June 16, 1964 P. L. STEFFENSEN 3,137,398

APPARATUS FOR FEEDING PELLETS

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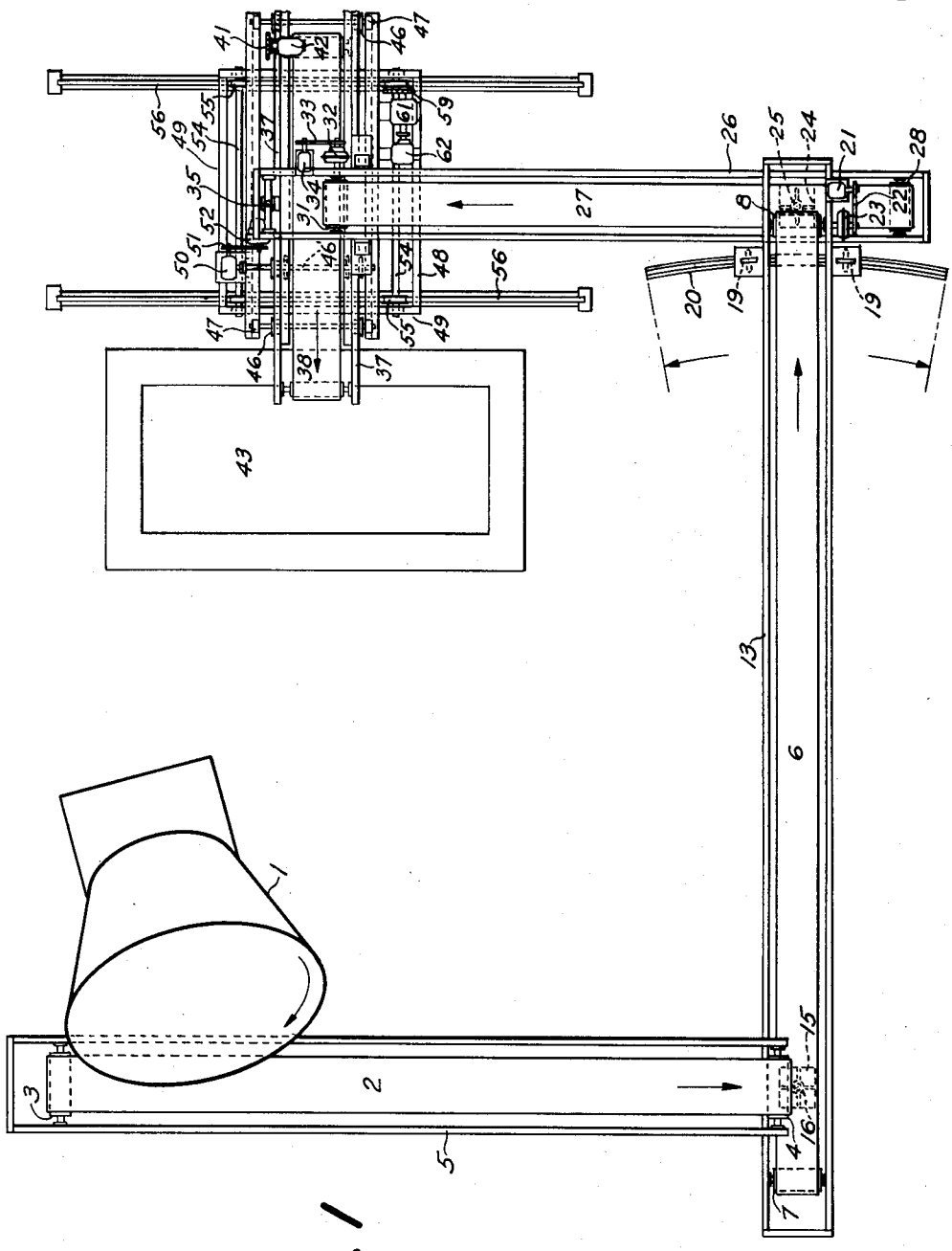


Fig. 1

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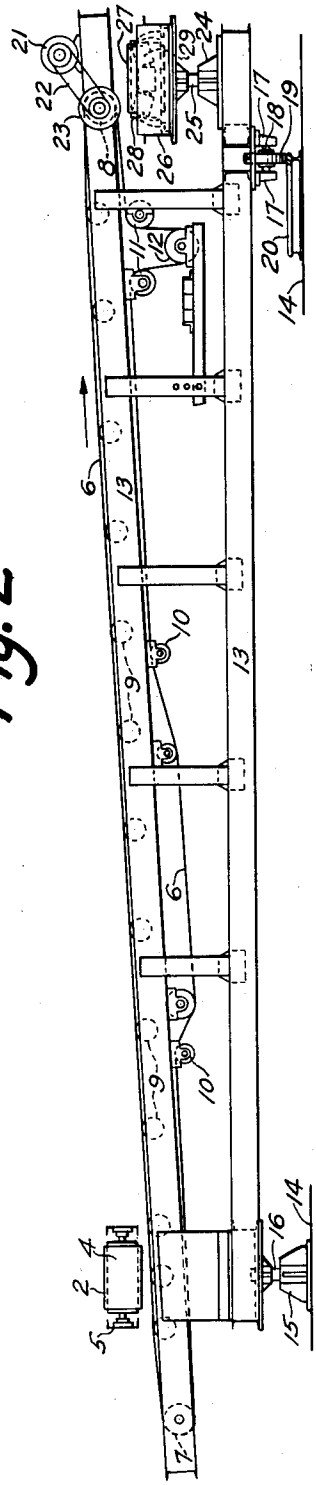


