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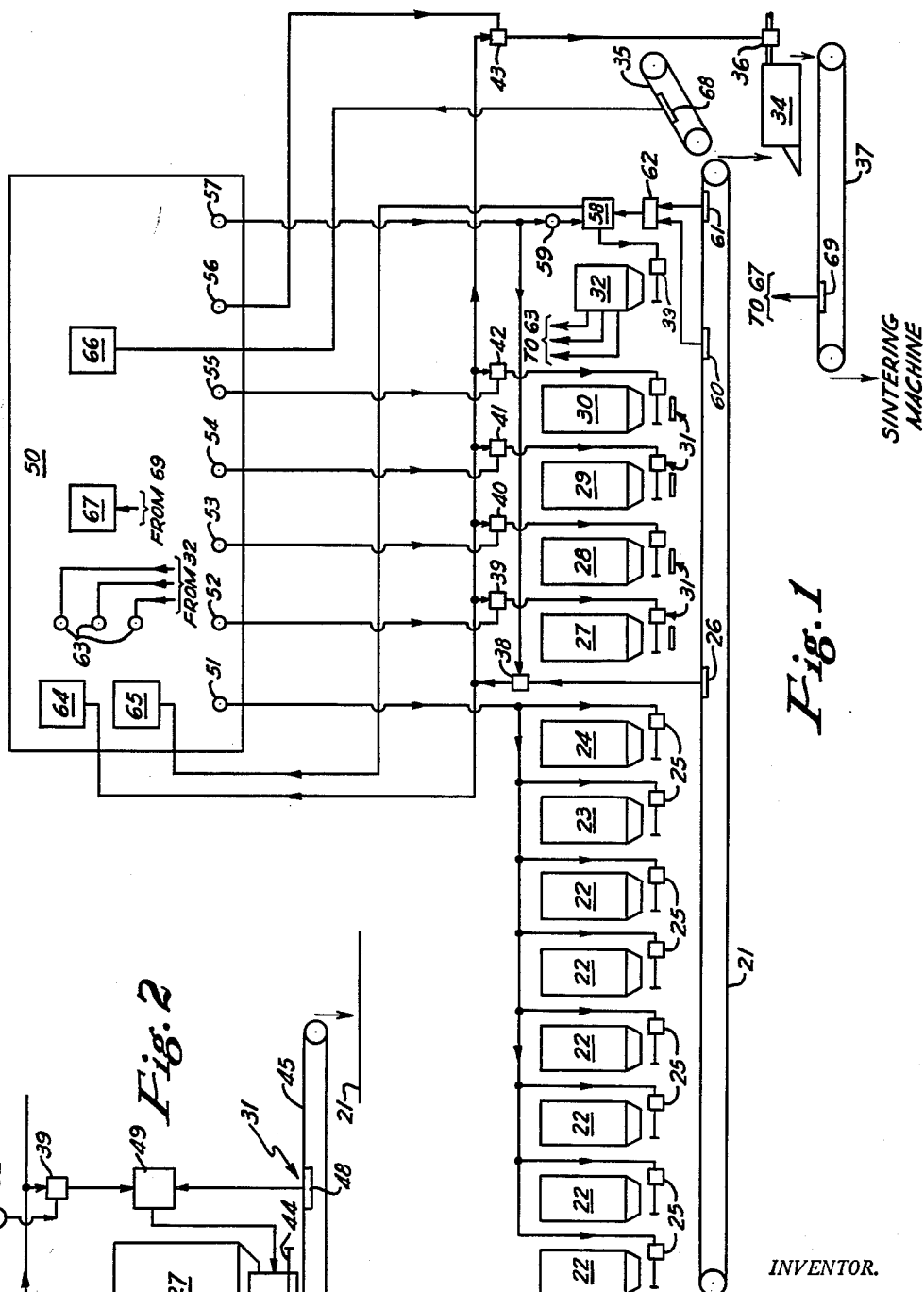
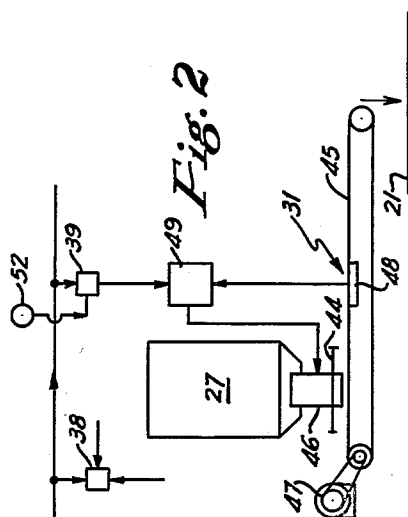
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2,980,291

