This invention relates to material processing methods and systems, and more particularly to control of crushing devices.

An object of this invention is to operate crushing devices, particularly of the cone type, at selected capacity, preferably optimum, without overloading.

Another object is to operate crushing devices, particularly of the cone type, without subjecting them to an overload.

Another object is to operate crushing devices, particularly of the cone type, at selected efficiency by continuously introducing into the crushe the right amount of material needed to operate the crushe at selected efficiency.

Another object is to operate a crushe of the cone type at a selected efficiency by governing the height of the cone relative to the crushing ring in accordance with the loading of the crushe.

Another object is to operate a crushe, particularly of the cone type, at selected efficiency with an automatic control system which will supply approximately the proper amount of feed to operate the device at selected efficiency.

Another object is to operate a crushe, particularly of the cone type, at maximum efficiency with an automatic control system which will position the cone in relation to the ring to operate the device at maximum efficiency.

Another object is to automatically operate a plurality of the crushing devices arranged to crush material in successive stages at selected efficiency, and particularly to operate such devices automatically.

Another object is to provide an automatic control system and method of operation for crushing devices, particularly of the cone type, in which a primary crushe feeds material to a plurality of secondary crushe in which the secondary crushe are automatically maintained under selected loading.

Another object is to provide an automatic control system and method of operation for crushing devices, particularly of the cone type, in which a primary crushe feeds material to a plurality of secondary crushe in which the secondary crushe are automatically maintained under selected loading and additionally automatically controlling the amount of material fed to the primary crushe in response to the needs of the secondary crushe to operate the secondary crushe at selected efficiency, and in which the primary crushe is maintained at selected operative efficiency by automatically positioning the mantle with respect to the concave in accordance with the loading of the primary.

Another object is to provide an automatic control system and method of operation for crushing devices, particularly of the cone type, in which a primary crushe feeds material to a plurality of secondary crushe in which the secondary crushe are automatically maintained under selected loading and additionally automatically positioning the mantle with respect to the concave of the primary crushe in response to the needs of the secondary crushe to operate the secondary crushe at selected efficiency, and in which the primary crushe is maintained at selected operative efficiency by automatically controlling the amount of material fed to the primary crushe in accordance with the loading of the primary crushe.

Another object is to provide an over-riding control and method of operation of the plurality of crushing devices as in the preceding objects in which the over-riding control on any of the crushing devices over-rides all of the control system and effects a reduction in feed of material to the primary crushe when the level of material in any one of the crushers is above a selected level, or effects a change in size of material to the overloaded crushe to relieve the overload condition.

Another object is to provide an automatic control system and method of operation for crushing devices, particularly of the cone type, in which a primary crushe feeds material to a plurality of secondary crushe, and in which the secondary crushe are automatically maintained under selective relative loading, and in which all of the crushe are operated at a desired efficiency, preferably maximum efficiency.

Other objects, features and advantages of this invention will be apparent from the drawings, the specification and the claims.

This invention is characterized by the operation of a single crushe, or a plurality of crushe in stages, at selected efficiencies. The desired operating efficiencies of the units are maintained through control of the volume of feed, by varying the speed of the feed conveyor, or through control of the size of the material in the feed, by varying the cone position and setting of the previous crushe stage, or through control of the degree of crushing and size reduction by the crushe, by varying the cone position and setting of the crushe. The operating efficiencies of the units are determined by sensing their loading condition which is accomplished by sensing the power input to the drive, or by sensing the thrust on the cone (crushing pressure), or by sensing the level of the material in the crushe.

Where a single crushe is involved the operating efficiency or loading can be determined by sensing the power input, the thrust on the cone, or the level of the material in the crushe, and the desired efficiency or crushe loading can be maintained by varying the feed rate to the crushe or by varying the cone position relative to the ring of the crushe.

Where crushe arranged in stages are employed, the control system and method are more complex. Where a plurality of secondary crushe are employed the loading of each secondary is sensed and compared. A divider is placed in the stream of material passing from the primary to the secondaries. This divider or proportioner is shifted in accordance with the compared loading to direct the right amount of material to each secondary to maintain the desired relative efficiency of operation of the secondaries. The sensed loading on the secondaries is also utilized to control the overall efficiency of the secondaries. This sensed loading may be utilized to control either the overall feed to the entire system or the size of material discharging from the primary crushe. For instance, the secondary loading may control the speed of the conveyor delivering material to the primary crushe. In this case it is preferred to also sense the loading on the primary crushe and change the cone position to also maintain the primary crushe operating at a selected efficiency. As an alternative, it is possible to have the loading on the secondaries control the cone position of the primary crushe. In this arrangement the loading on the primary is sensed and the speed of delivery of material to the primary is controlled in accordance with the loading on the primary.

