May 20, 1969 D. R. JACKSON 3,445,091

GRAIN CIRCULATOR

Filed March 18, 1968 Sheet 1 of 2

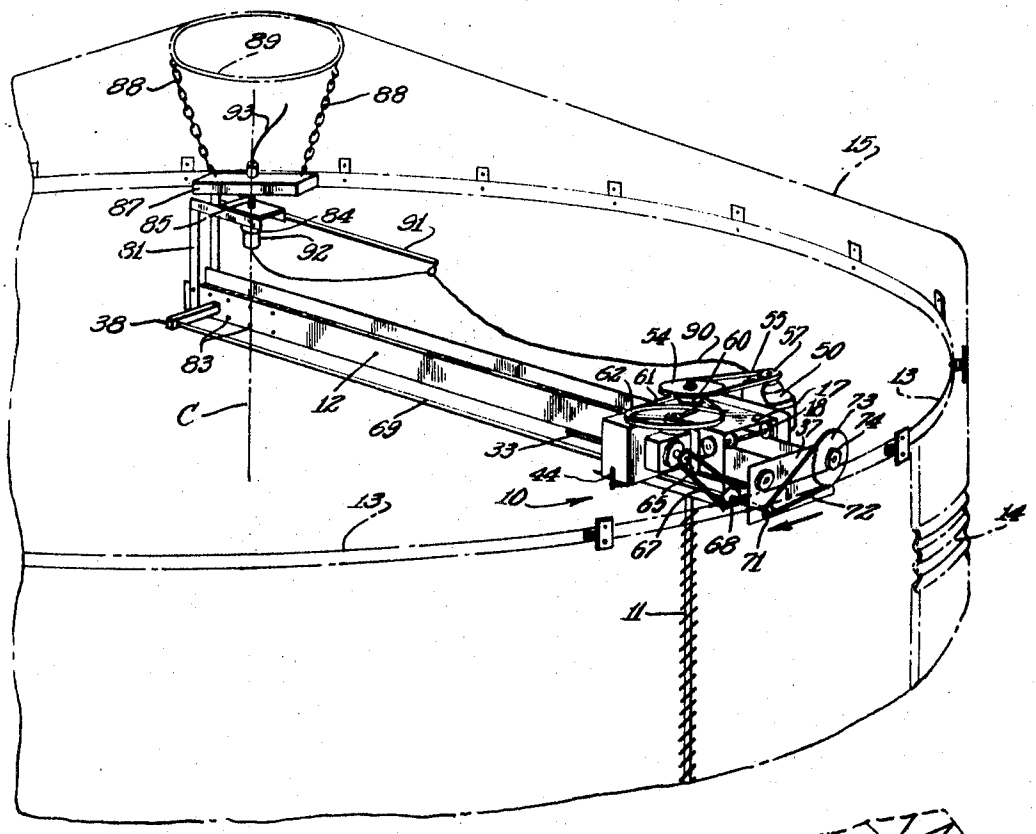


Fig. 1

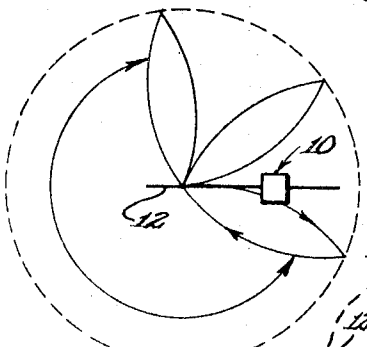


Fig. 2

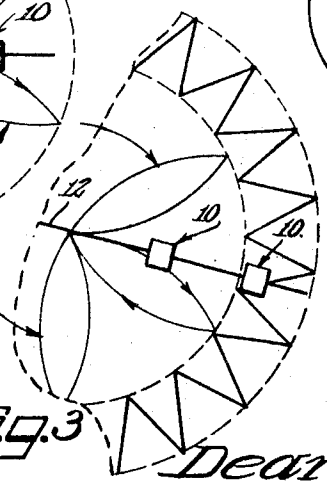


Fig. 3