METHOD AND APPARATUS FOR COMPOUNDING SINTER FEED

Filed May 1, 1959

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

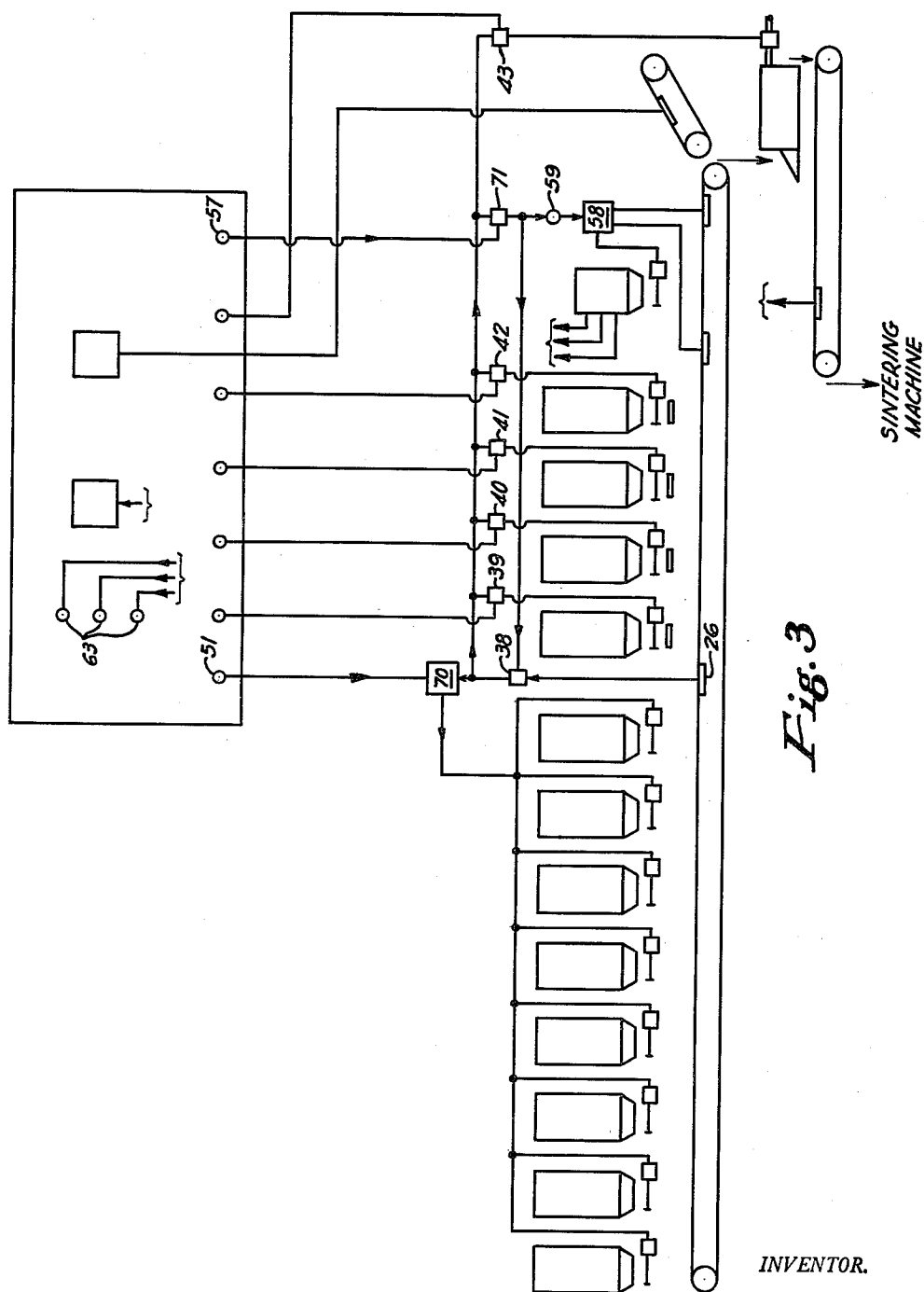


Fig. 3

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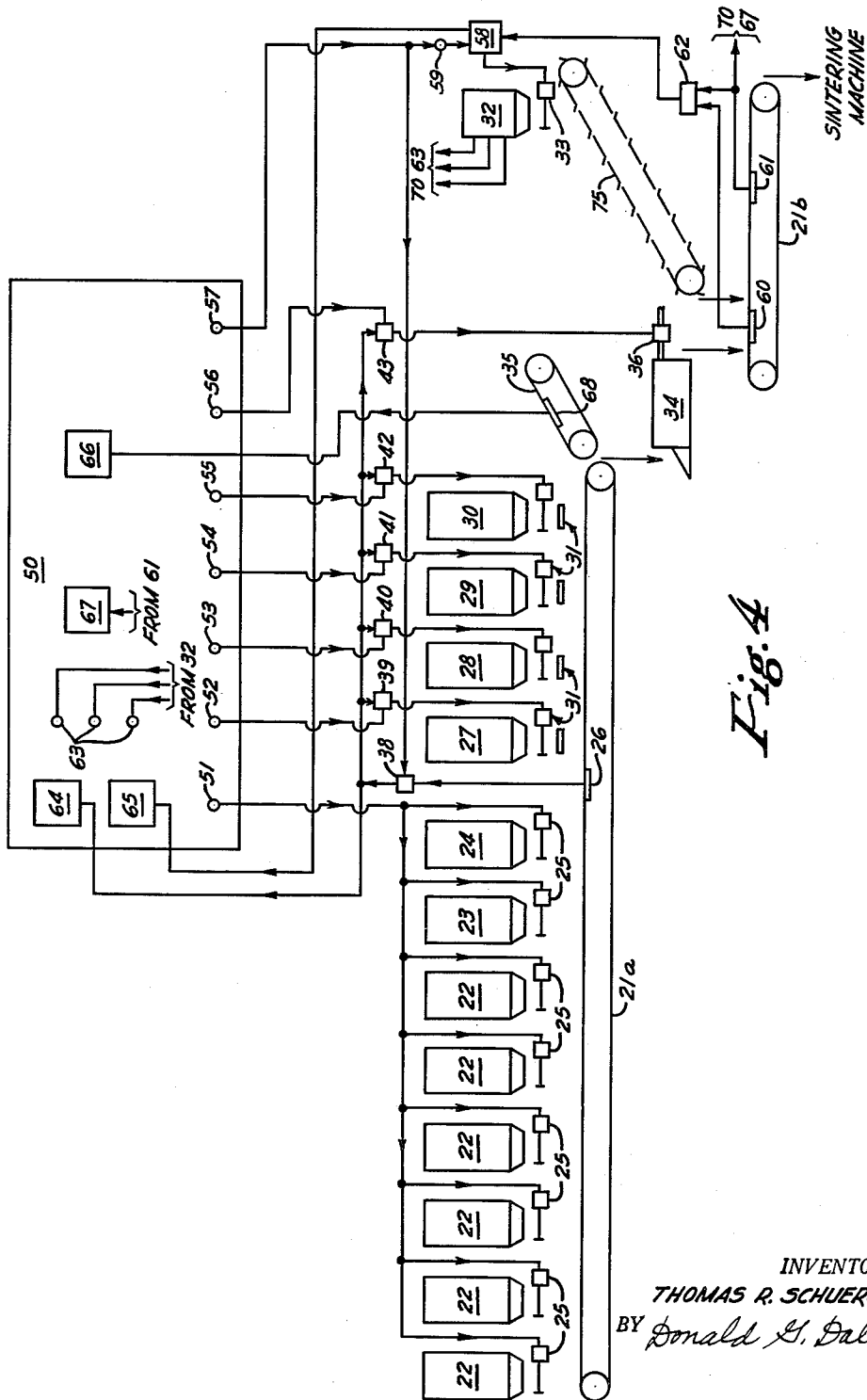


Fig. 4

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1

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METHOD AND APPARATUS FOR COMPOUND-
ING SINTER FEED

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15 Claims. (Cl. 222—1)

This invention relates to an improved apparatus and method for compounding sinter feed and proportioning the ingredients thereof. The present application is a continuation-in-part of my earlier application Serial No. 579,326, filed April 19, 1956, and of common ownership (now abandoned).

