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GRANULAR PRODUCT STORAGE

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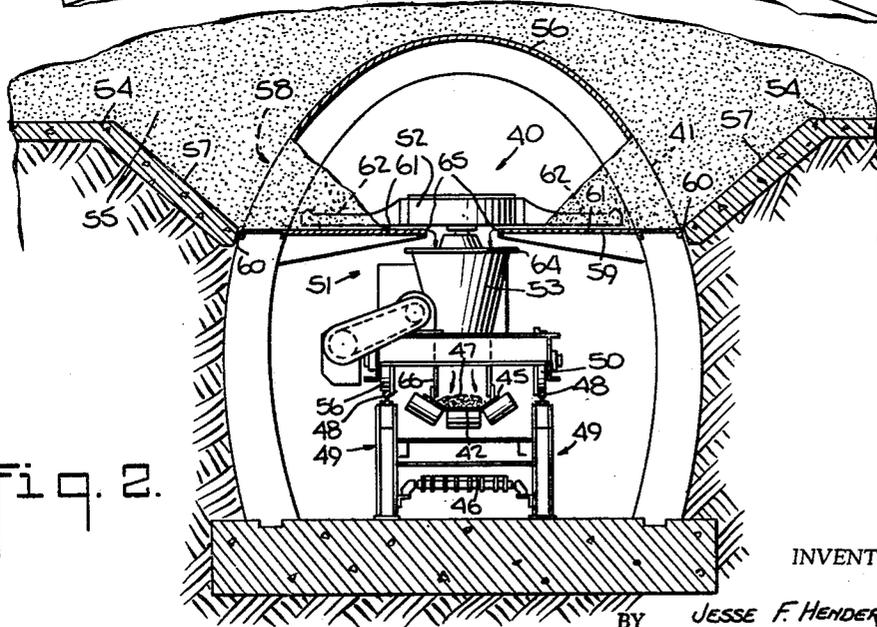
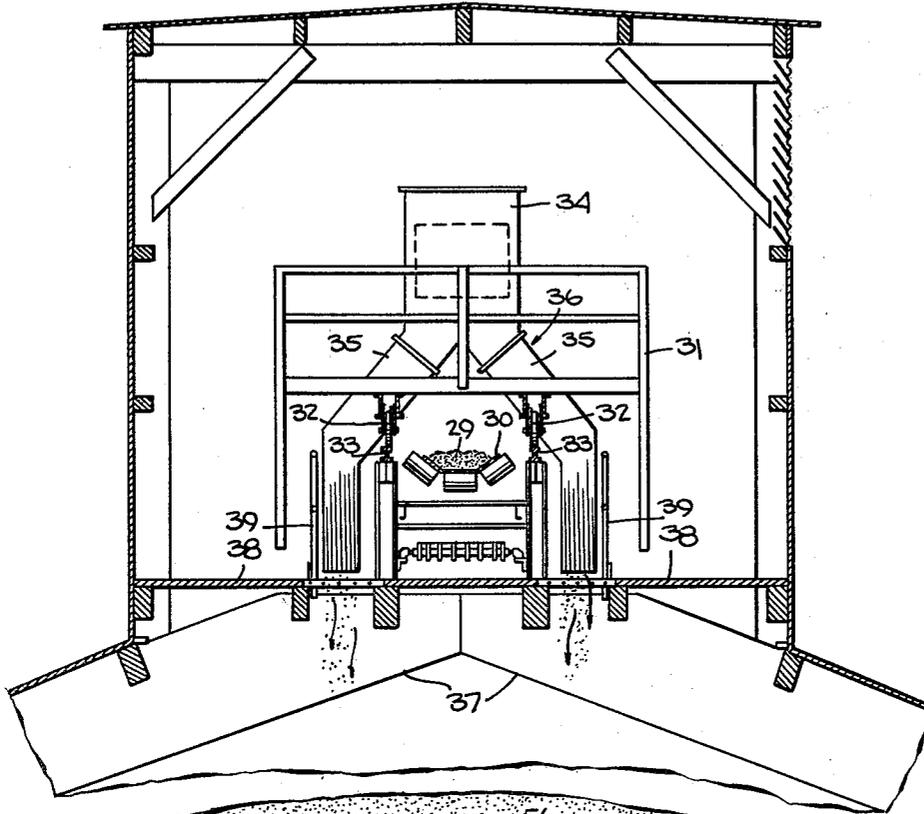


Fig. 2.