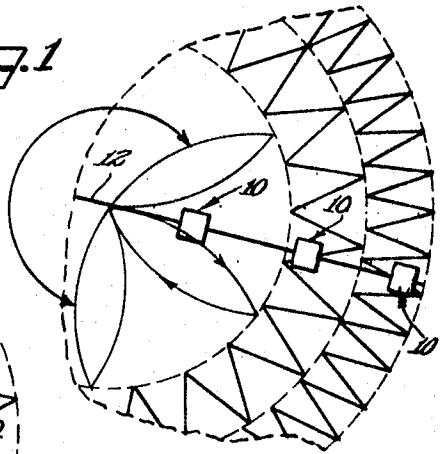


Fig. 4

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GRAIN CIRCULATOR

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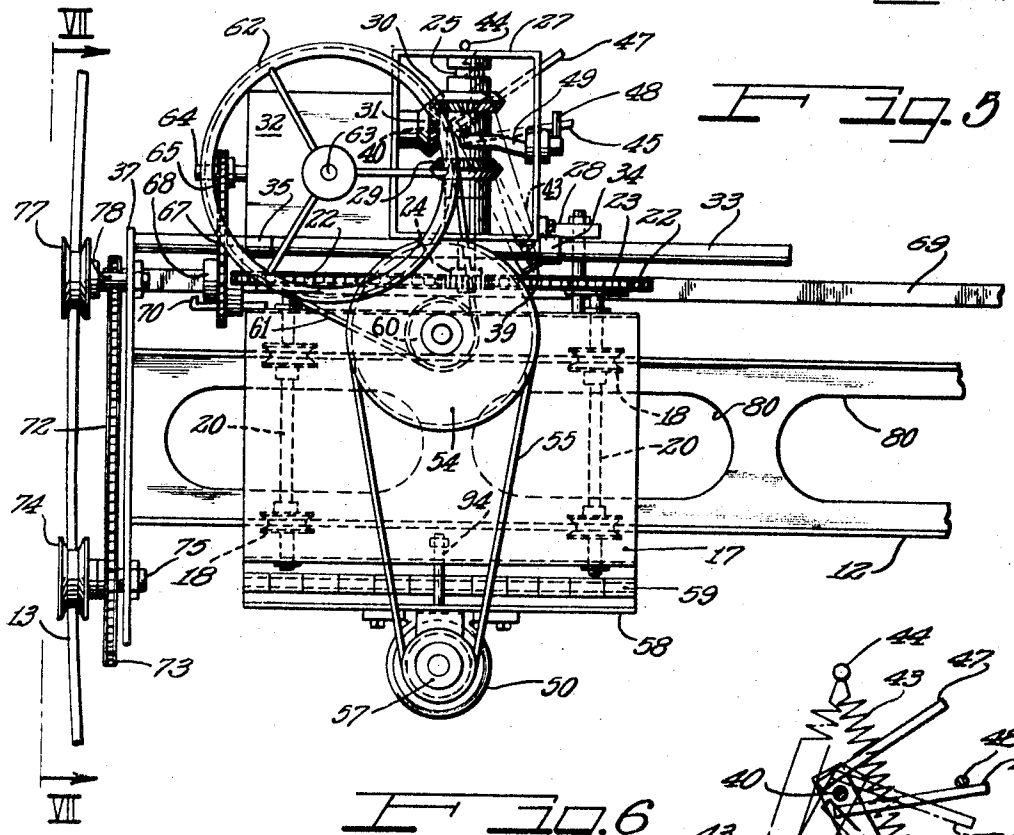
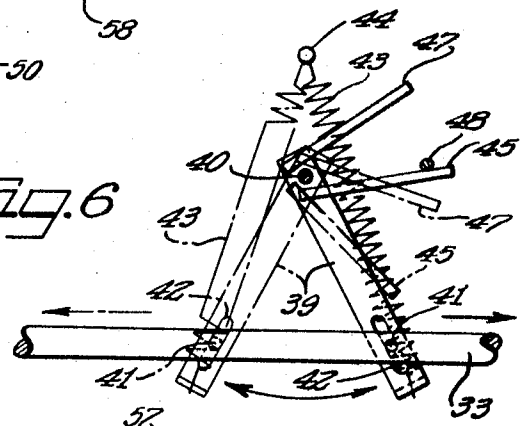


