GRANULATOR

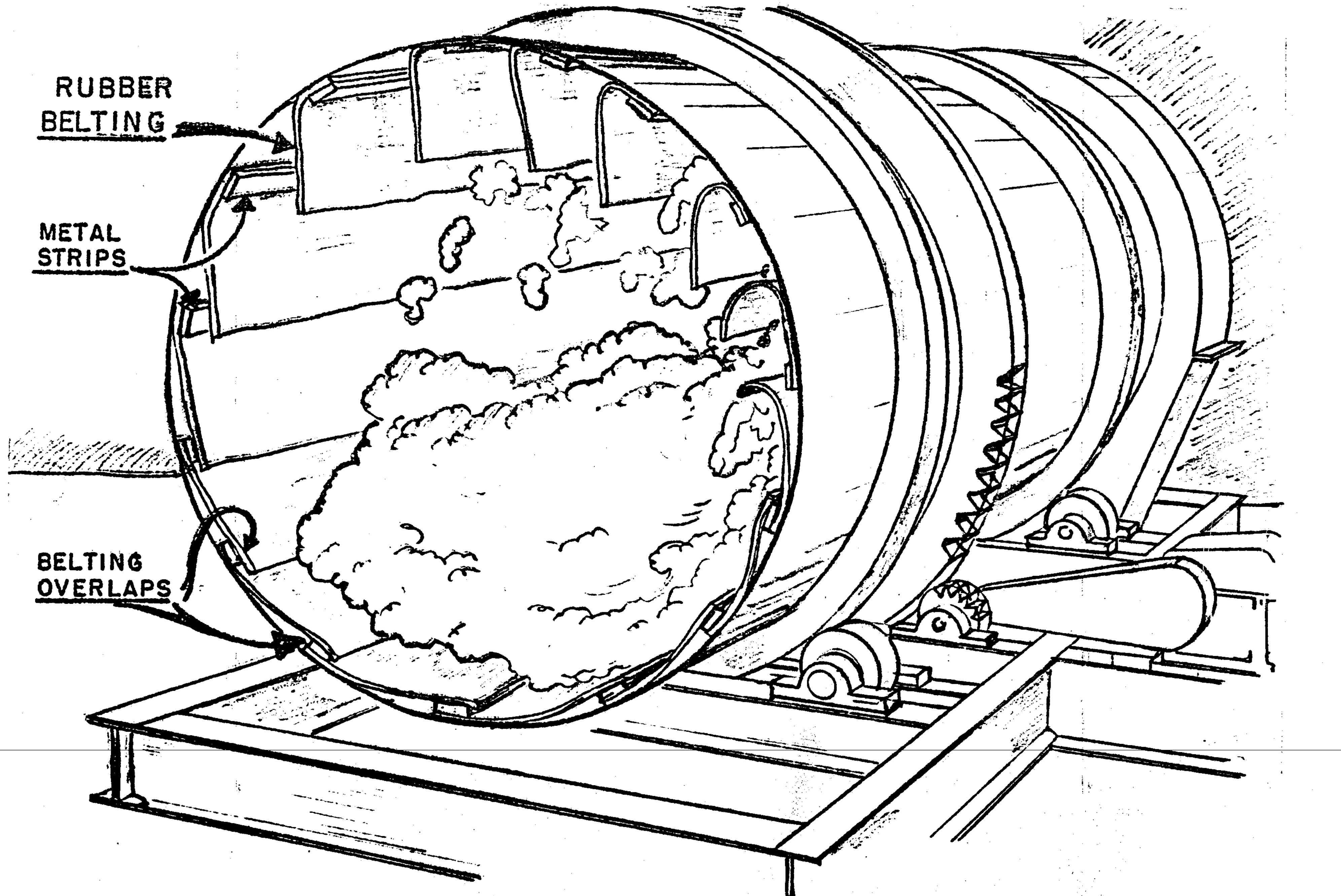

FIG. 3

AMMONIATOR GRANULATOR LINED WITH RUBBER BELTING