In the drawings, wherein like reference numerals indicate like parts, and wherein illustrative embodiments of this invention are shown:

FIGURE 1 is a schematic illustration of the method of operating a crushe;
FIGURE 2 is a schematic illustration of the method of operating a plurality of crushers; Figure 3 is a schematic illustration of the method of operating a plurality of crushers in which all crushers may be operated at a desired efficiency; and Figure 4 is a schematic illustration of the method of operating the crushers is sensed by determining the level of material therein.

In the single crusher form of this invention, the rate of delivery of material to the crusher or degree of crushing is controlled according to the efficiency at which the crusher is operated. Thus, desirably, if the crusher is operating below efficiency, more material is fed to the crusher or it is set to crush to a smaller size so that it may operate at maximum efficiency. If too much material is being fed to the crusher and it is being overloaded, then the flow of material to the crusher is reduced to permit it to regain optimum operating conditions. Alternatively, the finished size may be increased. In accordance with this invention, the loading of the crusher is utilized as the control medium, and the power consumption, level of material in the crusher, or hydraulic pressure of the crusher is utilized as indicia of the efficiency at which the crusher is operating.

Referring first to FIGURE 1, the invention is shown in a system which includes a cone-type crusher indicated generally at 10. The crusher illustrated is sold by the Allis Chalmers Company, of Milwaukee, Wisconsin, under the trade name Hydrocone, and is fully illustrated in Company Publication No. 2714. As indicated in FIGURE 1, the cone crusher includes a crusher ring 11 and a cone or mantle 12 which cooperates with the ring 11 to crush material fed into the mouth 13 of the crusher. The cone 12 is mounted for gyration. The cone 12 has provided on its spindle a gear 14 which meshes with a drive gear 15 on the arbor 16 of motor M. Operation of motor M causes gyration of the cone 12 which crushes the material between the cone and ring 11.

Material from the crusher 10 is discharged onto the conveyor belt indicated generally at 17 which conveys the crushed material to the next treating stage in the operation.

Material is fed to the cone crusher by any desired feed means, such as the conveyor belt indicated generally at 18. This conveyor belt is designed for variable speed operation for purposes of control of the crusher, as will more fully appear hereinafter. Material from the conveyor 18 is discharged onto the conveyor indicated generally at 19, the material below a predetermined mesh size bypasses the crusher 10 and is conveyed directly to the conveyor 17.

Any desired means may be used to sense the instantaneous power consumption of the crusher, such as a thermo-converter sensing device or a contact-making ammeter, and the signal from the sensing device is utilized as the basis for control of the speed of the conveyor 18, or the positioning of the cone 12.

Alternatively, the control system can utilize a pressure sensing device whereby the pressure on the hydraulic cone support system serves as the indicia of the crusher loading (see FIG. 3), or the level of material in the crusher may be determined as in FIG. 4. In FIG. 1 a power sensing device 21 senses the load on the crusher by sensing the load on motor M. This sensing device in combination with a controller 22 regulates the variable speed drive unit for the conveyor 18. The variable speed drive for conveyor 18 is schematically represented in the drawings in FIG. 23. As the details of construction and operation of the power-sensing device and the controller are not material, and any desired type could be used, they are also schematically represented in the drawings.

With the system of FIGURE 1, a determination may be made of the maximum efficiency to be obtained with the crusher under given operating conditions, and the power consumption of the crusher under these conditions determined. Then the controller system 22 may be set so that when the signal generated by the power-sensing device 21 is equal to the optimum value, no change is made in the speed of conveyor 18. However, when the power-sensing device indicates use of a lesser amount of power, then the controller should signal the variable speed unit 23 to increase the speed of conveyor 18 to feed more material into the crusher so that it will be operating under greater load conditions to bring it back to maximum efficiency. In like manner, where the unit is overloaded and the power-sensing device is indicating use of an excess amount of power, the controller system would signal the variable speed control of the conveyor to slow down the conveyor and reduce the flow of material to the crusher. It will be understood that, alternatively, the position of the cone or crusher setting can be modified instead of the feed rate to maintain the desired crusher loading or efficiency. It will also be understood that as alternatives to the power consumption, either the crushing pressure, or the level of the material in the crusher can be utilized as indicators of the crusher loading.