Fig. 5

Fig. 6



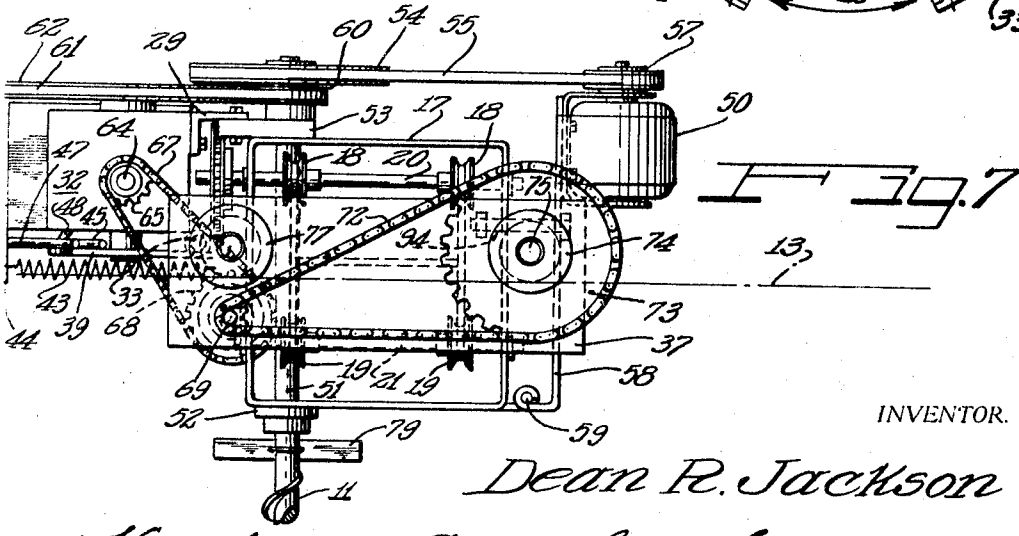


Fig. 7

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3,445,091

GRAIN CIRCULATOR

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Int. Cl. B01f 7/10, 7/00
U.S. Cl. 259—111 16 Claims

ABSTRACT OF THE DISCLOSURE

A grain circulator has a carriage which is reciprocally mounted on a track beam which has on one end roller means riding on a a horizontal rail running along the inside of the upper portion of a grain bin with the inner end portion of the beam flexibly suspended from the roof of the bin. A grain elevating auger rotatably carried by the carriage depends therefrom into the grain. An electric motor mounted on the carriage drives the auger rotatably, shuttles the carriage along the beam and motivates the roller means to advance the beam along the rail.

This invention relates to grain circulators, and is more particularly concerned with auger type circulators employed in grain storage bins

Various arrangements providing grain elevating augers have heretofor been proposed for circulating grain in storage bins such as may have means for circulating drying air, generally heated, upwardly through the grain mass. The auger is moved in a stirring cycle through the grain, lifting it up from the bottom so as to effect periodic circulation and aeration, promote drying, avoid compaction or hard spots or crusting, effect mixing or blending, and the like.

In prior arrangements various deficiences and disadvantages have been inherent in construction and operation. For example, a plurality of power sources have generally been required to attain the several motivations necessary in operation. Undue maintenance has been required because of tendencies to overload the auger, the power means, and the supporting structures. With some prior devices the grain at the center of the bin is not adequately reached. Specific dimensioning for various bin sizes has been necessary. There has been excessive liability to stall, auger shear pin shearing, damaging distortions, mechanism jamming, and the like, necessitating frequent servicing shut downs, repairs, start ups, and consequent inefficiences and high maintenance costs.

An important object of the present invention is to provide a new and improved grain circulator for drying and storage bins and which will overcome the foregoing and other prior art deficiences.

Another object of the invention is to provide a grain circulator of unusually rugged, efficient, compact and self-sufficient construction and operating characteristics.

Another object is to provide a new and improved grain circulator which is self-releasing with respect to hard spots or compactions in the grain mass, so as to avoid jamming and other difficulties which have plagued prior devices.

A further object of the invention is to provide a novel grain circulator having improved driving means.

Still another object of the invention is to provide a new and improved grain circulator which is readily adaptable for various sizes of grain bins.

Yet another object of the invention is to provide a new and improved grain circulator which is readily adaptable to employ a plurality of auger-carrying shuttle units for large size grain bins.

A still further object of the invention is to provide a

new and improved grain circulator in which the auger is operative to the center of the grain mass.

A yet further object of the invention is to provide a new and improved grain circulating means operative in unusually efficient grain-stirring patterns.

Additional objects, features and advantages of the present invention will be readily apparent from the following detailed description of certain preferred embodiments thereof, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is an illustrative view of a grain circulator embodying features of the invention and having a single auger-operating shuttle unit;

FIGURE 2 is a schematic view showing the stirring pattern of the arrangement depicited in FIGURE 1;

FIGURE 3 is a schematic view showing the stirring pattern developed in a twin shuttle unit arrangement pursuant to the invention;

FIGURE 4 is a schematic view showing the stirring pattern developed in a three shuttle system pursuant to the invention;

FIGURE 5 is a top plan view of the shuttle unit of FIGURE 1 or the outermost of the units in FIGURES 3 and 4;

FIGURE 6 is an illustrative view of the traverse bar and gear-shifting yoke assembly; and

FIGURE 7 is an end elevational view taken substantially in the plane of line VII–VII of FIGURE 5.