Although my invention has general application to sintering operations in which hot fines recovered from a sintered product are recycle, it is particularly useful in sintering iron-bearing materials. An iron-bearing sinter feed commonly consists of a mixture of ore fines, scale, flue dust, sinter returns, filter cake and solid fuel particles (e.g. coke or anthracite fines). In modern plants sinter returns are separated into "sized returns" added to the feed to control the bed porosity and "hot recycle," which is dust or unburned sinter not suitable as a sintered product. Conventionally the various ingredients discharge from individual bins to table feeders and thence to a main feed conveyor of the belt-type, which carries them to a mixing device where moisture also is added. This conveyor can be formed of only a single belt, but more commonly is formed of several belts in series. Usually the only control of proportions is obtained by adjusting the discharge areas of the bins or speed of the table feeders, but this control is uncertain, since both bulk density of the materials and their ability to flow from a bin continually vary. Therefore a constant composition is difficult to maintain, and frequent pan sampling of material on the main conveyor is necessary.

Belt scales are available commercially for automatically registering the weight of material carried by a moving conveyor. Likewise weigh-feeders are available which are table feeders combined with and controlled by belt scales. Part of the difficulty in keeping a sinter mix constant can be overcome by installing a belt scale on the main feed conveyor and weigh-feeders on the bins which deliver such additives as fuel and sized returns. The ore reaches the main conveyor before the additives and the belt scale is located between the ore and additive bins, where it registers the actual weight of ore on the conveyor before the additives are introduced. A suitable transmitter connects this belt scale with the weigh-feeders to pace the latter and insure that they deliver additives in proper proportion to the weight of ore actually on the conveyor.

However, in many installations an arrangement as described neglects one significant variable. To a large extent hot recycle must be fed to the main conveyor in whatever quantities it is returned from the sintering machine, despite considerable variation. In proportioning the ingredients, hot recycle should be considered as an equivalent to ore, and the additives should be proportioned in accordance with the combined weight of ore and hot recycle. The hot recycle bin often is situated after the additive bins, and even after the mixing device, and feeds hot recycle to the main conveyor after the additives already have been proportioned according to the weight of ore alone plus some constant factor. Conse-

2

quently there is no controlled compensation for variations in the hot recycle.

An object of the present invention is to provide an improved sinter feed compounding apparatus and method which take into account variations in hot recycle in proportioning the other ingredients, regardless of the location of the hot recycle bin.

A further object is to provide an improved sinter feed compounding apparatus and method which combine the weight of ore and hot recycle in determining the weight of additives to be included in sinter feed, even though the hot recycle bin follows the additive bins and may follow the mixing device.

A more specific object is to provide a sinter feed compounding apparatus which includes belt scales and weigh-feeders arranged as hereinbefore described, plus additional belt scales for determining the weight of hot recycle fed to the main conveyor and means automatically combining this weight with that of the ore, the weigh-feeders being paced by the resulting combined weights.

In accomplishing these and other objects of the invention, I have provided improved details of structure, preferred forms of which are shown in the accompanying drawings, in which:

Figure 1 is a diagrammatic side elevational view of a sinter feed compounding apparatus constructed in accordance with my invention;

Figure 2 is a diagrammatic showing of a weigh-feeder embodied in my apparatus;

Figure 3 is a view similar to Figure 1, but showing a modification; and

Figure 4 is another view similar to Figure 1, but showing a further modification.

Figure 1 shows a conventional main feed conveyor 21 and its associated series of bins for compounding a sinter feed. For simplicity conveyor 21 is shown as a single belt, but more often in actual installations it is formed of a series of belts. The first six bins 22 contain ore, and the next two 23 and 24 scale and scrap, which in sinter feed are equivalent to ore. Each bin 22, 23 and 24 is equipped with its individual table feeder 25, which feeds material therefrom to the main conveyor 21. Immediately beyond bin 24, conveyor 21 traverses a conventional belt scale 26 which continuously weighs material fed thus far. The next four bins 27, 28, 29 and 30 contain coke, anthracite, flue dust and sized returns, each of which is added in a predetermined proportion with respect to ore and its equivalents. Each bin 27 to 30 is equipped with its individual weigh-feeder 31, which feeds the respective ingredient to the main conveyor 21, as hereinafter explained. For simplicity I refer hereinafter to ore, scrap and scale combined as "ore," and coke, anthracite, flue dust and sized returns generically as "additives." The last bin 32 contains hot recycle and is equipped with a table feeder 33 which feeds this material to the main conveyor 21. A mixing device 34 is situated to receive material from the main conveyor, filter cake from a conveyor 35 and water from an adjustable source 36. The mixing device can be a pug mill or a balling disk or drum, and it discharges mixed sinter feed to a conveyor 37 which carries it to a sintering machine not shown.