If desired, a recorder might be included in the controller system to plot against time one or more of the signals flowing through the controller system to give a permanent record of operation of the crusher.

To guard against overloading of the crusher, a level-sensing device 24 is provided which is actuated when the level of material in the crusher rises above a desired point. The level-sensing device, upon being actuated, signals the controller system 22 and the controller system is constructed so that the level-sensing device is an overriding control and over-rides the signal induced by the load-sensing device to call for a reduction in speed of the conveyor 18 until such time as the level-sensing device is deactivated.

Referring now to FIGURE 2, a system is shown for operating a plurality of crushers. A pair of secondary crushers indicated generally at 16b and 16c receive material from the primary crusher 16a and further crush the material. As in the FIGURE 1 form of the invention, the material is fed to a screen 19 by a means such as conveyor 18 whose speed is variable.

Material crushed by primary crusher 16a is discharged onto the receiving means indicated generally at 20. This means receives the material and divides it into separate portions and conveys the separate portions to the secondary crushers 16b and 16c.

In accordance with this invention, the two crushers 16b and 16c are operated at selected loads by dividing the material from the primary crusher on the receiving means 20 and feeding the secondary crushers approximating the means 20 and feeding the secondary crushers approximately what is required to operate them at the selected loads. Preferably both secondary crushers are operated at maximum efficiency. For this purpose the receiving means 20 is automatically controlled to divide and deliver to the secondary crushers the right amount of material. Preferably, the receiving means 20 is a platform 26 receiving material from primary crusher 16a and positioned to overlie at each end the two secondary crushers. The platform 26 may be confined by side walls (not shown) on two opposite sides to direct flow toward the two secondary crushers.

It will be noted that the receiving means 20 receives material at its mid-section and extends from the receiving section to points over the secondary crushers. This causes material to pile up on platform 26 in a dividing ridge. With the platform 26 centered between the secondary crushers, an equal amount of material is delivered to each crusher. By moving the platform 26 toward crusher 16b the dividing ridge is shifted with the platform 26 toward crusher 16b and thus more material will be fed into crusher 16b than crusher 16b. If a more positive split is desired, an artificial dividing ridge might be
provided by an upright member carried on the center section of platform 26. It will of course be apparent that more than two secondary crushers might be utilized and that the material from the primary stage of crushing might be divided in any desired way. The illustrated embodiment is preferred because it does not employ parts readily eroded by contact with the stream of material. Preferably the platform 26 may be shifted along a line extending between the two secondary crushers 10b and 10c automatically in accordance with the relative loads between the secondary crushers.

In maintaining the relative loading on the secondary crushers at selected values, their loads are sensed and compared, and a control system utilized to shift the position of platform 26 in accordance with the situation.

In carrying out this control system, a power-sensing device 28 senses the load on secondary crusher 10b and a similar power-sensing device 29 senses the load on secondary crusher 10c. The signals from these sensing devices are then fed into a splitter control 32 which compares the output of the power-sensing devices 28 and 29, and, if the signals indicate that the secondary crushers are not operating at the desired relative loads, the splitter control operates the shift control positioner 34 to shift platform 26 on supports 30 in the proper direction to shift the proportion of the output of the primary crusher 20 to the secondary crushers to cause them to operate at approximately the desired relative loads. Preferably, the secondary crushers are operated at equal efficiencies in this manner.

In some instances it may be desired to operate the secondary crushers at difference loads. For instance, where one crusher has new crushing surfaces and the other crusher has older crushing surfaces, it will be apparent that maximum efficiency will be obtained with different loads on the crushers. Therefore, it is preferred to place a loading ratio device in the power-sensing circuit such as at 31. This device may be suitably multiply or divide the signal from power-sensing device 28 to form a false signal into splitter control 32. With loading ratio device set at other than 1 to 1 ratio, the platform 26 will tend to remain in an off-center position and load one crusher more than the other crusher. In this manner each crusher may be operated at the same efficiency.

A signal is fed by each of the power-sensing devices of the secondary crushers to controller recorder system 22 and the combined signal controls variable speed unit 23 in the manner previously explained to supply the right amount of material to operate the secondary crushers at maximum efficiency. Preferably, the power-sensing devices signal an averaging device 33 which averages the power-sensing device signals and feeds the average signal to the controller-recorder system 22. System 22, the variable speed means 23 and the conveyor belt 18 are identical with those shown in FIGURE 1, and the signal from the averaging device operates the controller system to increase or decrease the amount of material fed to the primary crusher, which in turn will increase or decrease the amount of material passing to the secondary crushers and maintain the amount of feed through the system at a value which will give maximum efficiency of operation of the secondary crushers. It will be understood that the loading of the secondary crushers can be determined not only by sensing the power consumption, as just described, but alternatively by sensing the crushing pressures, or by sensing the level of material in the crushers.