On reference to FIG. 1, a grain circulator is depicited comprising a shuttle unit **10** rotatably supporting a depending grain elevating auger **11** and mounted to shuttle along a track beam **12** having a radially outer end equipped to run along a horizontal circulator rail **13** mounted along the inside of the upper portion of an upright wall **14** of a grain drying and storage bin adapted to receive a substantial depth of grain therein and below the rail, and supporting on its upper end a roof **15** from which the radially inner end portion of the beam is supported in a manner to enable the beam to travel full 360° operating cycles around the rail.

In a simple, rugged, efficient low cost construction, the shuttle unit **10** comprises a carriage **17** (FIGS. 1, 5, and 7) which is a simple tubular steel member of quadrangular transverse cross section and of a suitable length for the present purpose. It may be made from inexpensive steel plates welded together along their joining edges and providing a box-like frame of sufficient inside dimensions to accommodate the beam **12** therethrough with ample running clearance. Desirably, the beam **12** is of H-cross section having its flange edges located to face respectively upwardly and downwardly to provide tracks for upper rollers **18** to run along the upper tracks and lower rollers **19** to run along the lower tracks. There is a pair of the rollers **18** adjacent to each end of the carriage **17** mounted on a shaft **20** journaled in the vertical side walls of the carriage. Similarly, there is a pair of the rollers **19** adjacent to each end of the carriage and mounted on respective axle shafts **21** journaled in the side walls of the carriage. Preferably all of the rollers **18** and **19** are grooved to engage the beam flange rails with complete stability against lateral horizontal or vertical displacement relative to the beam but enabling free running of the carriage along the length of the beam.

Self-propulsion of the unit **10** is effected by means driving certain of the carriage rollers, and desirably the upper rollers **18** since they afford excellent traction upon the track beam by reason of the weight of the unit imposed on these rollers. To this end, the rollers **18** are fast upon their shafts **20**, and the shafts have end portions which extend beyond the outside of one of the side walls of the carriage **17** with respective sprockets **22**

thereon in a common plane and over which is trained a sprocket or roller chain 23 for unison driving of the shafts 20 and thereby the rollers 18. Drivingly meshing with the chain 23 is a drive sprocket 24 fixed upon a rotary shaft 25 journaled in and extending across a gear shift frame box 27 which is attached as by means of brackets 28 and 29 to the adjacent side of and supported by the frame providing the carriage 17. Longitudinally shiftably but corotatably keyed to the shaft 25 are respective bevel gears 29 and 30 adapted for selective meshing with a driving bevel gear 31 mounted on a suitable shaft extending from a transmission gear case 32 mounted on the gear shift box 27. Rotation of the driving gear 31 is in one direction so that when the bevel gear 29 is in mesh therewith, the carriage 17 is driven outwardly along the beam 12, and when the bevel gear 30 is in mesh with the driving gear 31 the carriage is driven inwardly along the beam.

For automatic shifting of the gears 29 and 30 at each opposite end of the run of the carriage along the track beam 12, a traverse rod extends in longitudinally slidable relation through respective spaced bearings 34 and 35 on respectively the gear box 27 and the gear case 32 and parallel with the beam and projecting sufficiently beyond the opposite ends of the carriage 17 and associated mechanism to engage a stop shoulder provided by a transverse outer end plate flange 37 fixed on the outer terminus of the beam 12 to shift the traverse rod for reversing travel of the carriage from outward direction to the inward direction. At the inner limit of travel of the carriage, the traverse rod 33 strikes and is shifted by a stop 38 (FIG. 1) which effects reversal of the carriage from inward travel to outward travel.

To transmit respective shiftings of the traverse rod 33 to the respective bevel gears 29 and 30, an operating arm 39 (FIGS. 6 and 7) is mounted under the gear case 32 on a pivot 40 and extends operatively across the traverse rod 33, with a shifting pin 41 fixed on the traverse rod extending through a lost motion slot 42 in the arm. Thereby the arm 39 is swung about the pivot 40 in the shifting movements of the traverse rod, with an over-center tension spring connected at one end to the free end of the arm and at its opposite end to a stud 44 located in alignment beyond the pivot 40 maintaining the arm yieldably in its opposite limit positions. Fixed on the arm 39 is a shift yoke comprising an inward shift finger 45 and an outward shift finger 37 engageable with a shift lever 48 mounted on the gear box 27 and operating a shifting yoke 49 connected with the beveled gears 29 and 30. Thus, at each end of traverse movement of the carriage 17 the traverse rod 33 appropriately shifts the bevel gears by way of the arm 39, the appropriate shift yoke finger 45 or 47 and the shift lever 48, while the over-center spring 43 holds the assembly in the appropriate gear relationship until the next shifting through the traverse rod occurs.

