June 6, 1961

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2,987,307

COMBINED CONTINUOUS SINTERING AND COOLER MACHINE

Filed June 18, 1958

6 Sheets-Sheet 1

Fig. 1.

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The present invention relates to improvements in an apparatus for combined continuous sintering and cooling of material, and more particularly, to continuous sintering machines of the modern type constituted of an endless train of pallets movable in side by side abutting relation successively along upper and lower strands, and provided with crushing and screening means for delivery of crushed and screened hot sinter from the sintering pallets to sinter cooler pallets.

The primary object of the present invention is the provision of a machine of the aforesaid modern type having as a novel and important characteristic a mode of construction and operation which very greatly simplifies, and reduces the cost of, such sintering plants and their general operation.

Modern sintering plants incorporate separate machines in tandem for continuous sintering and cooling of the sinter with a crusher and screen intermediate the discharge end of the sintering strand and the feed end of the cooling strand for more effective and high capacity operation in sintering and cooling. Both machines usually require an endless loop of moving pallets. The sintering operation utilizes the top strand only of the sintering machine, and the sinter cooler likewise utilizes the top strand only for cooling. The lower strands of both machines are utilized only for returning empty pallets. The ratio of working pallets to empty pallets is about 40 to 60 for both machines.

The present day modern equipment and most general method of sintering involves the use of a crusher and screen between the sintering machine and the cooler, whereby the hot sinter discharges by gravity from the sintering machine through the crushe and Screen, and then on to the cooler. These machines are usually built in tandem, with the result that a very long and high plant is necessary.

In accordance with the present invention, there is provided for the purpose of capacity a continuous sintering crushing and cooling combination machine which utilizes the top strand for the sintering operation, the intermediate area, and the bottom or return strand for the cooling operation.

Hot sinter is discharged from the top strand directly into a crusher and screen located in the area between the upper and lower strands for delivery to the bottom strand. The screen sizes the sinter, placing the #4 size on the bottom strand and the fines being withdrawn from the machine and recycled to mix with new material to be sintered on the top strand.

Air is pulsed down through the top sintering strand by one set of fans while air is blown up through the lower cooling strand by another set of fans. The drive of the upper sintering strand is at the feed end and is synchronized with a drive at the opposite end of the strands for moving the pallets on the lower strand, so that the machine is fully and mechanically synchronized.

The pallets run on a continuous track for both strands but the pallets do not turn upside down to enter the lower strand as they do now on the present day modern machine. Instead, they return on the lower return track or strand at an upright position, so that the grate bars are above and supported by the tracks in both strands for both cooling and sintering.

For this, means are provided at the hot sinter discharge end of the strands for tilting the pellets, as they leave the upper strand, toward the area between the upper and lower strands, to discharge the hot sinter for crushing, and for restoring the pallets to upright position as they enter the lower strand, and means are provided at the cool sinter discharge end of the strands for tilting the pallets, as they leave the lower strand, toward the area outside the strands, to discharge the cooled sinter from the machine, and for restoring the pallets to upright position as they enter the upper strand.

A particular advantage of the present machine is that a substantial saving in cost of construction and operation is realized, as most of the present day tandem type of cooler equipment is eliminated, and great savings are accomplished in the plant itself, due to a reduction in length and height of plant area, reduction of material handling equipment, and simplification of operation.

The machine as shown has 130 pallets, with 100 working and 30 empty, has the same capacity of present day modern machinery which requires 260 pallets for the sintering and cooling operation, with 104 working and 156 empty. The saving of 130 pallets in a sintering and cooling plant not only represents a substantial amount in initial investment, but also represents a substantial amount in reduced maintenance cost.

In addition to the above, a substantial savings is realized due to the elimination of the dual equipment, such as the machine frame, drive, foundations, controls, electrical equipment, material handling equipment, mechanical equipment, etc., required by the present type of tandem sinter machine and cooler.

In addition to the general objects recited above, the invention has for further objects such other improvements and advantages in construction and operation as may be found to obtain in the apparatus and mode of operation hereinafter described or claimed.