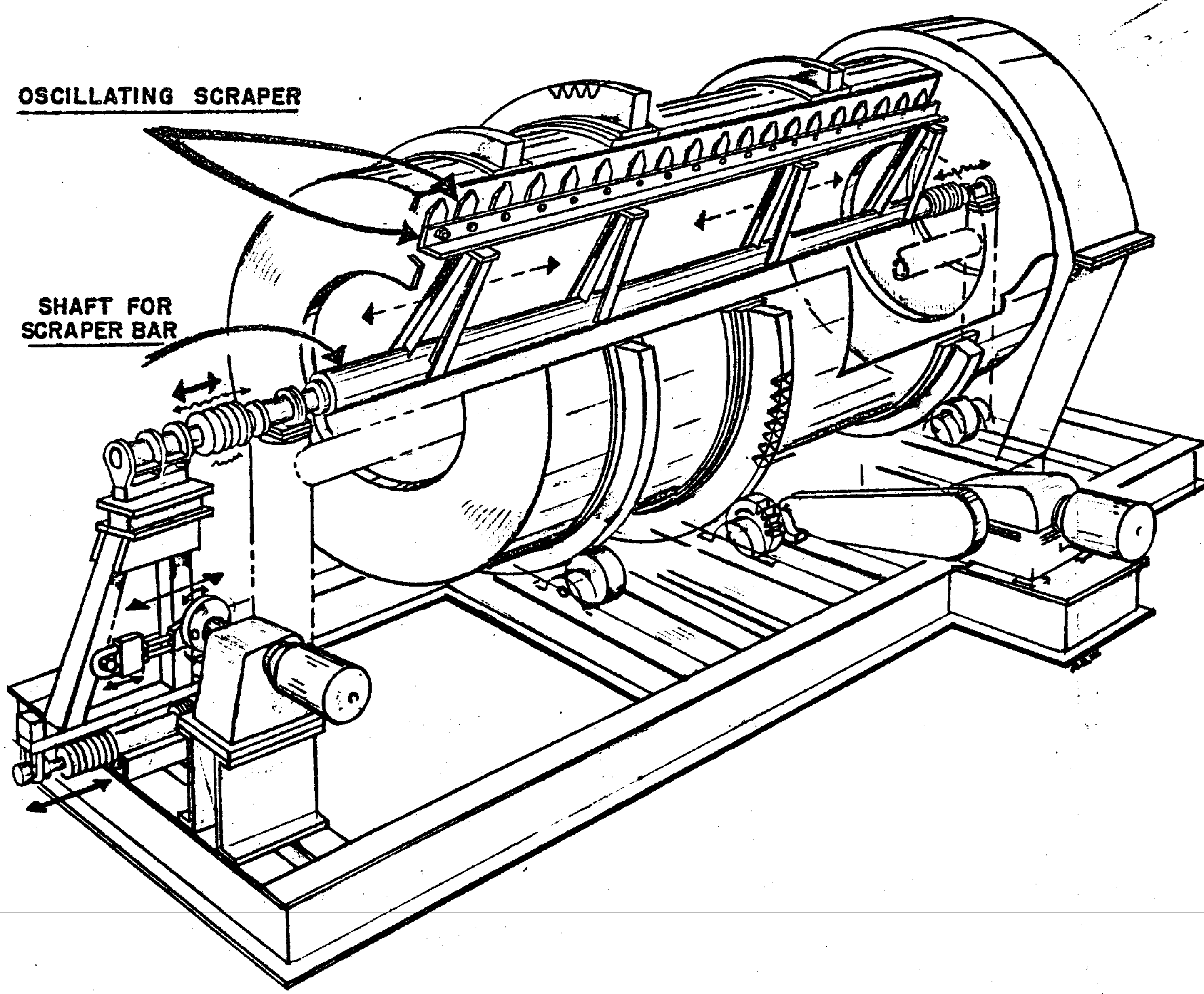

FIG. 4
AMMONIATOR GRANULATOR WITH OSCILLATING SCRAPER