Driving of the carriage wheel rollers 18 and of the grain auger 11 is effected by a common prime mover mounted on and travelling with the carriage 17. While the prime mover may comprise a suitable internal combustion engine, an electrical motor 50 is advantageous. Accordingly, the auger 11 has an upward shaft extension 51 extending upwardly through the midportion of the carriage 17 adjacent to the side thereof nearest the gear box 27 and journaled in lower and upper bearings 52 and 53, respectively of which at least the upper bearing is a thrust bearing.

On the upper extremity portion of the shaft extension 51 are means for connecting the auger drivingly to the motor 50 and to the carriage driving transmission gear assembly in a manner to afford a safety factor should either the auger 11 become jammed or encounter unusual torque, or should the carriage meet an obstruction or otherwise tend to stall along its track. To this end, a suitable diameter grooved pulley 54 is fastened on the upper extremity portion of the shaft extension 51 and has trained thereover a frictional driving belt 55 running over a grooved driving pulley 57 on the shaft of the motor 50 and of sufficiently smaller diameter than the auger shaft pulley 54 to afford the desired auger speed ratio. Suitable driving tension for the belt 55 is provided by the weight of the motor 50 by having the motor mounted on the upper end portion of the bracket plate 58 connected through a horizontal hinge 59 to the lower end portion of the opposite side of the carriage 17 from that which the auger is mounted. By free-hinging the bracket 58, outward swinging gravity of the motor 50 sufficiently tensions the drive belt 55 to drive the pulley 54 and thereby the auger shaft, but should the auger stall or slow down for any reason, the belt 55 may slip and thus avoid overloading the motor 50.

Driving of the carriage motivating gear system is effected through a small diameter pulley 60 fixed on the auger shaft extension 51 and having trained thereover a frictional driving belt 61 which engages with and drives a large grooved pulley 62 fixed on a rotary shaft 63 depending through the top of the gear case 32 for driving the transmission gears therein and through them the driving gear 31. Should the carriage stall or be retarded in normal movement, and the grooved roller wheels 18 do not slip to relieve the driving torque, the belt 61 may slip to afford such safety relief to avoid straining or damage to the driving system.

Power from the motor 50 also motivates the beam 12 along the rail 13. For this purpose a connection is made with the motor through the transmission gearing in the gear case 32 from the side which nearest the outer end of the beam 12 extends a drive shaft 64 on which is mounted a driving sprocket 65 over which is trained a sprocket chain 67 in mesh with a driven sprocket wheel 68 which is corotatably but longitudinally slidably mounted on a square shaft 69 extending in parallel relation between the beam 12 and the gear box 27 and gear case 32, with an outer end portion journaled in the end flange plate 37 and an inner end portion journaled on the bracket 38. To keep the driven sprocket 68 in alignment with the driving sprocket 65 while travelling along the shaft 69, oppositely extending hubs on the sprocket 68 are retainingly confronted by respectively the adjacent end portion of the frame of the carriage 17 and a retaining bracket 70 which is mounted on the carriage. Rotation of the shaft 69 drives a corotative sprocket 71 on the end of the shaft which extends through the flange plate 37 and over which is trained a sprocket chain drivingly running over a larger sprocket 73 corotative with a grooved roller 74 which runs on the rail 13 and is mounted on a stub shaft 75 carried by the flange plate 37 on a portion thereof which extends beyond the opposite side of the beam 12 from that along which the shaft 69 extends. In addition, an idler grooved running roller 77 runs along the rail 13 and is carried by a stub shaft 78 mounted on the flange plate 37 preferably above the pulley 68. Through this arrangement, the beam is caused to advance along the rail 13 as the auger 11 operates and as the carriage 17 travels along the beam 12.