In the accompanying drawings, forming a part of this specification, and showing, for the purpose of exemplification, the best mode contemplated by the inventor for carrying out the invention, but without limiting the claimed invention specifically to such illustrative instance or instances:

FIG. 1 is a schematic side elevational view of a combined continuous sinter and cooler machine embodying the present invention.
FIG. 2 is a vertical side elevational view of the left-hand side end of the machine of FIG. 1 showing an enlarged scale the drive and feed of the upper strand and the discharge operation for the cooled sinter from the lower strand.
FIG. 3 is a like view illustrating the right-hand side of the machine of FIG. 1 and showing on an enlarged scale the discharge of the upper strand to the crushe and screen, and the drive of, and feed back of the crushing hot sinter into, the pallets in their restored upright position on the lower strand.
FIG. 4 is a vertical cross sectional view taken on the line 4—4 of FIG. 3, to show the trackways and wheels for the pallets, the pusher racks at the tops of the ends of the pallets, and the outlet wind boxes for the burner gases from the upper sinter strand and the air inlet wind boxes for the lower cooler strand.
FIG. 5 is a vertical cross sectional view taken on the line 5—5 of FIG. 3, to show the relationship of the crushe and screens to the tilting means between the two strands and the driving mechanism and hold back pinion for the lower strand.
FIG. 6 is an enlarged vertical cross sectional view showing the collars and pinion and rack mechanism for the pallets.
FIG. 7 is a perspective view more clearly showing the
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In its present embodiment, the invention is incorporated in an ore sintering machine with conventional elements including a crusher and screen between the strands, and in the preferred embodiment of the invention the machine also includes in its construction novel mechanisms for moving and restoring the pallets during their transfer at the opposite ends of the machine from one strand to the other, and twin pairs of tracks for each strand, with idler collars on the pallets and a pair of sprockets at each end of the machine for coaction with the sprocket to control the progress of movement of the pallets from each strand to the other for progressive discharge of clinker to the lower strand for cooling after crushing and progressive transition of the pallets between the strands. For convenience, the present invention will be confined to this use of the invention. The invention is not limited in all its aspects to this preferred embodiment of the invention, since much of the advantage of the invention is attained with the use of different means for tilting and restoring the pallets at each end of the machine, and with discharge of the cooled clinker to the interior rather than the exterior of the upper and lower strands for take-off of the product. The present invention is not limited in all its aspects to the specific means disclosed as the best mode of operation hereinafter described and claimed.

As shown on the drawings, the machine incorporates in its construction the following conventional elements commonly employed in systems for combined continuous sintering and cooling, namely: a continuous sinter machine of the endless conveyor type comprising an upper strand 10 with pallets 11, and a lower strand or run 12 with pallets 11, sprockets 13, at each end of the machine, wind boxes 14 below the strands for off-flow of burnt gases from the pallets undergoining sintering in the upper strand to a stack 15 through a gas flow line 16 and exhaustors 80, and wind boxes 17 for inflow of cooling air from blowers 90 to the bottoms of the pallets undergoing cooling of the sinter or clinker in the lower strand, as well as a crusher 18 and screen 19 for crushing and screening the hot sinter or clinker from the upper strand before cooling the same in the lower strand.

The wind boxes are sealed by wear bars 21 and seal bars 22, FIGURES 4 and 6, in the conventional manner, and the upper sinter strand is provided with a hearth layer feed 23, a sinter material feeder 24 in the form of a sinter mix roll feeder for supply of material to be sintered, as well as an ignition furnace 25.

The elements of the structure thus far described is typical of the elements of this type of sintering plant and hence need not be described in further detail.

In previous practice, for full capacity and most efficient operation, two machines in tandem with a crusher and screen in between, has been adopted as standard to make full use of the upper strand of the first machine for sintering, and the upper strand of the second machine for cooling.

In accordance with the present invention, this principle of operation for full capacity and efficiency is carried out in a single machine by continuing the full use of the upper strand of the machine for sintering and by crushing the sinter cake in the intermediate area and thereby making full use of the pallets in the lower strand for cooling the crushed hot sinter from the upper strand.