The belt scale 26 transmits a signal to a summator 38, which signal is proportionate to the weight of ore on conveyor 21. Another signal proportionate to the hot recycle is also transmitted to this summator, as hereinafter explained. The summator transmits a signal proportionate to the sum of its two input signals to a series of ratio devices 39 to 43. The ratio devices 39 to 42 control the proportion of each additive which the weigh-feeders 31 feed to conveyor 21 from bins 27 to 30. The ratio device 43 controls the proportion of water delivered from the water source 36. Actually the proportion of

3

water is a function of the total solids in the mix, but since my invention positively apportions the additives in accordance with ore plus hot recycle, for convenience the water also can be apportioned in accordance with this sum.

The belt scale 26, summator 38 and ratio devices 39 to 43 per se are conventional instruments and not part of my invention; hence they are not disclosed in detail in the present specification. Nevertheless for exemplary showings of a suitable belt scale, summator and ratio device, reference can be made to Frazel Patent No. 2,664,286, Markson Patent No. 2,631,599 and Sorteberg Patent No. 2,643,055 respectively, although obviously my invention is not limited to the specific devices shown in these patents. These particular instruments are pneumatically operated and the connections therebetween are air conduits, but it is also apparent that equivalent electric devices could be substituted. When the devices shown in these patents are used, the tube 17 of the Frazel scale is connected to one of the units A or C of the Markson summator and the line from the hot recycle is connected to the other of these units. Unit B of the summator is left uncoupled so that the force thereon is effectively zero. The Sorteberg force bridge is set up for multiplication, and the output line from the unit D of the summator is connected thereto to provide the force A on the bridge. The force B on the bridge is set manually to provide the desired ratio of the particular additive. The force D is maintained constant. The force C, which is the product, is transmitted to the weigh-feeder. Another example of a suitable ratio device is shown in Donaldson Patent No. 2,304,783, whose input 6 can receive the signal from the summator and whose line 9 can carry a signal to the weigh-feeder.

Figure 2 is a diagrammatic showing of a suitable weigh-feeder 31 for the coke bin 27, showing also its relation to the ratio device 39. The other weigh-feeders are similar; hence the showing is not repeated. The weigh-feeder includes a conventional table feeder 44 and a conveyor belt 45. The table feeder has a variable speed drive 46 and delivers coke from bin 27 to the belt, which has a constant speed drive 47 and delivers this coke to the main conveyor 21. Belt 45 traverses a belt scale 48, which can be similar to 26, and transmits a signal to a controller 49. The ratio device 39 transmits another signal to this controller. The output signal from the controller is proportionate to the difference between its two input signals and is transmitted to the variable speed drive 46 to control the speed of the table feeder 44. The belt scale determines the actual weight of material fed and transmits this weight to the controller, which changes the table feeder speed to correct for any difference between the weight set by the ratio device and the actual weight. Per se the controller is a conventional instrument not part of my invention and hence is not shown in detail. For an exemplary showing of a suitable controller, reference can be made to Moore Patent No. 2,520,468, although obviously my invention is not limited to the specific device shown in this patent. When the Moore controller is used with the patent devices previously discussed, the product signal from the Sorteberg force bridge (force C) or from the Donaldson ratio relay (line 9) is applied as the control setting pressure to Moore's line 16, and the signal from the belt scale is applied to Moore's line 11. Moore's valve 13 controls my variable speed drive 46 through any suitable speed regulator.

Referring to Figure 1, the apparatus includes a control panel 50 which carries seven panel set controls 51 to 57. The control 51 is connected to the table feeders 25 for bins 22, 23 and 24. This control can be any suitable known device for varying the speed of an electric motor, and its manual adjustment varies the table feeder speed and thus varies the weight of ore fed to the main conveyor 21. The controls 52 to 56 are connected to the ratio devices 39 to 43 respectively to adjust the settings

4

thereof, whereby manual adjustment of controls 52 to 56 varies the proportion of the respective additives and water. In a pneumatic system these controls can be pressure regulating valves that permit manual regulation of the pressure on the input B of the Sorteberg force bridge. If the Donaldson ratio relay is used, the relay itself is mounted in the control panel and its knob 20 becomes the panel set control. The control 57 governs hot recycle and its action is explained hereinafter.