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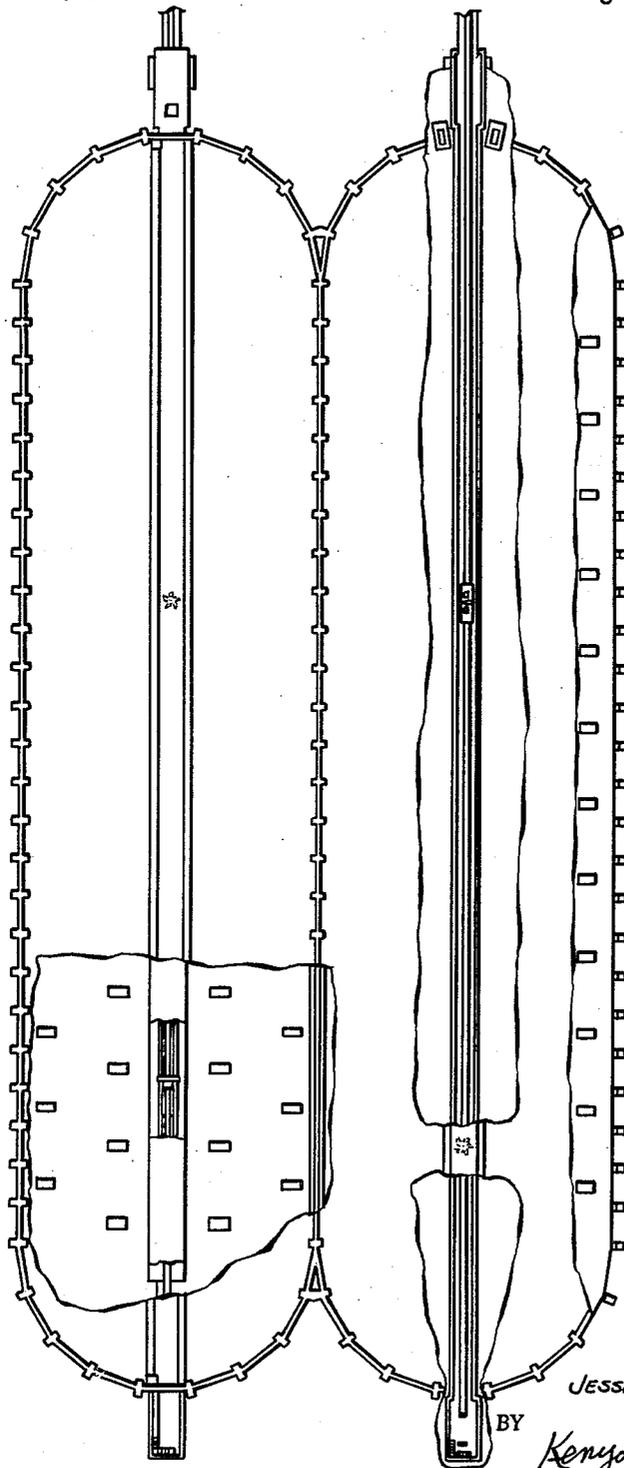


FIG. 3

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**GRANULAR PRODUCT STORAGE**

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1 Claim. (Cl. 214-17)

This invention relates to a free-flowing granular product facility in which the product may be continually fed in and out while maintaining substantially uniform product size distribution in the stored and reclaimed product.

Since potash sales are more or less seasonal, large storage facilities are required by a production facility in order to maintain an even level of plant production during the peak shipping seasons. Round or rectangular buildings are common in the industry, with round buildings being 75 to 150 feet in diameter, and rectangular structures from 125 to 175 feet wide and up to 650 feet in length. Commonly these buildings have vertical side walls up to 15 feet in height, with dome shaped roofs beginning at the top of the side wall. Finished product is usually transported to the top of the structure by conventional conveyor belts and distributed, in the case of a rectangular building, along the long axis of the building, to the floor below, which could be a vertical distance of up to 100 feet.