As the FIGURE 1 embodiment, each of the crushers is provided with a level-sensing device 24 which when activated signals the controller system to reduce the amount of material fed to the system until such time as the overloaded crusher is relieved.

While only a pair of secondary crushers is shown, it is apparent that, if desired, a larger number of crushers could be used and a suitable dividing means provided for dividing the material among the several crushers in the manner taught herein.

It is apparent that the rate of material fed in a two-stage system may be controlled as in FIGURE 1, and the material distribution controlled as in FIGURE 2, but the entire system of FIGURE 2 is preferred.

Reference is now made to FIGURE 3 which illustrates the preferred form of the invention when multiple crushers are used. In this form of the invention the efficiency group of operation of all of the crushers may be controlled.

A primary crusher 10d receives material from conveyor belt 18 over screen 19 and delivers material to platform 26.

In order to operate the primary crusher 10d at desired efficiency, means are provided for adjusting the position of cone 12 relative to ring 11. In this manner the primary crusher 10d at desired efficiency. Preferably this will be maximum efficiency. To provide for adjustment of cone 12, it is mounted on a plunger 35 which is vertically reciprocal within cylinder 36. Hydraulic fluid under pressure is supplied to the cylinder 36 through conduit 37. The hydraulic fluid in cylinder 36 is transferred to or from the cylinder from reservoir 38 in accordance with the needs of the system.

The amount of hydraulic fluid in cylinder 36 will determine the height of cone 12 relative to ring 11, and this amount may be supplied or removed in any desired manner in response to the needs of the system to maintain the primary crusher 10d under the desired load conditions. For instance, the load on the primary crusher might be determined in the manner disclosed in FIGURE 1, or the pressure under which the fluid is confined in cylinder 36 may be determined by a pressure sensitive controller 41. The pressure within chamber 36 will be a measure of the load on the primary crusher 10d. A signal representative of the load on the primary crusher is transmitted to a pressure sensitive controller 41 which will signal the release or addition of hydraulic fluid from or to chamber 36 as needed to keep the crusher operating at the desired level of efficiency. The pressure sensitive controller 41 might be provided by any device having a variable set point and capable of generating or controlling a signal when the input signal to the controller is above or below the predetermined set point by a selected amount.

The reservoir 38 is connected to conduit 37 through parallel conduits 37a and 37b. A pump 42 is provided in branch conduit 37b and is maintained in constant operation by a motor 43. The pump is of the type having a built-in bypass and maintains the conduit 37b under a selected pressure.

Flow of additional fluid to cylinder 36 is provided by the pressure sensitive controller 41 opening a solenoid-controlled valve indicated generally at 44. When this valve is opened, the output from pump 42 is fed through lines 37b and 37c into chamber 36 to raise cone 12 and increase the load on the cone crusher. As soon as the pressure on the fluid in chamber 36 comes up to the selected value, the pressure-sensitive controller 41 will close valve 44 to retain this pressure on the fluid in cylinder 36.

In the event the crusher 10d becomes overloaded, the pressure within cylinder 36 will excessive which will be signalled to the controller 41. The controller 41 will in turn open fluid controlled valve indicated generally at 45 in branch line 37a to permit flow of hydraulic fluid from cylinder 36 through conduits 37 and 37a into the reservoir 38.

In the event of a sudden overload of the crusher 10d, pressure within cylinder 36 will be relieved by device 46. This device is conventionally used for this purpose and is a closed chamber having a gas filled bladder therein which can be collapsed under excess pressure to permit flow of hydraulic fluid from cylinder 36. The pressure at which the bladder relief means 46 will collapse is greater than the operating range of pressure which is
controlled by controller 41. Thus, the relief means 46 will not interfere with normal operation of the system to maintain the primary crusher operating at desired efficiency, but in the event of a sudden overload will relieve pressure within cylinder 36 to protect the primary crusher 42. The relief valve 47 indicates the pressure within cylinder 36. To illustrate a different manner of control with overload means 24 it has been connected to controller 41 and will override signals from sensing means 39 to relieve pressure in cylinder 36 in case of material building up in the crusher high enough to energize the overload control means 24. Obviously, the primary crusher shown and controlled as in FIG. 3 might be used alone or in conjunction with the secondary crushers. It is further obvious that controller 41 might control the speed of conveyor 18. In like manner, controller 22 of FIG. 1 might control the height of piston 35.