The mechanism thus far described controls the proportion of additives with respect to the ore by pacing the weigh-feeders 31 in accordance with the weight registered on belt scale 26, although it has been mentioned that the invention embodies a further control based on hot recycle. This material arrives in variable amounts from the sintering machine and must be used approximately at the rate received, although bin 32 affords sufficient surge capacity to enable hot-recycle to feed at constant rates for extended periods. The panel control 57 is connected to a controller 58 through a time delay device 59. The controller 58 can be of similar construction to 49 (Figure 2) and is connected to the table feeder 33 for the hot recycle bin to control the feed rate thereof. In a pneumatic system the control 57 can be a pressure regulating valve for adjusting the pressure on the input 16 of the Moore controller, and the time delay device conveniently can be a simple coil of tubing of a length sufficient to delay impulses transmitted therethrough. The main conveyor 21 traverses another pair of belt scales 60 and 61 located at opposite sides of the table feeder 33, and both transmit signals to an algebraic summator 62 which can be similar to 38 but connected to subtract and whose output signal is proportional to the difference between the weights registered by these two scales, that is, to the actual weight of hot recycle fed to the main conveyor. The output signal from summator 62 is continuously transmitted to controller 58, whose own output signal controls the table feeder 33 so that it feeds hot recycle accurately at the rate set by the control 57. It is seen that the arrangement is the equivalent of the weigh-feeder shown in Figure 2, and in fact a weigh feeder can be substituted if the recycle has been cooled beforehand. The control 57 is connected also to summator 38 to transmit a signal thereto. Consequently this summator continuously determines the actual total of the weight of ore plus the hot recycle setting and governs the ratio devices 39 to 43 accordingly.

The control panel 50 carries indicators 63 which show the level of hot recycle in bin 32. Whenever this level changes, the operator adjusts the control 57 to a setting such that the table feeder 33 feeds hot recycle at approximately the rate it is currently received. He also adjusts the control 51 to make an inverse change in the rate of ore feed to keep the total weight of ore and hot recycle substantially constant, and thus keep the equipment operating at substantially a constant rate, preferably its rated capacity. The purpose of the time delay device 59 is to retard changes in hot recycle feed rate until the section of conveyor 21 on which the ore-feed rate has been changed reaches feeder 33. For example, if indicator 63 shows hot recycle is building up in bin 32, the operator adjusts both controls 57 and 51 to increase the hot recycle feed rate and decrease the ore feed rate. Immediately the table feeders 25 feed less ore to conveyor 21 and the increase in the hot recycle feed rate setting is immediately transmitted to summator 38 to offset the lower weight registered on the belt scale 26. Consequently no appreciable variation occurs in the output signal from the summator transmitted to the ratio devices nor in the additive feed rate. The time delay device assures that the increase in hot recycle feed rate occurs when the section of the conveyor belt which received less ore actually reaches feeder 33.

Preferably the control panel 51 also carries additional indicators 64 to 67. The first two are connected respectively to the summator 38 and controller 58, and register

5

the weight of ore plus hot recycle fed to the conveyor and the weight of hot recycle alone. Indicator 66 is connected to a belt scale 68 which the filter cake conveyor 35 traverses to indicate the weight of filter cake added to the sinter feed. This weight is not taken into account in the control system, since the material is used irregularly and in relatively small quantities. Indicator 67 is connected to a belt scale 69 which conveyor 37 traverses to indicate the total output of sinter feed from the installation.

Figure 3 shows a modification in which changed settings in the hot recycle feed rate automatically change the ore feed rate. Except for the parts and connections which accomplish this function, the apparatus is similar to Figure 1; hence this description is not repeated. In Figure 3 the panel set control 51 is connected to a controller 70 (which can be similar to 49 and 58) to regulate the total feed of ore and hot recycle, rather than ore alone, as in Figure 1. In the example of a controller constructed as shown in the aforementioned Moore patent, control 51 is a valve for regulating the pressure on Moore's line 16. The apparatus of Figure 3 embodies an additional ratio device 71 which receives signals from the summator 38 similar to the ratio devices 39 to 43. The panel set control 57 is connected to the ratio device 71 to set it to the desired ratio of hot recycle with respect to ore. The output signal from the ratio device 71 goes to the controller 58 via the time delay device 59, and also feeds back to the summator 38. When indicator 63 shows a change is needed in the rate of hot recycle feed, the panel set control 57 is adjusted as in Figure 1, but now it adjusts the setting of the ratio device 71 to change the ratio of hot recycle to ore without changing the total. The feedback connection to summator 38 transmits an immediate signal thereto that the hot recycle ratio is changed. The output signal from the summator to the controller 70 changes correspondingly. This controller changes the rate of ore feed inversely to the change in hot recycle feed to maintain the total constant, that is, to maintain constant the sum of the signals from the belt scale 26 and the feedback signal from the ratio device 71.