It is a well known and accepted fact that where dry material containing a range of mesh sizes falls freely onto a heap of like material, segregation of the mesh sizes occurs in that the coarser fractions tend to roll or travel down the heap along the top surface, so that the larger components of the material are concentrated in the lowest layers of the heaped material. Since the stored material must eventually be reclaimed onto a belt conveyor for transportation to the shipping station, and since it is mandatory that the reclaimed material consist of the equivalent range of mesh sizes as was in the original material on the incoming belt conveyor, the particle size segregation becomes a serious problem.

Due to day to day variations in grade and particle size of raw ore as produced by any mining procedure, the finished material from a beneficiation plant will usually reflect these differences in that at a certain time the material may vary slightly in product grade and screen analysis from that produced at another time. Consequently, it is of benefit to spread the material to be stored as evenly as possible along the longitudinal axis of the storage building so that, in effect, the stored material is blended as much as possible with respect to grade and screen analysis.

Because of the large size of the required storage structures it is not economically possible to achieve a substantial "live" storage. Usually, only 25 to 30% of the material in a filled building can be removed directly by a reclaiming system so that 70 to 75% of the material constitutes "dead" storage in that it must be transported to the reclaim devices by auxiliary means, such as bulldozers and the like.

Due to the present design of box car loading equipment, the capacity of reclaim and load-out systems is limited to rates of 250 to 300 tons per hour. Such systems would not be suitable for larger operations involving of the order of 1,200,000 annual tons.

It is an object of the present invention to provide a storage-reclaim-load-out system which minimizes the problem of mesh size segregation.

Another object is to provide such a system which permits thoroughly blending the stored material for grade control.

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An additional object is to drastically reduce the dead storage in the facility.

A further object is to provide a storage facility in which the reclaim and load-out capacity is at least double that of any other system presently known.

Briefly, the present invention relates to a storage facility for a free-flowing granular product having a predetermined angle of repose comprising an elongated storage warehouse defining an enclosed storage area for said product including an internal elevated endless conveyor belt means disposed lengthwise of said warehouse adjacent the top thereof and along the longitudinal axis thereof. An automatic reciprocally travelling belt-tripping means is coupled with said conveyor belt means and includes bifurcated funnel means disposed either side of said conveyor belt means for uniformly spreading said product lengthwise into said storage area below both sides of said conveyor belt means. Product reclaiming means is longitudinally disposed along the bottom of said storage area in substantial alignment with said elevated conveyor belt means and includes a longitudinally extending vaulted tunnel member having a plurality of oppositely disposed elongated openings extending along the length in the upper part thereof adapted for communication with the stored product.

A pair of opposed shelf members are disposed along the inside of said tunnel adjacent the bottom edges of said openings and being of sufficient width in relation to the height of said openings to accommodate said granular product at its said angle of repose. A pair of ramps are disposed downwardly at an angle substantially equal to said angle of repose in the bottom of said storage area on respective sides of said tunnel and communicate with said openings.

A second endless conveyor belt means is disposed longitudinally of said tunnel below the level of said shelf members and rotary plow means bridges said shelf members and is reciprocally movable along the length of said tunnel and has funnel means included therewith communicating with said second conveyor belt means. Said rotary plow means is adapted for reclaiming the stored product substantially uniformly from said storage area and delivering it from said shelf members to the second conveyor belt means for conveyance externally of said warehouse.

Other objects and features of the invention will become apparent in the following description and claim, and in the drawings in which:

FIG. 1 is a fragmentary elevation of a storage facility according to the present invention in partial section;

FIG. 2 is an enlarged fragmentary view in partial section taken along lines 2-2 of FIG. 1;

FIG. 3 is an enlarged fragmentary view in elevation of the rotary plow means and related structure;

FIG. 4 is a fragmentary plan view of the rotary plow means; and

FIG. 5 is a fragmentary plan view of a modified arrangement according to the present invention.