Material from the primary crusher 10d is delivered to platform 26, which in turn transfers the material to the two secondary crushers 10b and 10c. These crushers and their control systems are identical with the system shown in FIGURE 2.

It might be noted that in FIGURE 3 the means for handling the platform 26 is shown in slightly more detail. To shift the platform 26, a piston 48 carried by the platform reciprocates within a cylinder 49. Fluid lines 51 and 52 convey hydraulic fluid to and from the cylinder 49 on opposite sides of piston 48. These two lines 51 and 52 connect to opposed outlets of a four-way valve four-valve unit 53. The other two outlets of the four-way valve are connected to lines 54 and 55 which are in turn connected to reservoir 56. A continuously operating pump 57 is provided in line 55. Thus, with the four-way valve set for inter-connecting lines 54 and 55, fluid merely circulates through the four-way valve. When the valve is shifted in one direction, it interconnects lines 51 and 57 and also interconnects lines 52 and 54 to introduce pressure fluid into cylinder 49 through line 51 and to remove fluid from the cylinder through line 52. When the four-way valve is shifted in the other direction, the reverse flow of fluid occurs. The operating handle for the four-way valve 53 is connected to two solenoid operators 58 and 59. Thus, when solenoid 58 is activated the four-way valve is shifted in a direction to introduce pressure through line 51 into cylinder 49. When solenoid 59 is activated, the four-way valve 53 is shifted to introduce pressure into cylinder 49 through line 52.

The two solenoids 58 and 59 are controlled by the splitter control. For instance, if the splitter control is set to maintain the platform 26 at its median position with nine pounds of instrument air and the power-sensing device 28 sends an eight pound signal due to underloading of crusher 10b, while at the same time the power-sensing device 29 is sending a nine pound signal, then splitter control 32 will compare these two signals and effect operation of solenoid 59 to open four-way valve 53 and shift the platform 26 toward crusher 10b to increase its load. Of course, the reverse operation would occur if the loading on the secondary crushers be reversed. It will be apparent that desirably the system for controlling the three crushers be so designed that there will not be a constant seeking of each of the control means due to minute changes in conditions. To avoid such conditionally means are provided where needed in the system to permit a signalled change to be effective through only a short period of time. For instance, the splitter control 32 would include a timer which would limit the duration of signals to solenoids 58 and 59 and would limit the frequency in which a new signal might be generated in these circuits during a finite period of time. Other portions of the system, such as the controller recorder system 22, might likewise be provided with means for limiting the frequency and magnitude of changes of the variable speed unit 23.

In the operation of the system shown in FIGURE 3, material from a suitable source will be delivered by a conduit 15 to screen 19 which will direct the larger particles into primary crusher 10d. This crusher will coarse-grind the material and deliver it to the platform 26 which will in turn deliver it to the secondary crushers 10b and 10c. The material will be further crushed to a smaller size and then removed by a suitable conveyor means for further treatment. The control system for platform 26 will maintain the two secondary crushers operating at approximately the same efficiency, preferably maximum efficiency.

The device 33 will sense the load of each of the secondary crushers and will generate a signal responsive to this load which will be sent to the controller recorder system 22. While the device 33 is an averaging device, it will be appreciated that any device for sensing the total load on the power-sensing devices 26 and 29 and generating a signal proportional to the sum, or some proportion of the sum, may be employed. In the event the device 33 is signalling a need for additional material to maintain the secondary crushers operating at maximum efficiency, the controller system will increase the speed of the conveyor 18 to produce such material. This might perhaps increase the load on primary crusher 10d to slightly oversize a load it. If this occurred, the cone 12 would lower to return the primary crusher 10d to proper operating efficiency which would result in a larger sized material leaving the primary crusher. As this larger size will require more power to handle it in the secondary crushers, it will be appreciated that a portion of the need for additional loading for the secondary crushers may be supplied by a coarser material being fed to these crushers. The reverse operation is true, and when the feed stream to the primary crusher is reduced, the cone will raise to provide a finer grind which will require less power in passing through the secondary crushers.

FIGURE 4 illustrates a further modified form of this invention which is identical with that shown and explained in FIGURE 3, except that the overload devices 24 are not employed and the load on the crushers is sensed by determining the level of material in each crusher.