Accordingly, the usual form of crusher and screen as used heretofore in tandem is located instead in the intermediate area 26 between the upper strand and the lower strand, at the ends thereof at which the pallets leave the upper strand with hot sinter. This entails tilting the pallets or their grates toward the intermediate area 26 for discharge of the hot sinter from the pallets, as they leave the upper strand, into the crusher and screen in the intermediate area 26 for crushing and screening the material before it is fed back into the pallets in the lower strand, and entails restoring the pallets, or their grates, to upright or horizontal position to receive the crushed sinter from the upper strand for cooling of the sinter as the pallets move into and along the lower strand. It also entails tilting the pallets, or their grates, either into the intermediate area 26 or to the area outside the strands at the sprockets or else and restoring the pallets or their grates to upright or horizontal position for sintering as they move again into and along the upper strand.

For tilting the pallets or their grates, each pallet is provided with a pair of front and rear wheels 27, 28, on each end 29, FIGURE 4, and each strand is provided with twin pairs 30, 31 of rails over which the front 27 and rear 28 wheels ride to support the pallets for sliding movement over the wind boxes of the upper and lower strands. The front wheels 27 at each end of the pallets are located at a higher level than the rear wheels 28, and ride on one pair of tracks 30 over each strand. The rear wheels 28 at each end of each pallet ride over the other pair of tracks 31 which are located at a lower level over each strand. The upper pair of tracks 30 are endless, but the lower pair 31 are provided for opposite ends of the machine. The lower pair of tracks 31 are interrupted at each end of the machine so that the pallets, or their grates 20, can tilt by gravity at each end of the machine, to discharge the hot sinter to the crusher 18 in the interior area 26 as the pallets leave the upper strand 10 with the hot sinter or clinker, and to discharge the cooled sinter from the pallets 11 either to the exterior of the strands, or to the interior 26, at the cool end of the machine as the pallets leave the lower strand 12.

The lower pairs of tracks 31 in the lower strand 12 are inclined 32 upwardly, FIGURE 3, around the hot end of the machine to a horizontal level below the axes 33 of rotation of the sprockets 13, but above the lower periphery of the sprockets 13, to be in a position to support the rear wheels 28 of the pallets as they leave the sprocket 13 and thereby begin to restore the pallets to upright horizontal position as they enter the lower strand 12. At the cool end of the machine, FIGURE 2, the lower tracks 31 of the upper strand 10 are constituted a curved portion 34, downwardly around the axis 35 of rotation of each sprocket 13, to engage the lower rear wheels 28 as they ride above the axis 35 of sprocket 13 to restore the pallets 11 to horizontal for the upper strand 10. At each of the hot 33 and cool 35 ends of the machine the upper tracks 30 of the lower strand 12 extend upwardly around the axis 33, 35 of rotation of the pallets at those ends of the machine to overlap the upper tracks 30 in the upper strand 10, and the upper tracks 30 of the upper strand 10 extend downwardly around said axis 33, 35 of rotation to overlap the upper tracks 30 in the lower strand 12, to form a confined guideway 36 for the front wheels 27 of the pallets 11 during the rotation of the pallets from one strand to the other by the sprockets 13.

To control the progressive movement of the pallets from each strand to the other, a pair of sprockets 13 are provided at each end 33, 35 of the machine to rotate on said axes 33 of rotation. The sprockets 13 are provided with grooves 37 to rotatably support the pallets 11 tilting during their progress from one strand to the other, permitting the tilting and restoring of the pallets. For this, FIGURES 4 to 6, each shaft or hub 38 for the upper front wheels 27 of the pallets are provided with a freely rotatable collar 39 to seat in the grooves 37 of the sprockets 13. The sprockets 13 thus support the pallets 11 while allowing them to tilt and restore to upright position during their transition from one strand to the other.