Referring to the drawings, and particularly FIGS. 1-4 a storage facility according to the present invention is designated generally by reference numeral 10 and is comprised of an elongated warehouse structure 11 having more or less conventional design with bottom vertical side walls 12 of approximately 15 feet in height running in straight sections along a substantial part of the length of the building and merging with rounded end sections 14 (see also FIG. 5). The straight sections may run for approximately 500 feet or more and the total width may be of the order of 150 feet. A dome shaped roof 15 rises from the top edge 16 of said walls 12 to enclose the structure to provide a center height of the order of 100 feet along the axis of the building. Disposed along

the longitudinal axis of the building at the top thereof is elevated conveyor belt means 17 which extends from end pulley 18 at the innermost end of upper gallery 19 to end pulley 20 at the forward end 21 of the warehouse 10, the latter said pulley being located in transfer tower 22 which receives granular product for storage. The upper gallery 19 may be provided with translucent paneling 23 alternating with metal louvers 24 to provide natural interior lighting in the building and natural ventilation. Conveyor belt-tripping means 25 of conventional design is provided in upper gallery 19 which, as shown schematically in FIG. 1, has upper pulley 26 and lower pulley 27 mounted in conjunction with hopper assembly 28 for causing conveyor belt 17 to release its conveyed contents 29 being conveyed into the storage facility on the upper run 30 of the conveyor belt which moves in the direction of arrow A (see also FIG. 2).

As shown in greater detail in FIG. 2 the belt-tripping means 25 has a framework 31 supported by wheels 32 on tracks 33 extending for the length of upper gallery 19 in the top of warehouse 10. Between the tracks is disposed the upper run 30 of conveyor belt 17 which is caused by pulleys 26, 27 to release conveyed contents 29 into discharge hood 34 whereupon the granular product passes downwardly through the angular legs 35 of bifurcated funnel means 36 where it passes downwardly to laminated timber arch ribs 37 and is distributed along both sides of the conveyor belt means into the storage facility. The gallery may also be provided with plank decking 38 and hand rails 39 along either side of the conveyor belt 17 and belt-tripping means 25 for access by personnel to the upper gallery and its associated equipment.

The belt-tripping means 25 is provided with propulsion means (not shown) which may be either electrical or other motive power as desired so as to automatically move back and forth along gallery 19 to spread the granular product 29 substantially uniformly along the length of the facility.

Disposed longitudinally along the bottom of the storage area in substantial alignment with the elevated conveyor belt means 17 is product reclaiming means 40 comprised of a reclaim tunnel 41 extending the length of warehouse 10, a second endless conveyor belt means 42 being supported at its innermost end 43 by pulley 44 and at its other end, externally of the tunnel by another pulley (not shown) located, for example, at a box car loading platform or the like. Conveyor belt 42 has an upper run 45 and lower run 46 (see also FIG. 2), the former conveying granular product 47 in the direction of arrow B to a point external of the storage facility 10. Mounted at about the same general level as upper run 45 of the conveyor belt 42 and on either side thereof are rails 48, supported by any conventional or desired supports 49 which also constitute the supporting framework for the conveyor belt means 42. Supported on rails 48 and movable therealong on wheels 50 is a product reclaiming apparatus 51 comprising rotary plow member 52 and hopper 53 which will be described below.

The floor 54 of warehouse 10, upon which rests the stored granular product 55 has, at each side of the upwardly extending vaulted roof 56 of tunnel 40, a pair of downwardly extending ramp portions 57 which are disposed at an angle substantially the same as the angle of repose of the granular product being stored. Along either side of tunnel 40 in the vaulted portion 56 thereof are a plurality of oppositely disposed window members or openings 58 which are adjacent ramps 57 for delivering the granular stored product 55 into the interior of the tunnel 40 along opposed shelf members 59 which are disposed along the inside of the tunnel 40 adjacent the bottom edges 60 of openings 58 and being of sufficient width in relation to the height of the openings to permit the stored product to extend inwardly along the shelves 59 to achieve its characteristic angle of repose thereon.