Figure 4 shows another modification in which the main conveyor includes two belts 21a and 21b in series, and the mixing device 34 is situated between these belts. Bin 32 feeds hot recycle to an apron-type conveyor 75, which in turn feeds this material to belt 21b. Thus the ore, additives, filter cake and water mix before hot recycle is added. Since scale 61 now registers the total weight of sinter feed, it furnishes the signal transmitted to indicator 67; conveyor 37 and scale 69 shown in Figure 1 can be eliminated. In all other respects this modification is similar to that shown in Figure 1; hence the description is not repeated. It is apparent also that the main conveyor and mixing device of the embodiment shown in Figure 3 could be arranged as shown in Figure 4.

From the foregoing description it is seen the present invention affords a simple apparatus and method for positively proportioning the composition of a sinter feed. Variations in the quantity of hot recycle are easily compensated, irrespective of the location of the hot recycle bin. The invention is readily applied to existing installations. Sometimes recycle is cooled beforehand to facilitate handling and screening, but such cooling does not affect the operation of my invention. Therefore I do not intend my terminology to exclude this obviously equivalent variation.

While I have shown and described only certain preferred embodiments of my invention, it is apparent that other modifications may arise. Therefore, I do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

I claim:

1. In an apparatus for compounding sinter feed, which apparatus includes a main conveyor, and individually

6

controllable means for feeding ore, additives and hot recycle successively to said conveyor, the combination with said feeding means of a proportioning mechanism comprising a scale for determining the weight of ore fed to the conveyor, means for adjusting said hot recycle feeding means to feed this material substantially at the rate received, a summator connected to said scale and to said adjusting means for combining the weights of ore and hot recycle, and ratio devices connected to said summator and to said additive feeding means for proportioning the rate of feeding additives as definite ratios of the combined weights of ore and hot recycle.

2. A combination as defined in claim 1 further comprising a time delay device in the adjusting means for said hot recycle feeding means to delay adjustments in the rate of feeding hot recycle until compensated for by adjustments in the rate of feeding ore.

3. In an apparatus for compounding sinter feed, which apparatus includes a main conveyor and individually controllable feeders for feeding ore, additives and hot recycle successively to said conveyor, the combination with said feeders of a proportioning mechanism comprising means for adjusting the rate of ore feed, a belt scale traversed by said conveyor between said ore and additive feeders for determining the weight of ore fed thereto, means for adjusting said hot recycle feeder to feed this material substantially at the rate received, a summator connected to said belt scale and to said second named adjusting means for continuously combining the weight registered on said scale with the setting of said second named adjusting means, and ratio devices connected with said summator and the respective additive feeders for proportioning the rate of feeding additives as definite ratios of the combined weights of ore and hot recycle.

4. In an apparatus for compounding sinter feed, which apparatus includes a main conveyor and individually controllable feeders for feeding ore, additives and hot recycle successively to said conveyor, the combination with said feeders of a proportioning mechanism comprising means for adjusting said hot recycle feeder to feed this material substantially at the rate received, means for adjusting said ore feeders inversely to said hot recycle feeder to maintain the combined feed of hot recycle and ore substantially constant, means for computing the combined weight of ore and hot recycle fed to said conveyor, and control means for said additive feeder operatively connected with said computing means for proportioning the additives in accordance with the combined feed of hot recycle and ore.

5. A combination as defined in claim 4 further comprising a feedback connection between the adjusting means for said hot recycle feeder and the adjusting means for said ore feeder via said computing means to adjust the ore feed rate automatically with adjustments in hot recycle feed rate.

6. In an apparatus for compounding sinter feed, which apparatus includes a main conveyor and individually controllable feeders for feeding ore, additives and hot recycle successively to said conveyor, the combination with said feeders of a proportioning mechanism comprising means for adjusting said hot recycle feeder to feed this material substantially at the rate received, means for adjusting said ore feeders inversely to said hot recycle feeder to maintain the combined feed of hot recycle and ore substantially constant, a time delay device in the adjusting means for said hot recycle feeder to delay adjustments in the rate of feeder hot recycle until the portion of said conveyor on which the rate of feeding ore has changed reaches said hot recycle feeder, and control means for said additive feeder for proportioning the additives in accordance with the combined feed of hot recycle and ore.