The pallets 11 move along the strands 10, 12, in successive abutting relation. For this, the pallets 11 are pro-
vided, FIGURES 2, 4, 6, with a rack 41 along the tops of the ends 42 of the pallets 11 which are driven by separate pusher pinions 43 at the entrance ends of the upper and lower strands. To engage the pallet racks 41 with such pusher pinions 43 as the pallets leave the sprockets 13, retractable pushers 44 are provided, FIGURES 2, 5, 5, at each end of the machine to engage the rear sides of the ends 32 of the pallets 11 as they leave the sprockets 13 and push the entering pallets forward into abutting relation with the preceding pallet until the pusher pinion 43 engages the rack 41 of the entering pallet. These retractable pushers 44 are reciprocated by slides 45 which ride on wheels 46. The slides 45 are each operable by a crank 47 driven by a drive shaft 48 which also drives the pusher pinions 43 to push the pallets along the upper and lower strands to engage their racks 41 with the pinions 43. The sprockets 13 are likewise driven, through a sprocket 49, chain 51, and pinions 52, by drive shafts 48, 53, that drive the pusher pinions 43 and crank 67. The drive shafts 48, 53 for the upper and lower strands are driven in unison through the sprockets 55 and chain 56 connection with main drive shafts 57 operable through reduction gearing 58 by means of electric motors 59 which are synchronized to move the pallets 11 on the sinter strand 10 in synchronism with the cooling strand 12.

Since the pallets slide down by gravity, from the sprockets 13 at the hot discharge end 35 of the upper sinter strand to the entrance end of the cooling strand 12, they might tend to jar the pallets that are already ahead on the cooling strand 12 if left to fall freely by gravity without restraint. To eliminate this, the drive shaft 48 for the sprockets 13 for the hot end 33 of the machine is provided with a hold back pinion 61 which meshes with the racks 41 of the pallets 11 just ahead of the crank driven pusher 44 and pusher pinion 43 to hold back the descent of the pallets 11.

As shown in FIGURE 5, this drive shaft 53 is connected by sprockets 55 and chains 56 with the motor 59, and carries a pinion 54 in mesh with the pinion 52 to drive the chain and sprocket drive for the sprocket 13 at the cool end of the machine and also connected by a sprocket wheel 62 and chain 63 and sprocket 55 with a shaft 48 for driving the crank pusher 44 and pusher pinion 43 for the cooling strand.

The crusher is rotated by a separate motor drive 65, FIGURE 5, and the screens are of the conventional shaker screen type which are driven through an eccentric 66 for the pallets 11 move 67.

The ore in adjacent pallets 11 sinter together as a single mass, and the pallet charges are cracked apart as they leave the upper strand 10 to ride on the sprockets 13, to tilt to discharge the sinter for crushing of the sinter in the intermediate area 26 before the sinter is refilled in the pallets in the lower strand for cooling. A hump 68 is provided in the rails of the lower track 31 at the discharge end of the sinter strand, to cause the rear side of the pallets 11 to rise as they pass over the hump 68 and thereby shear the cake in adjacent pallets apart.

To avoid wear and weight on the rim or perimeter of the sprockets 13 as a result of the pallet parts riding on the rim or perimeter of the sprockets 13, until the grooves 37 rotate into position to grasp the collars 39 of the pallets, the ends of the rails of both the upper and lower tracks are inclined to carry such weight and thud away wear until the grooves 37 arrive in position to receive the collars 39. The collars being freely rotatable on the pallets, the collars merely rotate freely countercurrently to the direction of rotation of the sprockets 13, thus avoiding weight and wear on the sprockets 13.