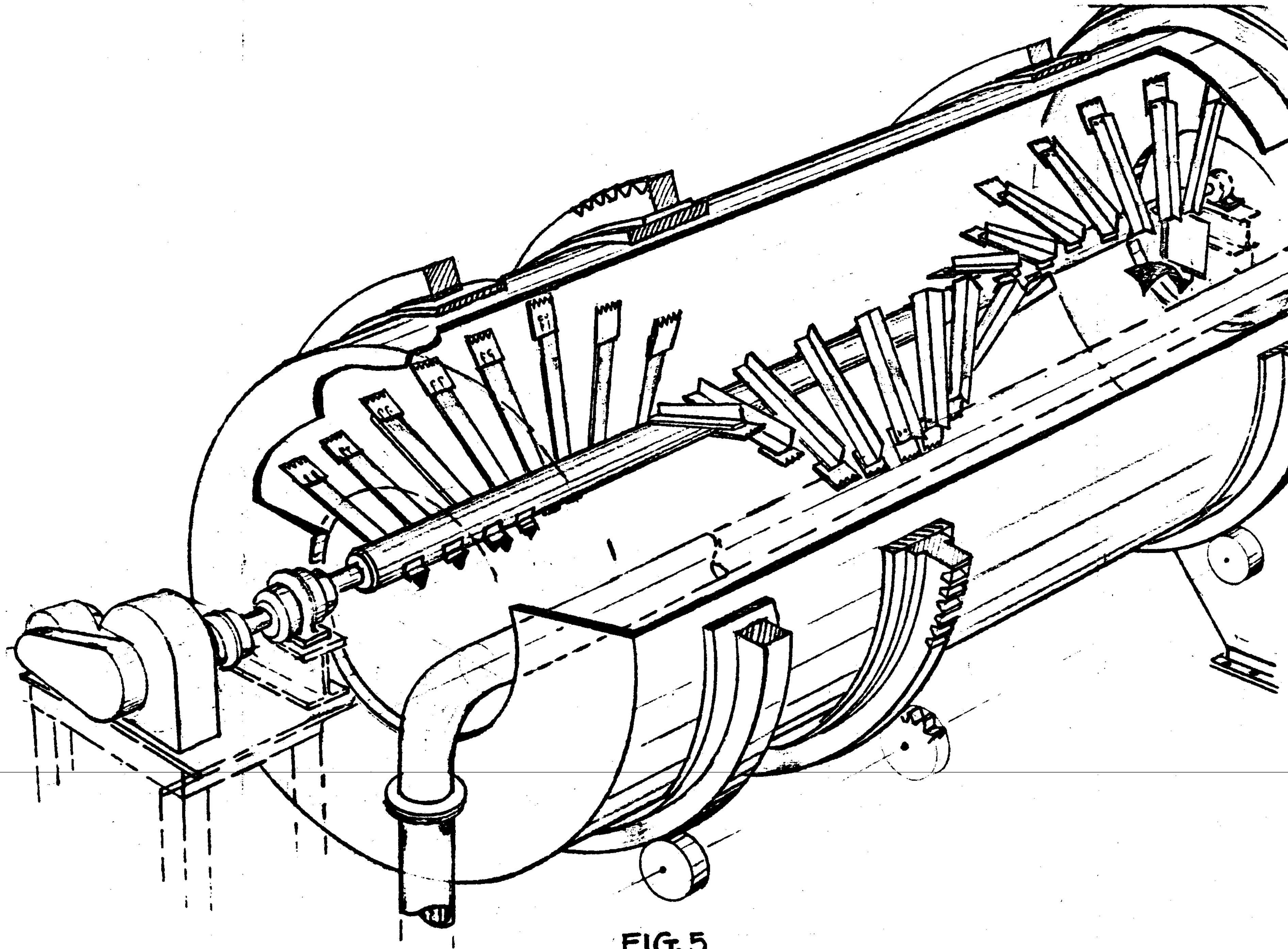

FIG. 5
AMMONIATOR GRANULATOR WITH SPIRIAL TYPE SCRAPER