Fig. 2

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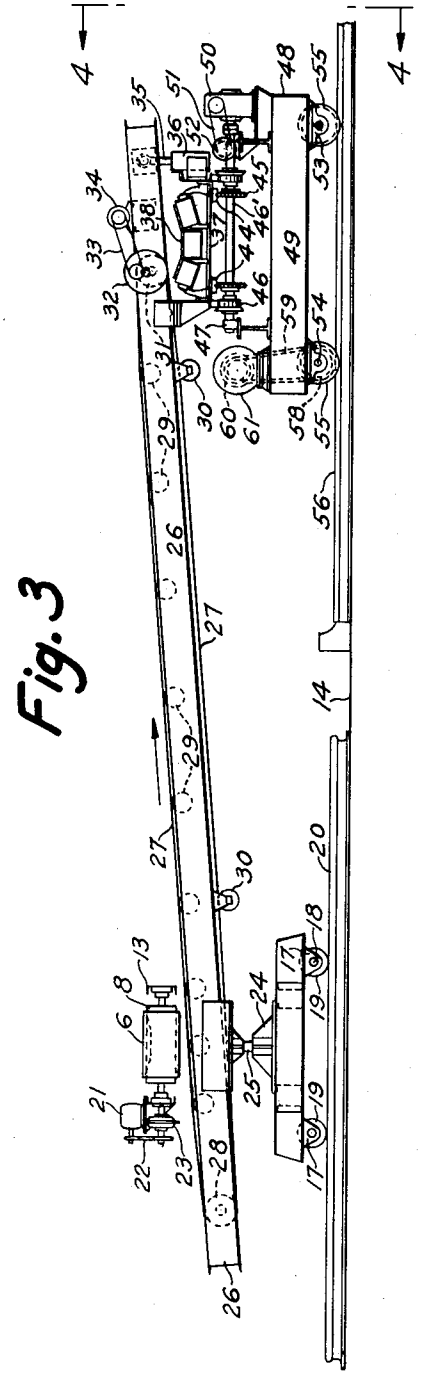