By having only the roller 75 which is at the opposite side of the beam 12 from the auger 11 power driven, and having the beam driven thereby in a direction toward the auger, namely in a clockwise direction as viewed in FIGS. 1 and 5, an important safety feature is afforded should the auger encounter unusual resistance such as a compaction of grain or hard spot therein which may tend to resist advance of the auger in the direction of movement of the track beam. The tendency of the auger 11 under such a condition is to lag behind the beam movement. Such resistance to advance of the auger results in a twisting leverage tending to turn the carriage 17 about the axis of the beam 12, and since the beam is thoroughly engaged by the multiple sets of running wheel rollers 18 and 19, this tends to twist the beam 12 about its axis, whereby the driven beam roller 74 lifts slightly from the

rail 13 about a fulcrum provided by the roller 77 so that traction of the driven roller 74 is released and it slips relative to the rail whereby the beam advance is stopped until the auger has bored its way through its resistance and normal operation is resumed by relief from the twisting leverage and normal advance of the beam through the driven roller 74 resumes.

To avoid undesirable pile-up at the upper end of the auger 11, there is desirably provided a spreading arm or sweep 79, projecting to a substantial extent at opposite sides of and corotative with the upper end portion of the auger under the bearing 52.

In order to avoid possible pile-up of grain on the horizontal web of the beam 12, it is desirably provided with substantial clearance openings 80 therethrough at suitable intervals as best seen in FIG. 5.

In a desirable arrangement, the inner end portion of the track beam 12 is suspended from the central portion of the roof 15 of the bin in a manner enabling the shuttle unit 10 to travel inwardly far enough to bring the auger 11 to substantially dead center C (FIG. 1). For this purpose, the inner end portion of the beam 12 which extends inwardly beyond the center line C is suspended by means of a hanger bracket 81 which is adapted to be secured to the beam adjustably along the length of the inner end portion as by means of one or more bolts 82, the beam being provided with a plurality of longitudinally spaced bolt holes 83 to accommodate adjustments for different sizes and more particularly diameters of bin. On its upper end the bracket 81 is pivotally hung on a swivel thrust bearing 84 carried by depending stem 85 on a head bar 87 flexibly suspended as by means of a pair of chains 88 from the central portion of the roof 15, as by connecting the same to a ring structure 89 about a fill or exhaust opening. Through this arrangement movement of the beam 12 about the axis of the hanger pivot stem 85 on the center line C is enabled for various diameters of bin with a standard length of track beam suitable for a substantial range of bin diameters, with the hanger bracket 81 and the stop flange 38 suitably positioned to permit inward travel of the shuttle unit 10 to bring the auger 11 to substantially the center C of the bin in each traverse cycle.

Electrical energy for operating the motor 50 is supplied from a suitable source through an electrical cable 90 attached thereto and supported in suitable clearance relation relative to the path of movement of the shuttle unit 10 by a cantilever arm or rod 91 carried by the upper end of the hanger bracket 81 and extending to about half way along the track beam from the hanger. Twisting of the electrical wires in the cable is prevented by connection of the cable 90 through a swivel connector 92 on the lower end of the hanger stem 85 and through which connection with source of electrical energy is made by way of a lead-in cable 93 which may conveniently extend down through the stem 85 where the latter is tubular. It will be understood, of course, that suitable control switch means may be provided at a convenient operating point, and that other usual electrical control and safety means may be employed in the circuit, such as fuses, overload cut-out switch means, timers and the like.

Operation of the circulator is desirably such as to effect adequate stirring and circulation of the grain related to drying heat and air input to attain the desired results of attaining a uniform preferred moisture content. For example, in a bin of about 30 ft. in diameter, a complete revolution of the stirrer about every six hours has been found desirable. In such a bin a rotary advance of about two inches per minute and shuttle travel of one and a half to one and three quarters inches per minute may be effected. The drying and grain circulation are continued until the grain, at least in the case of corn, is reduced to a moisture content of about 15% to 16%. Thereafter, if the grain is to be stored for any length of time, the circulator may be shut off but operated for a revolution at a week to ten day intervals.

Where the inside wall 14 is of corrugated metal having the corrugations running circumferentially, the lower end of the auger 11 is desirably calculated to be sufficiently above the bottom of the bin, which may be perforated for drying air circulation, to compensate for grain-weight-induced vertical compression shrinkage or "squatting" of the bin wall. Where the lower end of the auger is about four inches above the bin floor when empty, adequate clearance is afforded for such height shrinkage in a full bin to bring the lower end of the auger close to the floor.

As the present circulator operates, the auger 11 is caused to move in circulating and stirring relation through the grain in a cyclical path describing generally lanceolate loops extending from the bin center to the outer end of shuttle traverse along the slowly advancing track beam 12, substantially as shown in FIG. 2. Inasmuch as the track beam advances continuously during normal operation and in the absence of any unusual resistance to travel of the auger, the loops are along substantially uniform arcs of movement between the traverse limits, both on the outward run and on the inward run of each traverse cycle of the shuttle unit 10.