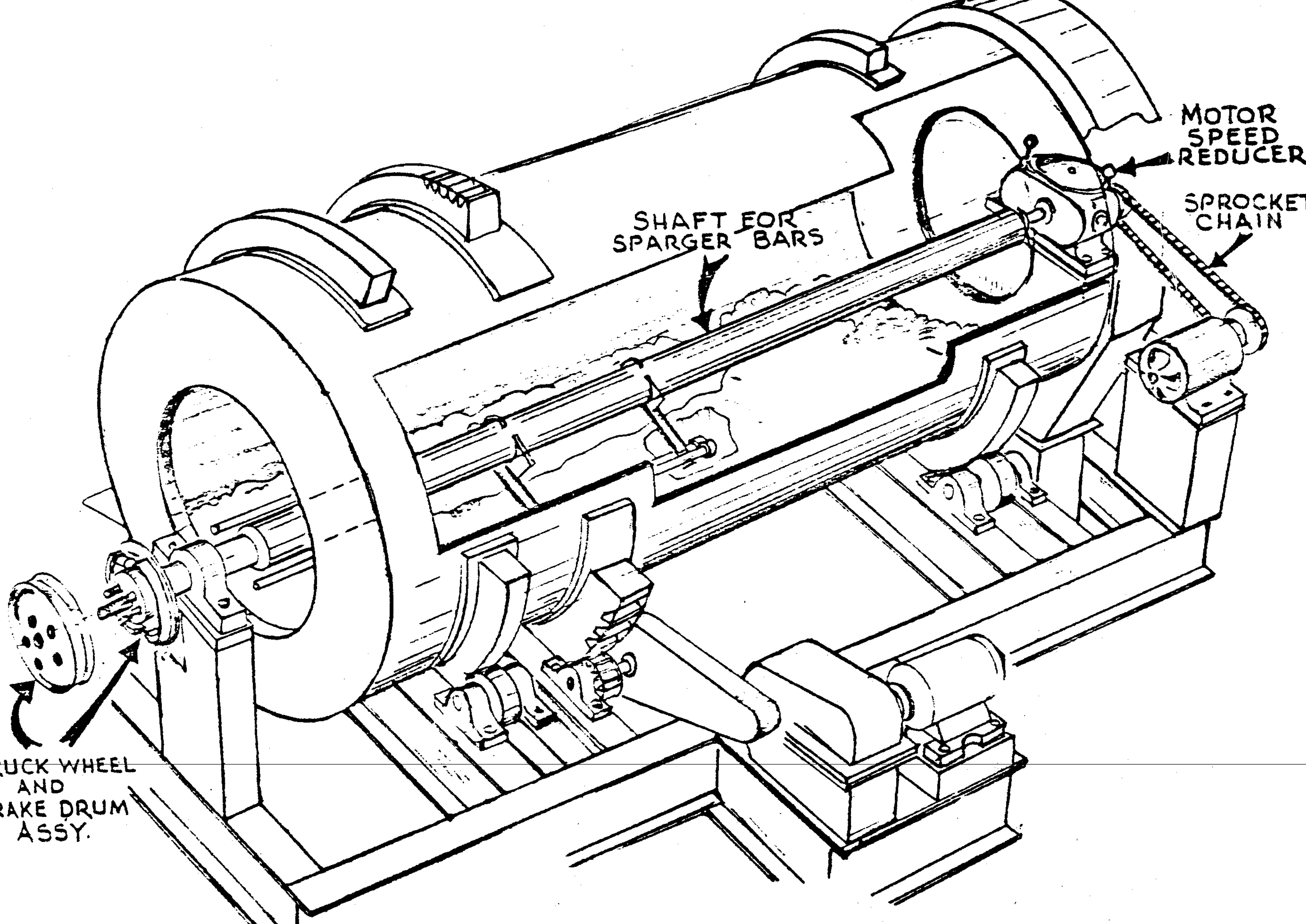

FIG. 6

AMMONIATOR GRANULATOR WITH ROTATING SPARGER BARS