Fig. 3

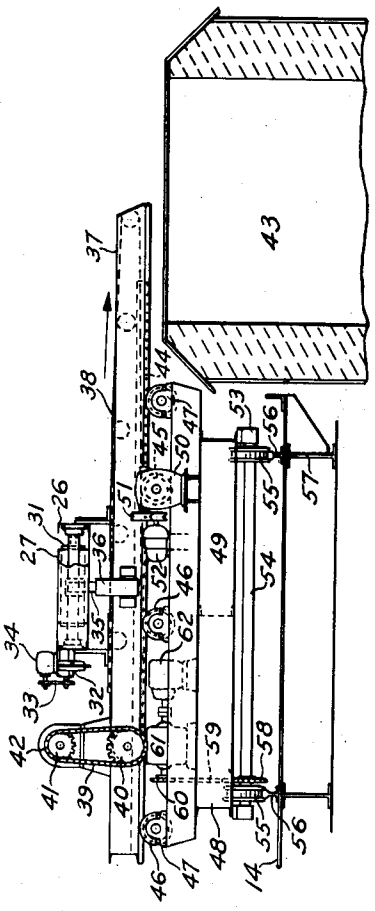


Fig. 4

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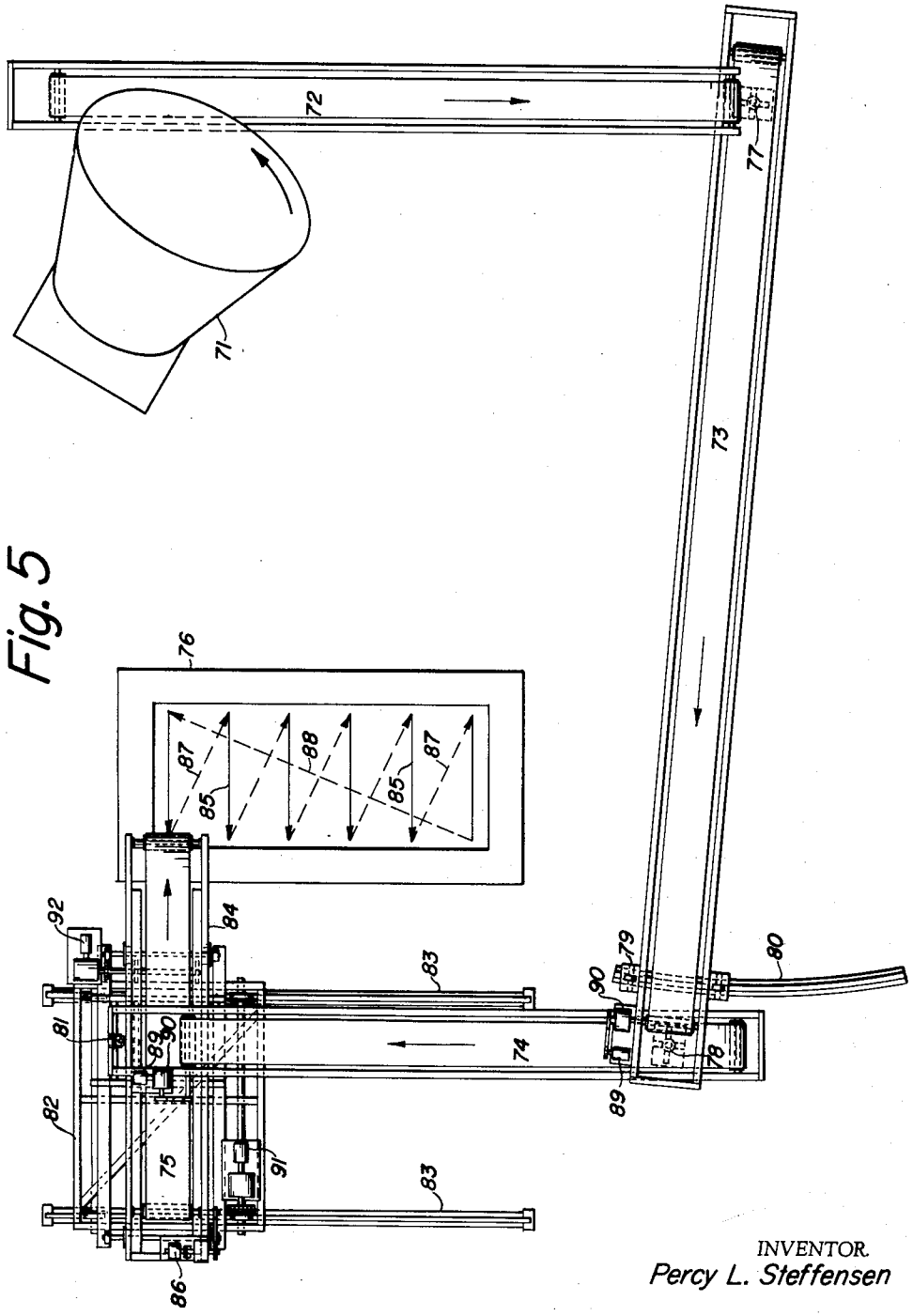
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June 16, 1964 P. L. STEFFENSEN 3,137,398

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Fig. 5



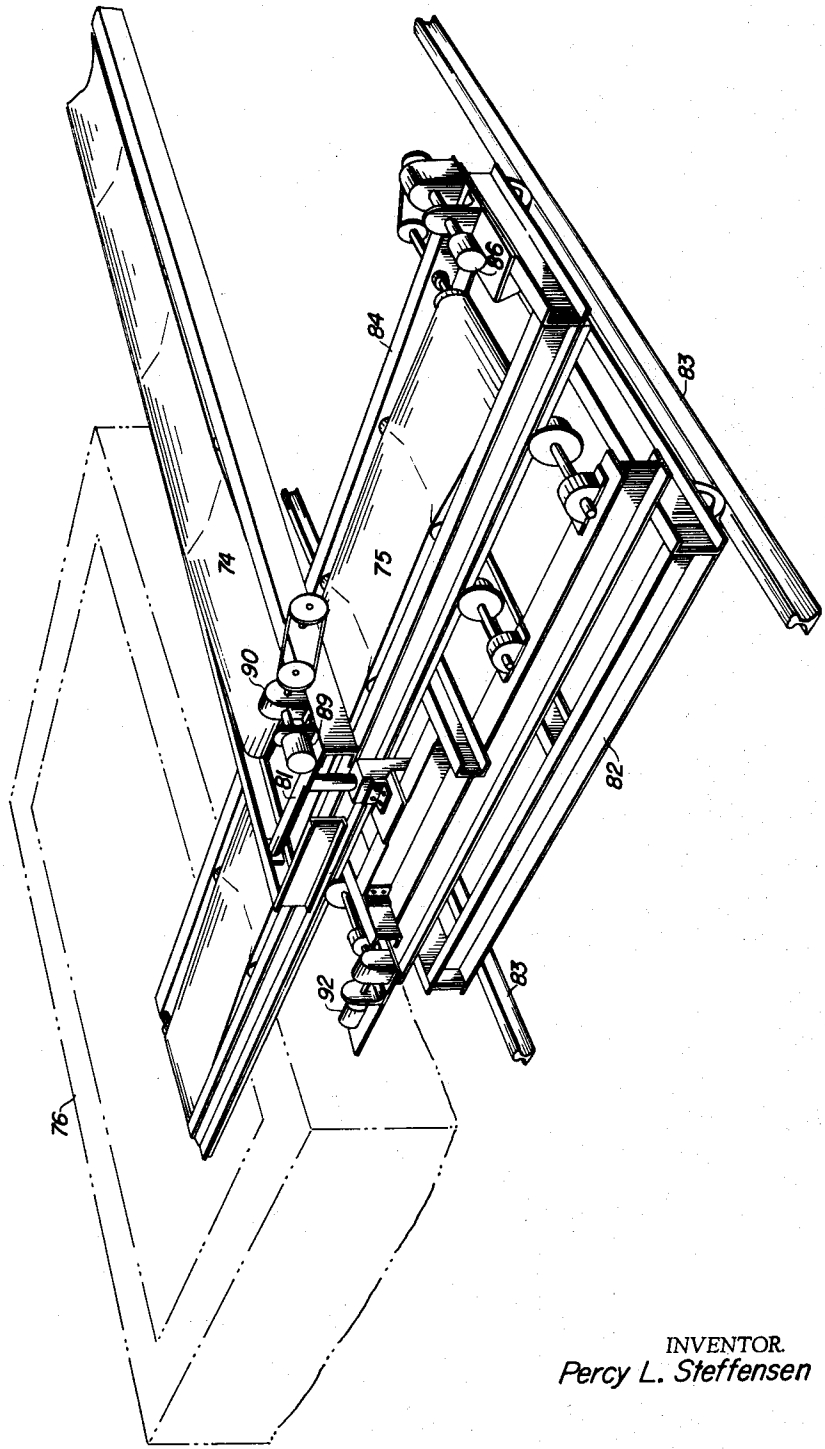
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Fig. 6