Reclaiming apparatus 51 is disposed centrally within tunnel 40 between shelf members 59 with rotary plow 52 disposed adjacent the respective upper surfaces 61 of shelves 59 and having its arcuate plow arms 62 extending laterally over substantially the entire width of the shelves 59. (See also FIGS. 3 and 4.) The reclaiming apparatus 51 is mounted on a suitable base support 63 having wheels 50 resting on and movable along ramp 48 as aforementioned. Disposed centrally beneath rotary plow 52 and below the level of shelves 59 is hopper 53 which has an upper mouth portion 64 extending laterally beyond the inner edges 65 of shelves 59 to receive the granular product as removed therefrom by plow 52, and a bottom portion 66 disposed above the upper run 45 of conveyor belt 42, and of a narrower width than said belt 42 for delivering the reclaimed product 47 thereto.

Suitable motive power is supplied to the wheels 50 by, for example, electric motor 67 and to the plow 52 by, for example, electric motor 68, and by suitable automatic controls (not shown) the reclaiming apparatus 51 can be moved continuously back and forth longitudinally of reclaim tunnel 40 to remove the stored product from the warehouse 10.

By the continuous back and forth movement of the belt-tripping means 25 in storing the product, and by the reclaiming apparatus 51 in removing the stored product, substantial uniformity in granular product is achieved.

Due to the nature of the product and the design of the reclaim tunnel 40 it is to be understood that a product is removed from shelves 59 by rotary plow 52, additional product flows through access windows 58 from the ramps 57 to again achieve its characteristic angular repose on the shelves 59 for further removal upon the return pass of the rotary plow 52.

While the above described invention has particular adaptability for use in connection with potash storage and the like it is to be understood that it is adaptable for all free-flowing granular materials.

While generally the average angle of repose of potash materials from a usual potash mill is about 40°, such angle varies as follows:

Mesh size:	Angle of repose (average)
28 x 65	32°
14 x 28	36°
6 x 14	40°

With a storage facility as above described the reclaim and load-out capacity in a typical installation has been found to be from 600 to 800 tons per hour and the "dead" storage in the building only about 36%.

As shown in FIG. 1 it may be desired to store two or more different granular products in the same building such as product X (of a lesser capacity) and product Y. In such instant a transverse divider wall may be provided at 70 and, whereas one belt-tripping means 25 can be employed, it is preferable that two rotary plows 52 be provided in the reclaim tunnel 41.

As shown in FIG. 5, for a typical potash plant, two side by side warehouse facilities might be deemed necessary, one building for the coarse product, and the other building for storing a standard product and a smaller granular product. Various combinations are possible.

While certain embodiments of the present invention have been shown and described, it is to be understood that changes and additions may be made by those skilled in the art without departing from the scope and spirit of the invention.

What is claimed is:

1. An elongated storage warehouse defining an enclosed storage area for a free-flowing granular product having a predetermined angle of repose comprising an internal elevated endless conveyor belt means disposed lengthwise of said warehouse adjacent the top thereof and along the longitudinal axis thereof, reciprocally traveling belt-trip-

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ping means coupled with said conveyor belt means including bifurcated funnel means disposed either side of said conveyor belt means for uniformly spreading said product lengthwise into said storage area below both sides of said conveyor belt means, product reclaiming means longitudinally disposed along the bottom of said storage area in substantial alignment with said elevated conveyor belt means including a longitudinally extending vaulted tunnel member having a plurality of oppositely disposed elongated openings extending along the length in the upper part thereof adapted for communication with the stored product, a pair of opposed shelf members disposed along the inside of said tunnel adjacent the bottom edges of said openings and being of sufficient width in relation to the height of said openings to accommodate said granular product at its said angle of repose, a pair of ramps disposed downwardly at an angle substantially equal to said angle of repose in the bottom of said storage area on either side of said tunnel and communicating with said openings, a second endless conveyor belt means

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disposed longitudinally of said tunnel below the level of said shelf members, rotary plow means bridging said shelf members and reciprocally movable along the length of said tunnel, funnel means included therewith communicating with said second conveyor belt means, said rotary plow means being adapted for reclaiming the stored product uniformly from said storage area and feeding it from said shelf members to said second conveyor belt means for conveyance externally of said warehouse.

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