In bins of up to 20 ft. in diameter a single shuttle unit 10 will be generally found adequate, as shown in FIG. 2. In bins over 20 ft. and up to 30 ft. in diameter, desirably two of the shuttle units 10 are employed, and in bins over 30 ft. in diameter, three of the shuttle units should be used for best results. The reason for this is that in a 20 ft. bin about half the grain volume is within a circle or zone about 5 ft. from the center and the remaining grain in an outer 5 ft. zone. In a 30 ft. bin about half the grain volume is in the outer 5 ft., and in bins of over 30 ft. up to half the grain volume is in the outer 5 ft. In view of increasingly efficient drying systems bins up to 36 ft. are becoming more common. A distinct advantage of the arrangement of the present invention is that a plurality of the shuttle units 10 may be operated on the same track beam 12, with reversing stops suitably disposed therealong. In such an arrangement, only the outermost of the plurality of units 10 need operate the beam drive through the square drive shaft 69. Although in all instances the inner one of the shuttle units 10 runs the auger in the lanceolate stirring loop pattern path in its zone of operation the outer of the shuttle units operate the augers thereof in a generally saw-tooth respective path in its zone. In each instance after a complete revolution of the track beam, the grain has been well stirred and circulated throughout the mass. Depending upon the initial moisture content of the grain filled into the bin, it may require several revolutions of the circulator as the drying progresses until the desired moisture content has been reached.

Because of the rugged stabilized construction of the present grain circulator and the self-correcting operation in respect to auger resistance, it is practicable to increase the diameter ruggedness and operating efficiency of the auger as compared with prior constructions. For example, the auger may have a shaft of about 1¼-inches with a ¾-inch spiral vane and the motor 50 may be of about 2 H.P., thus affording ample power to drive the large capacity auger. In order further to increase the efficiency of the auger the outer edge of the spiral vane is desirably provided with a chamfered lead of about 10° rather than the conventional square edge.

Because the auger shaft is journaled in ruggedly stabilized relation in the substantially spaced apart upper and lower walls of the box-like carriage frame 17, with the uppermost bearing 53 substantially above the height of the track beam and the lowermost bearing with the lower wall of the frame fairly close to the lower side of the beam, exceptionally low head room under the track beam enables substantial increase in bin capacity, a mounting in a typical instance to about six inches greater depth of grain where the present circulator is used.

In addition to the self-correcting operation as described in respect to the auger, and the safety factors afforded by the sliding relief of the drive belts during emergencies, another fail safe feature is present should one of the drive belts **55** or **61** break or otherwise fail to function properly. If the main drive belt **55** fails to function such as by breaking, the motor **50** will merely run free and without any overload, a suitable headed stop rod **94** (FIGS. 5 and 7) retaining the hinge motor mount bracket **58** to a limited range of outward swinging movement. Should the drive belt **61** fail to function or break, driving of the shuttle unit and the track bar will stop and while the auger **11** may continue to run idle, overload on the motor **50** is entirely avoided.

It will be understood that variations and modifications may be effected without departing from the spirit and scope of the novel concepts of this invention.

I claim as my invention:

1. A grain circulator for use within a storage bin having an upright wall and a roof and adapted for receiving a substantial depth of grain therein, with a horizontal rail mounted along the inside of said wall above a maximum level of the grain mass:

(a) a track beam having roller means on one end for running on said rail, and for extending inwardly therefrom above said level;

(b) means for supporting the opposite end of said beam;

(c) a shuttle unit mounted to travel along said beam, having a rotary grain elevating auger depending therefrom to elevate and stir the grain in said mass, and a prime mover for rotatably driving the auger;

(d) means motivated by said prime mover for effecting travel of said unit along said beam; and

(e) means also motivated by said prime mover for driving said roller means to advance the beam along said rail.

2. A grain circulator according to claim **1**, in which said beam is of H-transverse cross section providing spaced upper and lower rail flanges, said shuttle unit having aframe through which said beam extends, and rollers on said frame engaging said track flanges, certain of said rollers being driven by said means for effecting travel of said shuttle unit.

3. A grain circulator according to claim **2**, having reversing means operable at each opposite end portion of said track beam to reverse the driving direction of said driven rollers.

4. A grain circulator according to claim **3**, in which said reversing means comprise a traverse rod extending parallel to said beam, and respective stops longitudinally spaced relative to said beam engagable by said traverse rod for shifting the traverse rod longitudinally to effect said reversal of roller drive.