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Fig. 7

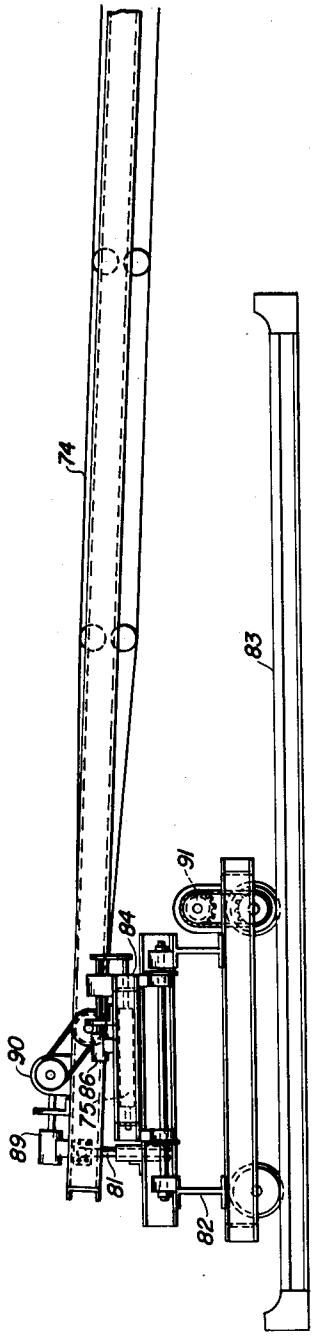
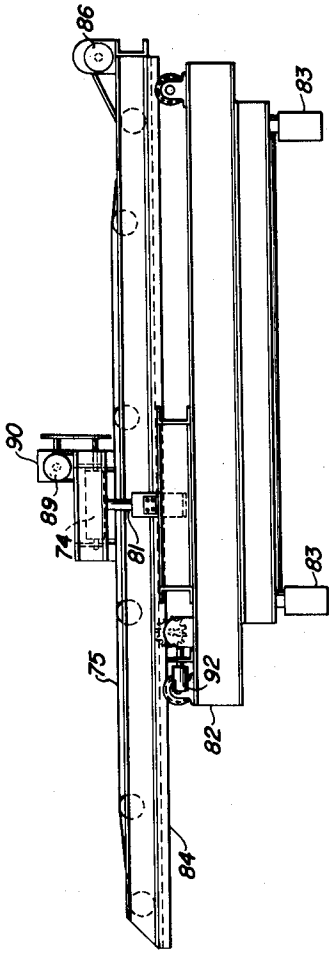


Fig. 8



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United States Patent Office 3,137,398 Patented June 16, 1964

3,137,398

APPARATUS FOR FEEDING PELLETS

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Filed Aug. 7, 1962, Ser. No. 216,946
12 Claims. (Cl. 214—18)

This application relates to apparatus for feeding fragile small objects, such as iron ore pellets, to a rectangular shaft furnace, and is a continuation-in-part to my copending application Serial No. 848,276, filed October 23, 1959, for Pellet Feeder, now abandoned.