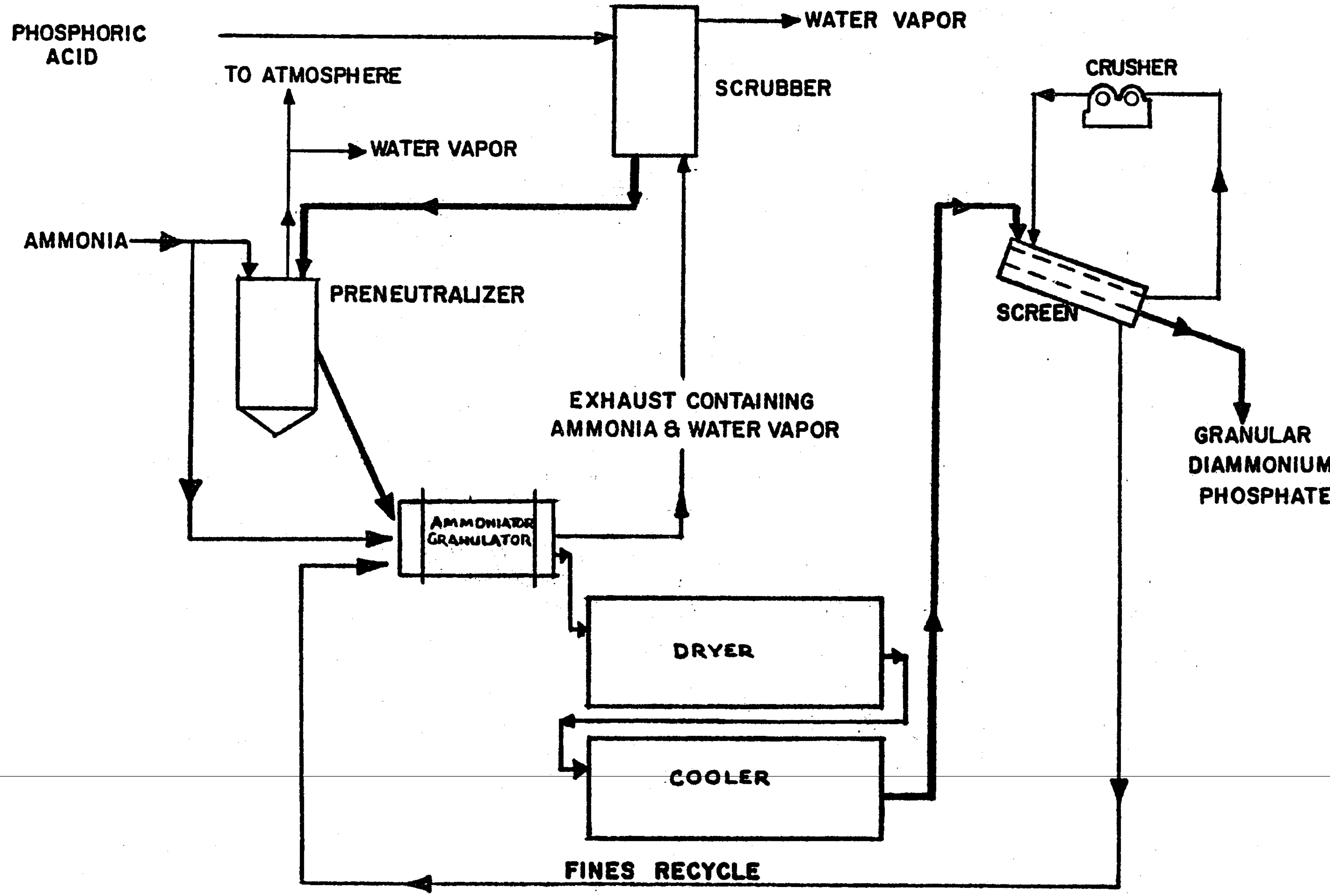

FIG. 7

FLOW SHEET OF TVA PROCESS FOR PRODUCTION OF GRANULAR