The primary crusher indicated generally at 10e is provided at its inlet above the working surface on the cone 12a with a source of radiation 60 which emits radiation across the feed inlet of the crusher. On the other side of the crusher a device indicated at 61, which in the Geiger counter, senses the intensity of the radiation at this point. The sensing device 61 preferably senses radiation over a vertical distance of about one foot. As the material within the mouth of the crusher will absorb radiation emitted by source 60, the amount of radiation received at device 61 will be dependent upon the level of material in the crusher. Preferably, the sensing means 61 will be arranged so that with the material level in the crusher at the bottom of the sensing means the output will be minus 10 millivolts. As the level of material rises in the crusher the signal will increase proportionally until the output with the level even with the top of device 61 will be zero millivolts.

The signal emitted by device 61 will be amplified in amplifier A and fed to the pneumatic converter 63 wherein the signal is converted to pneumatic output 65. The pneumatic signal is fed to the controller recorder system 63 which controls the operation of valves 44 and 45 to effect movement of plunger 35 in the same manner as in the FIGURE 3 embodiment. Thus, as the level of material in the crusher rises above the desired level the controller recorder system 63 will lower system 35 to increase the spacing between the cone 12a and the crusher ring 11a, and thus reduce the load in the crusher and
permit the level of material therein to decrease. Alternatively, the feed rate to primary crusher 10e could be varied in response to the level sensing device.

The secondary crushers 10f and 10g are also provided with radiation sources 60 and radiation sensing means 61. The signals from the sensing means is amplified in amplifier A and fed to pneumatic converter 62 in the same manner as in the primary crusher control system.

The signals from the pneumatic converters associated with each secondary crusher govern the operation of the splitter for determining the relative amounts of material fed to the two secondary systems, as well as the speed of the conveyors 18 to determine the total amount of material fed to the system, in the manner as in FIGURE 3 embodiment of this invention.

It might be noted that where the crushing surfaces of the secondary crushers have been worn to different extents, that the setting of the load ratio device 31 in the manner explained in FIGURE 3 will result in the level in one secondary crusher being maintained higher than the level in the other secondary crusher to thus increase the feed head on one crusher and maintain both secondary crushers operating at the desired efficiency.

From the above it will be seen that systems have been provided for operating one, or all of a plurality of cone crushers at the desired efficiency. In the FIGURE 1 form of the invention, a single crusher is controlled to operate at desired efficiency. In the FIGURE 2 form of the invention the secondary crushers operate at desired efficiency. In the FIGURES 3 and 4 forms of the invention, all of the crushers operate at a desired efficiency.

As an alternative control system it is obvious that the load on the secondary crushers can be utilized to vary the height of piston 35, thus varying the size of material fed to the secondary crushers. In this system the means of controlling conveyor belt speed shown in FIGURE 1 would be used.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What we claim is:

1. The method of operating a plurality of one-type crushers in which feed from a primary crusher is directed to a secondary crusher comprising, measuring the loading of each of the primary and secondary crushers, comparing the measured loading of the secondary crusher with a selected loading and moving the ring and cone relative to each other in the primary crusher to maintain the secondary crusher operating at a selected efficiency.

2. The method of operating a plurality of cone-type crushers in which feed from a primary crusher is directed to a plurality of secondary crushers comprising, measuring the loading of each of the secondary crushers, comparing the measured values and directing more or less of the stream of material from the primary crusher to each of the several secondary crushers, comparing the loading of the secondary crushers at selected relative values, and moving the ring and cone relative to each other in the primary crusher to maintain the secondary crushers operating at a selected efficiency.

3. The method of operating a plurality of cone-type crushers in which feed from a primary crusher is directed to a secondary crusher comprising measuring the loading of each of the primary and secondary crushers, comparing the measured loading of the secondary crusher with a selected loading and moving the ring and cone relative to each other in the primary crusher to maintain the secondary crusher operating at approximately a selected efficiency, and comparing the loading of the primary crusher with a selected loading and varying the feed of material to the primary crusher in accordance with the comparison of the measured and selected loading to increase or decrease the feed to the primary crusher to maintain the primary crusher operating at the selected efficiency.

4. The method of operating a plurality of cone-type crushers in which feed from a primary crusher is directed to a plurality of secondary crushers comprising measuring the loading of each of the secondary crushers, comparing the measured values and directing more or less of the stream of material from the primary crusher to each of the several secondary crushers to maintain the loading of the several secondary crushers at selected relative values, comparing the loading of the several secondary crushers at approximately a selected efficiency, and comparing the loading of the primary crusher with a selected loading and varying the feed of material to the primary crusher in accordance with the comparison of the measured and selected loading to increase or decrease the feed to the primary crusher to maintain the primary crusher operating at the selected efficiency.