5. A grain circulator according to claim **4**, having a gear transmission including shiftable bevel gears and means operated by said traverse rod for shifting the bevel gears.

6. A grain circulator according to claim **1**, said means for driving said roller means comprising a square shaft rotatably mounted on said beam, a shaft-driving member longitudinally slideably but corotatively mounted on said shaft, and means for moving said member longitudinally along the shaft with the shuttle unit.

7. A grain circulator according to claim **1**, said roller means comprising rollers spaced from one another along said rail and with their axes respectively located adjacent to opposite horizontally facing sides of said beam, said auger being mounted on said shuttle unit adjacent to one of said sides, and said means for driving said roller means being connected to drive only said roller which has its axis adjacent to the opposite of said sides to advance the beam and thereby said shuttle unit along said track in a direction toward the other of rollers, whereby unusual resistance to movement of the auger through the grain mass causes a torque reaction in said beam fulcruming on said other roller and disengaging said driven roller from the rail until the resistance has been overcome and the torque relieved.

8. A grain circulator according to claim **1**, said prime mover having an upright mounting plate, said shuttle unit including a frame having upper and lower portions, means pivotally connecting a lower portion of said mounting plate to the lower portion of said frame such that the prime mover and plate tending to swing gravitationally away from the frame, said auger having a shaft portion journaled on said frame spaced from said plate and an endless flexible driving mens connecting said shaft portion and said prime mover and maintained under driving tension by the weight of the prime mover tending to swing away from said frame.

9. A grain circulator according to claim **1**, said shuttle unit comprising a carriage frame through which said beam extends and having substantially spaced apart upper and lower portions, respective bearings on said upper and lower portions, and said auger having a shaft portion supported and journaled by said bearings.

10. A grain circulator according to claim **9**, said shaft portion having thereon means drivingly connecting the same with said prime mover, and also having thereon means for transmitting prime mover power to said means for motivating said shuttle unit.

11. A grain circulator according to claim **9**, said shaft portion having thereon means drivingly connecting it with said prime mover, and also having means for transmitting motive power from the prime mover to said means for driving said roller means.

12. A grain circulator for use within a storage bin having an upright circular wall and a roof and adapted for receiving a substantial depth of grain therein, with a continuous circular horizontal rail mounted along the inside of said wall adjacent to the roof:

(a) a track beam having means on one end for running on said rail and having an opposite end portion for extending inwardly beyond the vertical center line of the bin;

(b) a shuttle unit mounted to travel along said beam and having a rotary grain elevating auger depending therefrom to operate in a grain mass in the bin;

(c) means for driving said grain auger and for driving the shuttle back and forth along said beam, and for advancing the beam along said track; and

(d) means for supporting said inner end portion of the beam from said roof and spaced beyond said center line so that at the inner end of its traverse the shuttle unit carries said auger to substantially said center line.

13. A grain circulator according to claim **12**, having means for adjustably securing said supporting means along the length of said inner end portion of the beam for accommodating the length of travel of the shuttle unit for different diameters of bins in which the circulator may be installed and in each adjustment enabling the shuttle unit to carry the auger to substantially the center of the bin.

14. A grain circulator for use within a storage bin having upright wall and roof structures and adapted for receiving a mass of grain therein, with a horizontal rail mounted along the inside of the wall structure adjacent to the roof structure:

(a) a track beam having means on one end for advancement of the beam along the rail and the beam having a length for extending inwardly from the rail to the vertical center of the bin;

(b) means for supporting the inner end portion of the beam adjacent to said center; and

(c) a plurality of shuttle units mounted to travel along said beam and having respective grain elevating augers depending therefrom to work in the grain mass;

(d) respective means for driving said shuttle units along said beam; and

(e) means for controlling travel of one of said shuttle units from adjacent the center of the bin to a predetermined point along the beam spaced from the center and for controlling the operation of another of said units from said predetermined point to a second predetermined point therebeyond along the beam.

15. A grain circulator according to claim **14**, including a third shuttle unit on said beam, and means for controlling operation of said third unit between said second predetermined point and the rail end portion of the beam.

16. In means for circulating a mass of grain in a bin having a clearance space above the mass:

(a) a first unit in said space having an auger operative to stir and circulate grain in one zone of said mass in a generally lanceolate loop cyclical path; and

(b) a second unit having an auger operative to stir and circulate grain in another zone of said mass in a generally saw tooth cyclical path.

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ROBERT W. JENKINS, *Primary Examiner.*

U.S. Cl. X.R.

259—102