DIAMMONIUM PHOSPHATE

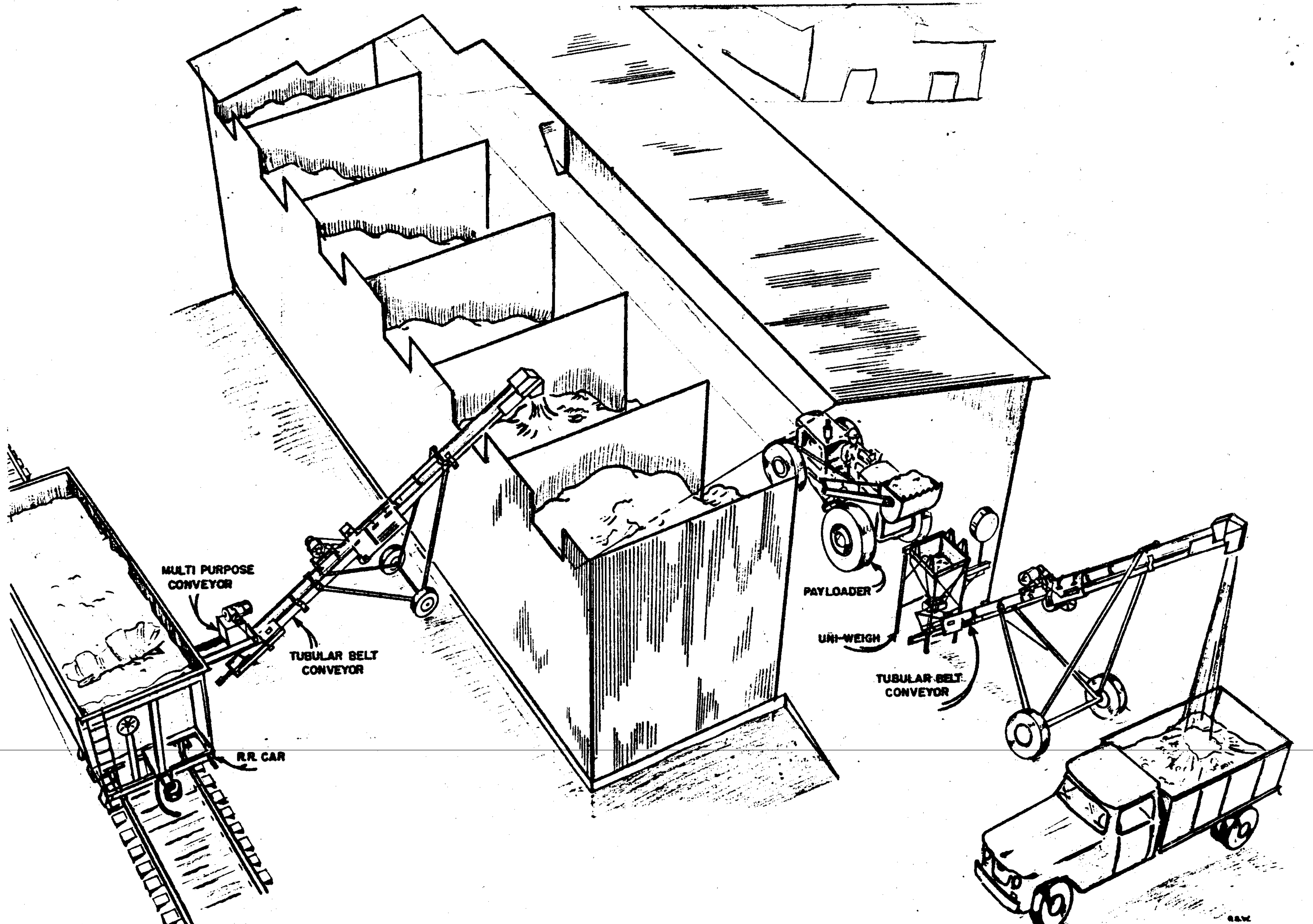

FIG. 8

GROUND STORAGE BULK BLENDING STATION