In the induration of fragile raw pellets of finely divided mineral particles, such as iron ore concentrates and the like, in a shaft furnace, it is required that they be charged in a manner such that the furnace is evenly filled.

The present application is particularly concerned with the problem of obtaining even distribution of pellets across the entire cross-section of the top of a rectanglar shaft furnace by means of a series of traveling belt conveyors.

Depending largely on the special proportions and dimensions of the individual rectangular furnace, it is possible for feeding from the last belt into the furnace to be either continuous or intermittent, in accordance with the pattern of feed path which it is desired to have traveled by the discharge end of that belt.

It is an object of this invention to provide conveyor means which produce uniform charging of material within a rectangular furnace very simply and without excessively expensive and complex installations of equipment.

Another object is to provide traveling conveyor means which will receive material from a stationary point and discharge it from a moving belt in fixed angular relation to the sides of a rectangular furnace.

Still another object is a feeder which maintains a rectangular feed path.

A further object is a feeder which deposits uniform layers of pellets from a reciprocating belt in successive parallel strips or rows across the full width of a shaft furnace.

Other objects, purposes, and advantages of the invention will appear hereinafter in the specification and claims, and in the annexed six (6) sheets of drawings,

In the drawings:

FIGURE 1 is a top plan view illustrating the overall arrangement of one embodiment of the invention, and showing the travel of feed material from pelletizing apparatus over a succession of linked conveyors to a rectangular shaft furnace;

FIG. 2 is a side elevation of the long first conveyor, showing its receiving end supported on the stationary pivot at the left of the figure and its discharge end on the wheel and curved track beneath the first movable pivot;

FIG. 3 is a side elevation of the second or intermediate conveyor, with its receiving end on the above-mentioned movable pivot at the left of the figure and its discharge end on a second movable pivot to the moving carriage on the shuttle car;

FIG. 4 is an end elevation of the shuttle car carrying the last conveyor;

FIG. 5 is a top plan view showing the general relationship of the furnace and conveyor belts in a modification of the feeder;

FIG. 6 is a perspective view of said modification showing the second belt, the shuttle car, and the third belt thereon;

FIG. 7 is a side elevation showing the pivotal mounting on the shuttle car supporting the discharge end of said second belt; and

FIG. 8 is an end elevation of the shuttle car with the third belt.

Referring initially to FIG. 1 of the drawings, raw pellets formed in a revolving cone 1 or other balling device may for convenience fall onto the moving conveyor belt 2 with a tail (idler) pulley 3 and head (driving) pulley 4 journaled in a stationary structural steel frame 5. This belt 2 serves to convey pellets from the balling devices onto the receiving end of the long first pivoted conveyor belt 6 of the invention. As shown in FIG. 2, said belt 6 extends between its tail pulley 7 and head pulley 8, with upper troughed idlers 9 and lower return idlers 10, bend pulleys 11, and adjustably weighted take-up pulley 12 all supported on a structural steel frame 13. On the floor 14 beneath the feed end of the belt 6 is the stationary pivot base 15 in which the pivot pin 16 supports the tail end of the frame 13. The head end of said frame 13 has beneath it bearings 17 for the shafts 18 of the rollers 19 resting on the arcuate rails 20 on the floor 14. The head end of said frame supports a conveyor belt drive motor 21 connected by a drive belt 22 and shaft-mounted speed reducer 23 to the head pulley 8; it also supports a pivot base 24 for the pivot pin 25 supporting the structural steel frame 26 for the receiving end of the second or intermediate conveyor belt 27. As in the case of the preceding belt 6, this belt 27 has a tail pulley 28, upper troughed idlers 29, lower return idlers 30, and a head pulley 31 driven through the speed reducer 32 and drive belt 33 by the conveyor belt drive motor 34 (FIG. 3).

The discharge end of the intermediate conveyor belt 27 is mounted on a second pivot pin 35 carried by the member 36 which is attached to the frame 37. Mounted on frame 37 is a conveyor belt 38 which is driven by chain 39, sprockets 40 and 41 and motor 42.

Beneath frame 37 is the carriage or shuttle car 49 having a movable frame 48 provided with bearings 53 in which are journaled shafts 54 which carry wheels 55. Wheels 55 are supported on rails 56 which are mounted on base 57 parallel to the length of furnace shaft 43.

Secured to frame 48 is motor 62 for driving the shuttle car 49 in either direction on tracks 56 through speed reducer 61, sprockets 58 and 60 and chain 59.

Frame 37 rests upon wheels 46 carried on shafts 46' mounted in bearings 47 on the frame 48 of shuttle car 49. Also mounted on one of said shafts are the pinions 45 which mesh with racks 44 on the bottom of frame 37. Pinions 45 are driven in either direction by means of motor 52, belt 51 and gear reducer 50.

By means of motor 62 the shuttle car 49 can be moved along the side of furnace 43 carrying with it the frame 37 and conveyor belt 38.

By means of motor 52 the frame 37 and conveyor belt 38 can be reciprocated over the furnace 43.