5. The method of operating a plurality of cone-type ore crushers in which feed from a primary crusher is directed to a plurality of secondary crushers comprising, measuring the load on each of the secondary ore crushers, comparing the measured values and directing more or less of the stream of ore from the primary ore crusher to each of the several secondary ore crushers to maintain the load on the several secondary ore crushers at selected relative levels, comparing the measured load on the several secondary ore crushers with a selected load, and varying the feed of ore to the primary ore crusher in accordance with the comparison of the measured and selected load to increase or decrease the load to the system by an amount needed to maintain the secondary ore crushers operating at a selected efficiency.

6. The method of operating a plurality of cone-type ore crushers in which feed from a primary crusher is directed to a plurality of secondary crushers comprising, measuring the load on each of the secondary ore crushers, comparing the measured values and directing more or less of the stream of ore from the primary ore crusher to each of the several secondary ore crushers to maintain the load on the several secondary ore crushers at selected relative levels, comparing the measured load on the several secondary ore crushers with a selected load, and varying the feed of ore to the primary ore crusher in accordance with the comparison of the measured and selected load to increase or decrease the ore fed to the system by an amount needed to maintain the secondary ore crushers operating at a selected efficiency.

7. The method of operating a plurality of cone-type ore crushers in which ore is first crushed in a primary ore crushe and then fed into a plurality of secondary ore crushers comprising, measuring the load on each of the secondary ore crushers, comparing the measured values and directing more or less of the load on the secondary ore crushers, comparing the measured load on the ore crushers with a selected load at which desired efficiency of operation of the secondary ore crushers would be obtained, and varying the height of the cone of the primary crusher in accordance with the compared average load and selected load to increase or decrease the size of ore fed to the secondary crushers as necessary to attain the desired efficiency of operation of the secondary ore crushers.

8. The method of operating a plurality of cone-type ore crushers in which feed from a primary crusher is directed to a plurality of secondary crushers comprising, measuring the load on each of the secondary ore crushers, comparing the measured values and directing more or
less of the stream of ore from the primary ore crusher to each of the several secondary ore crushers to maintain the load on the several secondary ore crushers at selected relative levels, comparing the load on the secondary ore crushers with the selected load values, and varying the height of the cone of the primary ore crusher in accordance with the comparison of said load on the secondary ore crushers and said selected load value to increase or decrease the ore size to the secondary crushers by an amount needed to maintain the secondary ore crushers operating at a selected efficiency.

9. The method of operating a plurality of cone-type ore crushers in which ore is first crushed in a primary ore crusher and then fed into a plurality of secondary ore crushers comprising, measuring the load on each of the secondary ore crushers, comparing the load on the secondary ore crushers with a selected load value at which a desired efficiency of operation of the secondary ore crushers would be obtained and varying the rate of feed of ore to the primary ore crusher in accordance with the comparison to increase or decrease the amount of ore fed to the system as necessary to attain the desired efficiency of operation of the secondary ore crushers.

10. An ore conveying system comprising, primary ore crushe means, means delivering feed ore to the primary ore crushe means, a plurality of secondary ore crushe means, motor means operating said ore crushe means, means receiving ore from the primary ore crushe means and dividing it into portions and delivering said portions to the respective secondary ore crushe means including movable means in the path of ore flow from the primary to secondary ore crushers, means for positioning said movable means, means sensing the load on each of said secondary ore crushe means, means for comparing the signals from the several sensing means and controlling said positioning means to vary the proportion of feed ore to the several secondary ore crushe means and maintain operation of all secondary ore crushe means at selected relative loads.

11. An ore conveying system comprising, primary ore crushe means, means delivering feed ore to the primary ore crushe means including means for varying the rate of delivery of said ore, means for controlling said varying means, a plurality of secondary ore crushe means, motor means operating said ore crushe means, means receiving ore from the primary ore crushe means and dividing it into portions and delivering said portions to the respective secondary ore crushe means including movable means in the path of ore flow from the primary to secondary ore crushe means, means for positioning said movable means, means sensing the load on each of said secondary ore crushe means, means for comparing the signals from the several sensing means and controlling said positioning means to vary the proportion of feed ore to the several secondary ore crushe means and maintain operation of all secondary ore crushe means at selected relative loads.