7. In an apparatus for compounding sinter feed, which apparatus includes a main conveyor and individually

7

controllable feeders for feeding ore, additives and hot recycle in the order named to said conveyor, the combination with said feeders of a proportioning mechanism comprising means for maintaining the combined feeding rate of ore and hot recycle substantially constant, means for continuously summing the actual combined feeding rate thereof, and ratio devices connecting said summing means and said additive feeders for maintaining the additive feeding rate as a definite ratio of the combined feeding rate of ore and hot recycle.

8. In an apparatus for compounding sinter feed, which apparatus includes a main conveyor and individually controllable feeders for feeding ore, additives and hot recycle successively to said conveyor, the combination therewith of a mechanism for regulating said ore feeders comprising means for transmitting a signal proportionate to the desired sum of the ore and hot recycle feed rates, means for transmitting another signal proportionate to the actual ore feed rate, means for transmitting a third signal proportionate to the setting of said hot recycle feeder, and control means operatively connected with said ore feeders and said transmitting means for adjusting the ore feed rate to maintain the sum of the ore and hot recycle feed rates at the constant desired level.

9. In an apparatus for compounding sinter feed, which apparatus includes a main conveyor and individually controllable feeders for feeding ore, additives and hot recycle successively to said conveyor, the combination therewith of a mechanism for regulating said ore feeders comprising means for transmitting a first signal proportionate to the desired sum of the ore and hot recycle feed rates, means for transmitting a second signal proportionate to the actual ore feed rate, means for transmitting a third signal proportionate to the setting of said hot recycle feeder, means for computing the sum of said second and third signals operatively connected to the transmitting means therefor, and control means operatively connected with said ore feeders, with the transmitting means for said first signal and with said computing means for adjusting the ore feed rate to maintain the sum of the ore and hot recycle feed rates at the constant desired level.

10. In an apparatus for compounding sinter feed, which apparatus includes a main conveyor composed of at least one power driven belt, a mixing device adapted to receive material from said conveyor, and individually controllable means for feeding ore, additives and hot recycle successively to said conveyor, the combination with said feeding means of a proportioning mechanism comprising a scale for determining the weight of ore fed to the conveyor, means for adjusting said hot recycle feeding means to feed this material substantially at the rate received, a summator connected to said scale and to said adjusting means for combining the weights of ore and hot recycle, and ratio devices connected to said summator and to said additive feeding means for proportioning the rate of feeding additives as definite ratios of the combined weights of ore and hot recycle.

11. A combination as defined in claim 10 in which the

8

feeding means for ore, additives and hot recycle are situated to feed these materials to a belt ahead of said mixing device, whereby said mixing device receives hot recycle as well as ore and additives.

12. A combination as defined in claim 10 in which the feeding means for ore and additives are situated to feed these materials to a belt ahead of said mixing device, and the feeding means for hot recycle is situated to feed the latter material to a belt beyond said mixing device, whereby said mixing device receives ore and additives, but hot recycle is excluded therefrom.

13. A method of compounding sinter feed comprising feeding successively to a traveling conveyor ore, additives, and hot recycle at a predetermined respective rate for each, continuously and separately obtaining measurements of the feeding rates of ore and hot recycle, continuously obtaining a summation of said measurements, and continuously controlling the feeding rate of additives to a rate proportional to this summation.

14. A method of compounding sinter feed comprising feeding successively to a traveling conveyor ore, additives, and hot recycle at a predetermined respective rate for each, maintaining the combined feeding rate of ore and hot recycle substantially constant, continuously and separately obtaining measurements of the actual feeding rates of ore and hot recycle, continuously obtaining a summation of said measurements, and continuously controlling the feeding rate of additives to a rate proportional to this summation.

15. A method of compounding sinter feed comprising receiving hot recycle at a variable rate from a sintering operation, feeding successively to a traveling conveyor ore, additives and hot recycle at a predetermined respective rate for each, adjusting the feeding rate of hot recycle to substantially the rate received, inversely adjusting the feeding rate of ore to maintain the combined feeding rate of ore and hot recycle substantially constant, continuously obtaining measurements of the actual feeding rates of ore and hot recycle, continuously obtaining a summation of these measurements, and continuously controlling the feeding rate of additives to a rate proportional to this summation.

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