By suitably regulating the operation of motors 52 and 62 the discharge end of belt 38 can be moved over the furnace 43 and may feed continuously in any desired pattern to assure proper loading of the furnace 43.

It will be apparent that as belt 38 is traversed by movement of the shuttle car 49 on tracks 56, or reciprocated by means of the motor 52, rack 44 and pinions 45, the belt 6 is moved around its pivot 16 and the belt 27 is moved around its pivot 25.

The direction and distance of travel of shuttle car 49 and frame 37 may be controlled by conventional limit switches and tripper arms (not shown).

Means are provided to control the speed of the shuttle car 49 in accordance with the height of the material in the furnace. These means may be of the type shown in Patent No. 2,792,132 to Fred D. De Vaney and Donald Beggs, issued May 14, 1957, a rider being suspended from the outer end of frame 37. During normal operation the rider contacts the top of the pellets in the furnace and com-

pletes an electrical circuit driving the shuttle car 49 at normal (high) speed. When a low spot is reached by the rider it modifies the electrical circuit so as to drive the shuttle car 49 at low speed.

The speed of reciprocation of the frame 37 with the belt 38 can be similarly controlled, if desired, by utilizing the rider to control the speed of the motor 52.

By the use of the three conveyor belts 6, 27 and 38, mounted and driven as shown and described, the discharge end of the belt 38 can always be maintained at right angles to the sides of the furnace. This feature has been found to promote the even distribution of the feed and is particularly useful in charging a rectangular furnace of the type shown.

In the modification of the invention shown in FIG. 5, the mechanical elements are essentially similar, but the feeding is preferably intermittent, with the path of the discharge end of the last belt over the furnace being shown in solid lines to indicate periods of actual feeding, and long and short diagonal movements without feeding being shown in dotted lines.

According to said modification of the invention, pellets formed in the balling cone 71 or other pelletizing device pass successively over the belts 72, 73, 74 and 75 while the furnace 76 is being fed. It will be understood that each belt has a conventional supporting frame. As the fixed belt 72 can be omitted if desired, belt 73 is hereinafter regarded as the first belt. The feed-receiving end of said belt 73 is mounted to swing laterally on a fixed vertical pivot 77, while its discharge end is supported as in the preceding arrangement on the first movable pivot 78 on a wheeled support 79 on the arcuate track 80.

The discharge end of said second belt 74 is firmly supported on a second movable pivot 81, the mounting of which differs from the previous arrangement in that its position has been changed slightly to enable it to be attached directly to the wheeled shuttle car or first carriage 82 so as to render it movable therewith. Said carriage 82 is adapted to reciprocate on the straight tracks 83 alongside the open top of the furnace 76. Said carriage 82 also supports a laterally movable frame or second carriage 84 on which the third belt 75 is mounted for receiving feed from the discharge end of said second belt 74 and charging it into said furnace 76.

The discharge end of this third or last belt 75 may be provided with a "flipper" and/or contact probe or "rider" as previously described.

Said discharge end of the belt 75 functions to deposit substantially uniform layers of pellets in successive feed passes 85 of parallel strips or rows across the width of the furnace 76. For this purpose, the last belt 75 supplies feed to the furnace only during the direct outward passes of the belt 75 over the furnace. The belts 72, 73 and 74 are continuously driven in the same direction, but the drive motor 86 for the last belt 75 is stopped and its feeding to the furnace interrupted during the short diagonal movements 87 and the long diagonal movements 88 produced by the travel and recycling of the carriages 82 and 84.

The belts 72, 73 and 74 may be continuously driven while the feeder is operating by their respective belt drive motors 89 and gear reducers 90. Said motors 89 may well be of any efficient standard electrical or hydraulic type of the necessary rating.

While arrangements of multi-speed and reversible electric motors and limit switches may obviously be used for driving the first carriage 82, the second carriage 84 and the last belt 75, it is preferable for the motors 91, 92 and 86 for these functions to be actuated hydraulically, because of the inherent quick response and simplicity of control with conventional arrangements of solenoid valves and flow control valves and limit switches (not shown).

Although these arrangements are not specifically claimed, it will be understood that fixed upright tripper arms (not shown) may be located at desired intervals along the track 83 and on the first carriage 82, so as to trip suitable limit switches mounted on the undersides of the carriages 82 and 84. Such limit switch arrangements are disclosed, for example, at column 5, lines 26–41, of the U.S. patent to Haley et al., 2,709,530, issued May 31, 1955. The relative positions of the limit switches and their respective tripper arms may obviously be modified as space or convenience may require. These devices may be used either to start, stop, reverse and change speeds of electric motors directly, substantially as shown in that patent, or to energize and de-energize conventional solenoid-actuated valves and motor-driven pumps so as to start, stop and reverse the flow of fluid through ordinary piping to hydraulic motors at velocities set by standard flow control valves. For suitable hydraulic circuits therefor, see any of the following standard texts: J. J. Pippenger and R. M. Koff, Fluid Power Controls (New York, 1959); J. J. Blackburn, G. Reethoff and J. L. Shearer, Fluid Power Control (New York, 1960) or E. E. Lewis and H. Stern, Design of Hydraulic Control Systems (New York, 1962).