12. An ore conveying system comprising, primary ore crushe means, means delivering feed ore to the primary ore crushe means including means for varying the rate of delivery of said ore, means for controlling said varying means, means sensing the instantaneous load on each of said secondary ore crushe means, means for comparing the signals from the several sensing means and controlling said positioning means to vary the proportion of feed ore to the several secondary ore crushe means and maintaining operation of all secondary ore crushe means at selected relative loads, said means for controlling said positioning means receiving signals from each of said sensing means and controlling said varying means in accordance with the signals received to increase or decrease the rate of delivery of ore to the primary ore crushe means upon a decrease or increase respectively in load on said secondary ore crushe means relative to a selected load to maintain said secondary ore crushe means operating at selected loads.

13. An ore conveying system comprising, primary ore crushe means, means delivering ore to the primary ore crushe means including means for varying the rate of delivery of said ore, means for controlling said varying means, a plurality of secondary ore crushe means, motor means operating each said ore crushe means, means receiving ore from the primary ore crushe means and dividing it into portions and delivering said portions to the respective secondary ore crushe means, means sensing the load on each secondary ore crushe means, means for controlling said positioning means receiving signals from each of said sensing means and controlling said varying means in accordance with the signals received to increase or decrease the rate of delivery of ore upon a decrease or increase, respectively, in load on said secondary crushe means relative to a selected load to maintain the right amount of ore in the secondary ore crushe means for selected operating efficiency thereof.

14. An ore conveying system comprising, primary ore crushe means, means delivering ore to the primary ore crushe means including means for varying the rate of delivery of said ore, means for controlling said varying means, said crushe including a ring and cone cooperating to crush ore, means for moving said ring and cone toward and away from each other, motor means for gyrating said cone, means operable in response to the load on said ore crushe means for operating said means for moving the ring and cone relative to each other to maintain the load on the ore crushe at selected value, secondary ore crushe means receiving ore from the primary ore crushe means and further reducing it in size, and means sensing the load on said secondary ore crushe means and signaling said means controlling said varying means in accordance with the load on said secondary ore crushe means; increase or decrease the rate of delivery of ore to the primary ore crushe means upon a decrease or increase, respectively, in load on said secondary or crushe means relative to a selected load.

15. The ore conveying system of claim 14 wherein the secondary ore crushe means is provided by a plurality of ore crushe means, provided for receiving ore from the primary ore crushe means and dividing it into portions and delivering said portions to the respective secondary ore crushe means including movable means in the path of ore flow from the primary to the secondary ore crushe means, means for positioning said movable means, means sensing the instantaneous load of each of the secondary ore crushe means, and means for comparing the signals from the several sensing means and controlling said positioning means to vary the proportion of feed ore to the several secondary ore crushe means and maintain operation of the secondary ore crushe means at selected relative loads.

16. An ore conveying system comprising, primary ore crushe means, said crushe including a ring and cone cooperating to crush ore, means for moving said ring and cone toward and away from each other, motor means for gyrating said cone, secondary ore crushe means receiving ore from the primary ore crushe means
and further reducing it in size, means sensing the load on said secondary ore crusber means, and means receiving signals from said sensing means and operable in response to the signals received for operating said means for moving the ring and cone relative to each other to maintain the load on the secondary ore crusber means at a selected value.

17. An ore crushing system comprising, primary ore crusber means, said crusber means including a ring and cone cooperaible to crush ore, means for moving said ring and cone toward and away from each other, motor means for gyrating said cone, secondary ore crusber means receiving ore from the primary ore crusber means and further reducing it in size, means sensing the load on said secondary ore crusber means, means receiving signals from said sensing means and operable in response to the signals received for operating said means for moving the ring and cone relative to each other to maintain the load on the secondary ore crusber means at a selected value, means delivering ore to the primary ore crusber means including means for varying the rate of delivery of said ore, means sensing the load on the primary ore crusber, and means operable in response to the load on said primary ore crusber and controlling said varying means in accordance with the load on the primary ore crusber to maintain the load on the primary ore crusber at a selected value.

18. A crushing system comprising a plurality of crushers, means for delivering feed material to the crushers including means for dividing the feed into portions and delivering said portions to the respective crushers, said dividing means including movable means in the path of the material flow to the crushers, means for positioning said movable means, means sensing the loading of each crusber, means for comparing the signals from the several sensing means and controlling said positioning means to vary the proportion of feed material to the several crusbers and maintain operation of all the crushers at selected relative loadings, and means for controlling the rate of delivery of feed material to the crushers in accordance with the load on said crushers relative to a selected value to maintain the crushers operating at selected loadings.

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