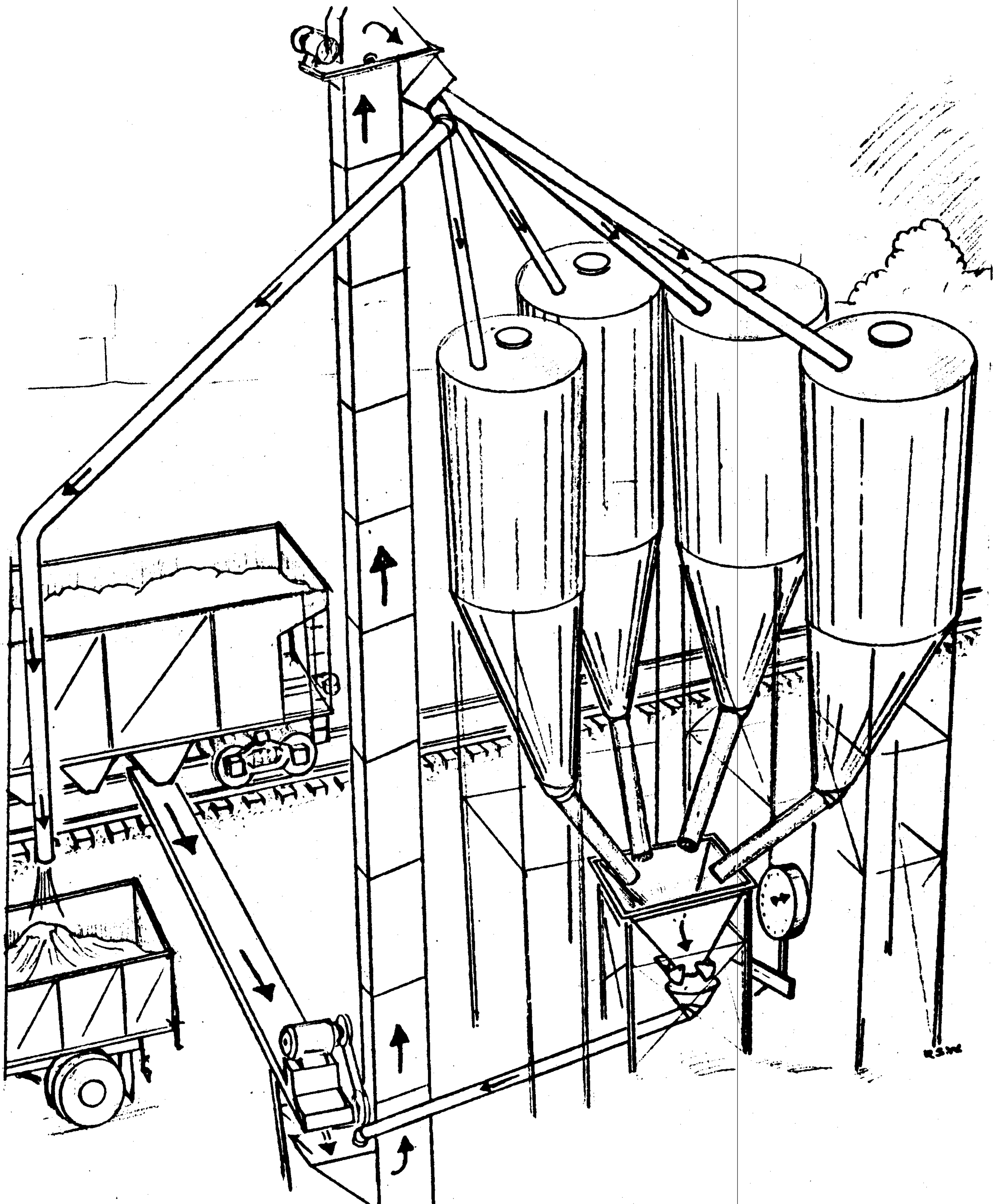

FIG. 9

BULK HANDLING STATION WITH ELEVATED STORAGE