In a typical installation of this modification of the feeder, the two belts 73 and 74 may have a constant belt speed of 133 f.p.m. The last belt 75 may have two belt speeds, e.g. 90 f.p.m. for high belt speed and 75 f.p.m. for the low speed. The second carriage 84 may also have two speeds, e.g., 45 f.p.m. or 30 f.p.m. There is of course no feeding while the first carriage 82 is moving along track 83.

Each feed pass 85 of the last belt 75 over a typical 6-foot wide furnace will then require 8 seconds at 45 f.p.m. or 12 seconds at 30 f.p.m., for one-way movement of the second carriage 84 laterally away from the furnace upon the first carriage 82. Each of the long and short diagonal movements 87 and 88 during the non-feeding periods is accomplished in 8 seconds of travel of said carriage 84.

In the non-feeding periods, the motor 86 is stopped while the belt 75 is being moved inward due to the inward movement of its carriage 84 by the motor 92. The preceding belts 73 and 74 will continue to feed pellets at 133 f.p.m. to the last belt 75.

During the non-feeding diagonal movements shown in dotted lines in FIG. 5, the second carriage 84 moves inwardly at 45 f.p.m., and the loading on the then stationary belt 75 is thus at a relative speed of 45 f.p.m.

During the periods of actual feeding to the furnace 76, the last belt drive motor 86 is actuated and the second carriage motor 92 is reversed. The second carriage 84 then moves outwardly, and its speeds of 30 or 45 f.p.m. are in effect subtracted from the speed of the opposite direction travel of 75 or 90 f.p.m. of the top surface of the last belt 75. That belt is thus still being loaded at a relative speed of 45 f.p.m.

The above-described manner of operation, of course, requires the last belt-drive motor 86 to be rotatable in one (forward) direction at two speeds, and the two carriage motors 91 and 92 to be reversible.

The load of material per unit length of the final belt 75 thereby remains substantially constant throughout the operation of the feeder. This arrangement avoids the piling of an excessive quantity of pellets on the belt 75 at any time, while permitting interrupted feeding with uniform charging to the furnace.

It should be noted that in both of the disclosed embodiments of this invention there are required to be three conveyor belts, which are in association with an initial fixed pivot and two subsequent movable pivots, and that during feeding the discharge end of the last conveyor belt is always in fixed angular relation to the sides of the rectangular shaft furnace to which it feeds, so that charging proceeds with uniform layers of pellets being deposited over the entire top area of the furnace.

I claim:

1. An apparatus for conveying material to a rectangular opening, including:

(a) three conveyors each having a receiving end and a discharge end,

(b) the first conveyor having its receiving end mounted on a stationary pivot,

(c) the second conveyor having its receiving end attached to the discharge end of the first conveyor through a first movable pivot,

(d) the third conveyor having its receiving end attached to the discharge end of the second conveyor through a second movable pivot,

(e) means supporting the third conveyor and adapted to move longitudinally of the opening, and

(f) means supporting the second movable pivot and moving said third conveyor transversely across the opening for delivering material through a predetermined path.

2. An apparatus for conveying material, including:

(a) three conveyors each having a receiving end and a discharge end,

(b) the first conveyor having its receiving end mounted on a stationary pivot,

(c) the second conveyor having its receiving end attached to the discharge end of the first conveyor through a first movable pivot,

(d) the third conveyor having its receiving end attached to the discharge end of the second conveyor through a second movable pivot,

(e) carriage means on which the third conveyor is supported, and

(f) reciprocating means supporting the second movable pivot and coacting with the carriage means for moving the discharge end of the third conveyor through a predetermined rectangular path and in fixed angular relation to the sides of a receptacle.

3. An apparatus for feeding material into a rectangular opening, said apparatus including:

(a) a plurality of conveyors each having a receiving end and a discharge end,

(b) the first one of said conveyors having its receiving end mounted on a stationary pivot,

(c) means supporting the discharge end of said conveyor for movement arcuately around said pivot,

(d) a second conveyor having its receiving end attached to the discharge end of the first mentioned conveyor through a first movable pivot,

(e) a third conveyor having its receiving end attached to the discharge end of the second conveyor through a second movable pivot,

(f) a carriage adapted to be reciprocated longitudinally of the rectangular opening and supporting the third conveyor, and

(g) means on the carriage for reciprocating the discharge end of the third conveyor transversely over the rectangular opening in fixed angular relation to the sides thereof.

4. The apparatus defined in claim 3, in combination with a reversible motor driving the carriage and constituting means for shifting the relative position of the first and second conveyors.