In operation, the motors 59 are operated in synchronism to drive the sprockets 13, pusher pinions 43, and pusher rams 44 in unison so that the pusher pinions 43 for the strands 10 and 12 make one revolution per pallet length, and the sprockets 13 rotate 45° as said pinions 43 make one revolution. The pallets 11 move continuously along each strand 10 and 12 and around each end 33, 35 of the machine in timed sequence. During this movement, a hearth layer is laid continuously by hopper 23 and a mixture to be sintered laid on top of the hearth layer by the mix roller feeder 24, which is thermostatically ignited by the furnace 25. The burner gases flow down through the sinter mix on, and through, the pallet grates 20 to the wind boxes 14, from which the hot gas flows through the flue line 16 to the stack 15. After the pallets ride the hump 68, the grooves 37 of the sprockets 13 at the hot end 33 of the machine pick up the collars 39 of the pallets 11. These collars 39 are on the same shaft 38 as the front wheels 27 of the pallets. As the sprockets 13 rotate they support the pallets 11 while the front wheels 27 ride through the guideway 36 formed by the looped overlapping upper tracks 30. The pallets being supported only on the shafts 38 of their front wheels 27 during their transition by the sprockets 13, the rear portion of the pallets descend by gravity, pivoting around the axis 38 of the front wheels 27. This tilts the grate 20 toward the interior area 26, and the hot sinter cake drops into the crusher 18. From the crusher 18 the ground sinter cake 63 is separated in the automatic manner, for example, by a knife from the coarse, to aid the cooling in the lower strand 12. The coarse particles are fed back into the pallets 11 in the lower strand by chutes and the fines are withdrawn from the area 26 by a conveyor which sends them back to be mixed with fresh ore to be fed to the sinter strand by the mix roll feeder 24. During this time, the pallets 11 on the sprockets 13 leave the sprockets as their rear wheels 28 ride on the top of the inclined part 28, 32 of the lower strand tracks, which elevates them to horizontal upright position. The descent of the pallets is controlled by the re-engagement of the pallet racks 41 with the hold back pinion 61. Pallets which have passed this pinion 61 slide on toward the last preceding pallets on the cooling strand 12 which is being pushed forward by the pusher pinion 43. The pusher ram 44 pushes each next pallet 11 to enter the cooling strand 12 up against the last previous one as it moves away from pusher pinion 43, so that the next following pallet is positively pulled into driven engagement with the pusher pinion 43.

As the pallets move up along the tracks 31 in the lower run 12 they first receive the oversize of the crushed sinter from the screen 19, which sinter is thereafter carried in the grooves 37 of the sprockets 13 which carry the pallets 11 up to within reach of the pusher ram 44 which pushes the pallets forward into side by side contact with the preceding pallet until the pinion 43 engages the rack 41 on the pallet so pushed forward. During this time, the rear wheels leave the lower tracks 31, and the pallet tilts downward, pivoting around the axis 38 of the sprockets 13, carrying the collars 39 and the forward wheels 27, thus discharging the finally cooled sinter product into the discharge hopper 71 for removal as the end product from the machine. As the pallets are carried up above the axis 35 of the sprockets 13, the curved portion 34 of the lower rails 31 urge the rear half of the pallets upward around the axes 38 of the collars 39 to restore the grates 37 of the pallets to upright horizontal position for engagement with the pusher ram 44.
The invention in its broader aspects is also useful with other means than the ones shown for transferring, tilting and pushing the pallets, and with other means for screening and crushing the hot sinter cake. For instance, the invention in its broader aspects, as well as in its best mode of operation, is also of utility without screening the crushed sinter cake before cooling, and is also of utility without the use of the fins from the sinter strand 19 to the pallets in the cooling strand 12 after the filling of the pallets with the orifice from the screen 19.

The invention as hereinabove set forth is embodied in a particular form of construction but may be variously employed within the scope of the following claims.

I claim:

1. Apparatus for continuous sintering and cooling, comprising: an upper strand of wind box means; a lower strand of wind box means underneath the upper strand of wind box means; pallets movable in side by side abutting relation successively across the top of said upper strand; pallets movable in side by side abutting relation successively across the top of said lower strand in the opposite direction to the movement of the pallets in the upper strand; means for layering sinter material on the pallets in said upper strand; means for igniting the top of the sinter from the pallets in said upper strand; means for exhaust of hot gases from the wind box means of the upper strand; means for transferring pallets containing sinter successively from the upper strand to the entrance end of the lower strand including means for tilting the pallets toward the intermediate area between the upper and lower strands as they leave the upper strand for discharge of hot sinter from the pallets in the intermediate area above the pallets in the lower strand, and means for restoring the discharged pallets to upright position as they enter the lower strand; a crusher disposed in the intermediate area between the upper and lower strands in position to receive hot sinter from the pallets as they tilt and to discharge the crushed sinter to the restored pallets in their upright position at the entrance end of the lower strand; means for introducing cooling air to the cooled sinter in the pallets in the lower strand; sprockets with peripherally spaced supporting parts in position for rotatably engaging a part on the axis of the eccentric wheels of the cooled sinter containing pallets for tilting the cooled sinter pallets as they leave the lower strand for discharge of cooled, crushed sinter toward an area beyond the lower strand and for control of the movement of the tilted, cooled pallets from the cooling strand toward the sinter strand and cam tracks extending from said sprockets to the upper strand tracks for restoring the cooled tilted pallets to their upright position in advance of their entry to the upper strand before the means for layering material thereon.

4. Apparatus as claimed in claim 3 and which includes racks on the pallets for driving engagement with driving pinions for pushing the pallets along the strands, a driving pinion in each strand for rotatable driving engagement with the racks to push the same along the strands, and a sliding pusher in each strand for pushing each pallet into rack meshing relation with the driving pinions for the strands.

5. Apparatus as claimed in claim 3 and which includes racks on the pallets for driving engagement with driving pinions for pushing the pallets along the strands, a driving pinion in each strand for rotatable driving engagement with the racks to push the same along the strands, a sliding pusher in each strand for pushing each pallet into rack meshing relation with the driving pinions for the strands, and a hold-back pinion for rotatably engaging the racks as they slide down the cam tracks to enter the lower strand, for prevention of jar of the pallets in the lower cooling strand by the free gravity movement of the pallets toward the cooling strand.

6. Apparatus as claimed in claim 3 and which includes racks on the pallets for driving engagement with driving pinions for pushing the pallets along the strands, a driving pinion in each strand for rotatable driving engagement with the racks to push the same along the strands, a sliding pusher in each strand for pushing each pallet into rack meshing relation with the driving pinions for the strands, and a hold-back pinion for rotatably engaging the racks as they slide down the cam tracks to enter the lower strand, for prevention of jar of the pallets in the lower cooling strand by the free gravity movement of the pallets toward the cooling strand, and a hump in one relation successively along the tracks by means of a set of front and rear wheels at each of the opposite ends of the pallets with the front wheels riding on one pair of the tracks and the rear wheels riding on the other pair of tracks and with one of the wheels of the set eccentric to the center of gravity of the pallets; means for layering sinter material on the pallets in said upper strand; means for igniting the clutch of the eccentric wheels of the sinter containing pallets for tilting the pallets toward the intermediate area between the upper and lower strands for discharge of hot sinter from the pallets into the intermediate area above the pallets in the lower strand as they leave the upper strand and for control of the movement of the tilted pallets from the sinter strand toward the cooling strand underneath; cam tracks extending from the periphery of the lower part of sprockets to the tracks in the lower strand for restoring the tilted pallets to upright position as they slide by gravity from the sprockets to the lower strand; a crusher disposed in the intermediate area between the upper and lower strands in position to receive hot sinter from the pallets as they tilt and to discharge the crushed sinter to the restored pallets in their upright position at the entrance of the lower strand; means for introducing cooling air to the cooled sinter in the pallets in the lower strand; sprockets with peripherally spaced supporting parts in position for rotatably engaging a part on the axis of the eccentric wheels of the cooled sinter containing pallets for tilting the cooled sinter pallets as they leave the lower strand for discharge of cooled, crushed sinter toward an area beyond the lower strand and for control of the movement of the tilted, cooled pallets from the cooling strand toward the sinter strand and cam tracks extending from said sprockets to the upper strand tracks for restoring the cooled tilted pallets to their upright position in advance of their entry to the upper strand before the means for layering material thereon.
of the pair of tracks in the upper strand over which each pallet rides in advance of the sprocket at the hot end of the sinter strand, for shearing the sinter cake in the pallets from the cake in the next following pallet on the upper strand.

7. Apparatus as claimed in claim 3 and which includes racks on the pallets for driving engagement with driving pinions for pushing the pallets along the strands, a driving pinion in each strand for rotatable driving engagement with the racks to push the same along the strands, a sliding pusher in each strand for pushing each pallet into rack meshing relation with the driving pinions for the strands, a hold-back pinion for rotatably engaging the racks as they slide down the cam tracks to enter the lower strand, for prevention of jar of the pallets in the lower cooling strand by the free gravity movement of the pallets toward the cooling strand, a hump in one of the pair of tracks in the upper strand over which each pallet rides in advance of the sprocket at the hot end of the sinter strand, for shearing the sinter cake in the pallets from the cake in the next following pallet on the upper strand.

and means for rotatably driving the sprockets, driving pinions, and sliding pushers in synchronism.

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