5. The apparatus defined in claim 3, wherein each conveyor comprises a conveyor belt and a supporting frame.

6. An apparatus for feeding material to a rectangular shaft furnace, comprising:

(a) a supporting floor,

(b) a stationary pivot on said floor,

(c) a first conveyor having its receiving end mounted on said stationary pivot,

(d) wheeled means supporting the discharge end of said first conveyer and a second pivot,

(e) a second conveyor having its receiving end mounted on said second pivot,

(f) a straight track in parallel spaced relation to the longer axis of the shaft furnace,

(g) a carriage adapted to traverse said track,

(h) a laterally movable frame mounted on the carriage at a right angle to the track,

(i) a pivot on the frame supporting the discharge end of the second conveyor,

(j) a third conveyor on the frame receiving feed from the discharge end of the second conveyor and distributing it over the top opening of the shaft furnace,

(k) means for shifting the frame laterally with respect to the carriage while the carriage is being reciprocated, and

(l) means for reciprocating the carriage on the tracks.

7. An apparatus for feeding material over the upper rectangular opening of a shaft furnace, comprising:

(a) a series of conveyors each having a receiving end and a discharge end,

(b) a stationary pivot,

(c) one of said conveyors having its receiving end mounted on said stationary pivot,

(d) wheeled means supporting the discharge end of said conveyor for movement around said pivot,

(e) a single arcuate track directing and supporting said wheeled means,

(f) a first movable pivot on the discharge end of said first conveyor,

(g) a second conveyor having its receiving end attached to the discharge end of the first mentioned conveyor by said first movable pivot,

(h) a third conveyor having its receiving end attached to the discharge end of the second conveyor through a second movable pivot,

(i) a carriage adapted to be reciprocated longitudinally of the rectangular opening and supporting the third conveyor,

(j) a straight track in parallel spaced relation to the longer axis of the opening and on which the carriage is reciprocated,

(k) motor means to drive the carriage and cause it to draw the first and second conveyors around their pivot points thereafter, and

(l) additional motors means to shift the discharge end of the third conveyor over the furnace opening and laterally with respect to the carriage while said carriage is being reciprocated longitudinally of the furnace opening.

8. An apparatus for conveying material to a rectangular opening, including:

(a) three conveyors each adapted to receive and discharge material,

(b) the first conveyor having its receiving end mounted on a stationary pivot,

(c) the second conveyor having its receiving end attached to the discharge end of the first conveyor through a first movable pivot,

(d) said second conveyor having its discharge end supported and feeding material to the third conveyor at a second movable pivot,

(e) means supporting said second movable pivot and third conveyor and adapted to move longitudinally of the opening, and

(f) means moving said third conveyor transversely across the opening for delivering material therethrough through a predetermined path.

9. An apparatus for conveying material, including:

(a) three conveyors each adapted to receive and discharge material,

(b) the first conveyor having its receiving end mounted on a stationary pivot,

(c) the second conveyor having its receiving end attached to the discharge end of the first conveyor through a first movable pivot,

(d) the discharge end of said second conveyor being

supported adjacent the third conveyor on a second movable pivot,

(*e*) carriage means on which the second movable pivot and the third conveyor are supported, and

(*f*) reciprocating means supporting the third conveyor and coacting with the carriage means for moving the discharge end of the third conveyor through a predetermined path in fixed angular relation to the sides of a receptacle while material is being deposited therein.

10. An apparatus for feeding material to a rectangular opening, comprising:

(*a*) three conveyors each adapted to receive and discharge material,

(*b*) a stationary pivot supporting the receiving end of the first conveyor,

(*c*) means supporting the discharge end of said first conveyor and a first movable pivot,

(*d*) said movable pivot supporting the receiving end of the second conveyor,

(*e*) a carriage supporting the third conveyor and a second movable pivot beneath the discharge end of the second conveyor,

(*f*) means for moving the discharge end of the third conveyor transversely over the opening, and

(*g*) means for reciprocating the carriage longitudinally beside the opening.

11. An apparatus for feeding material to a rectangular opening, comprising

(*a*) three conveyors each adapted to receive and discharge material,

(*b*) the first conveyor being pivotable about its receiving end,

(*c*) the first two conveyors being pivotally connected together in succession by an interposed movable pivot,

(*d*) a carriage reciprocating longitudinally of the opening and supporting the discharge end of the second conveyor, and

(*e*) a third conveyor mounted on said carriage and movable transversely of and under said discharge end of the second conveyor and over the rectangular opening.

12. An apparatus for feeding material to a rectangular opening, comprising:

(*a*) three conveyors each adapted to receive and discharge material,

(*b*) a stationary pivot supporting the receiving end of the first conveyor,

(*c*) a first movable pivot connecting the discharge end of the first conveyor to the receiving end of the second conveyor,

(*d*) a second movable pivot supporting the discharge end of the second conveyor,

(*e*) the third conveyor receiving feed from the discharge end of the second conveyor,

(*f*) a carriage supporting said third conveyor and the second movable pivot,

(*g*) means for moving the carriage longitudinally beside the opening, and

(*h*) means for moving the third conveyor transversely of the discharge end of the second conveyor and for moving the discharge end of the third conveyor transversely over the opening.

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