

March 2, 1937.

C. H. FREESE

2,072,747

CARRIER SYSTEM

Filed Jan. 23, 1932

2 Sheets-Sheet 1

Fig 1

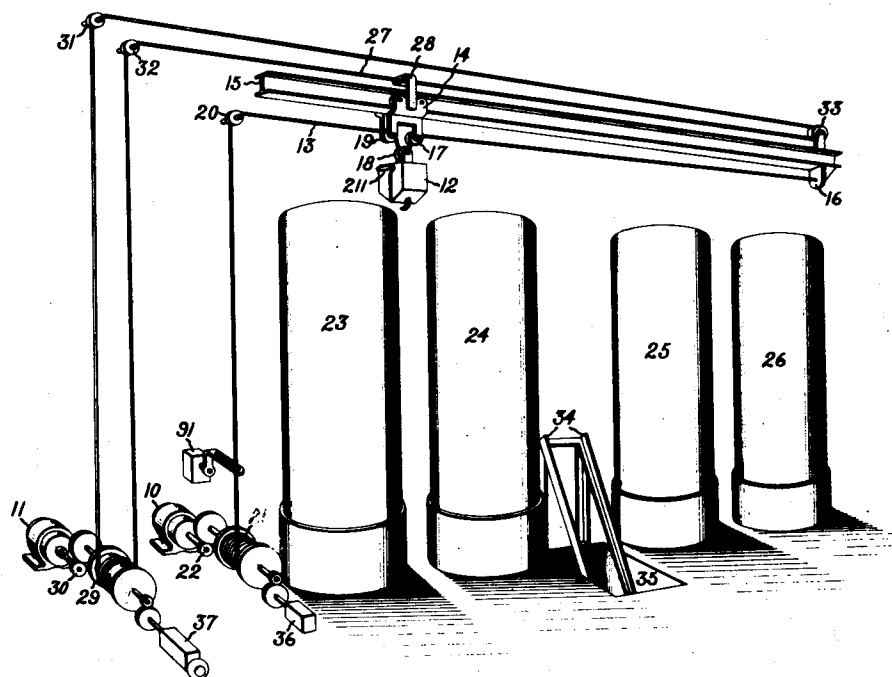
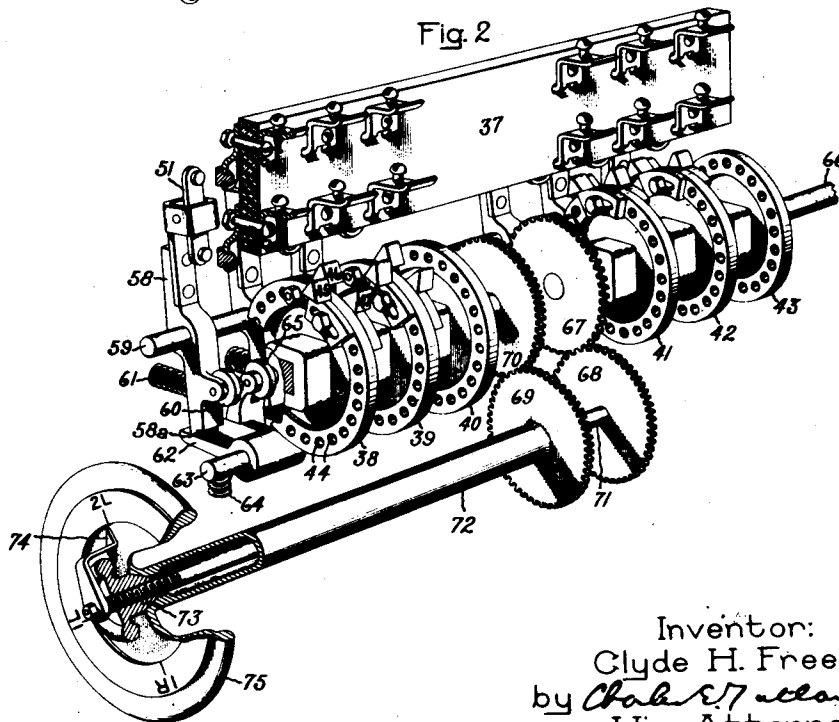


Fig 2



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March 2, 1937.

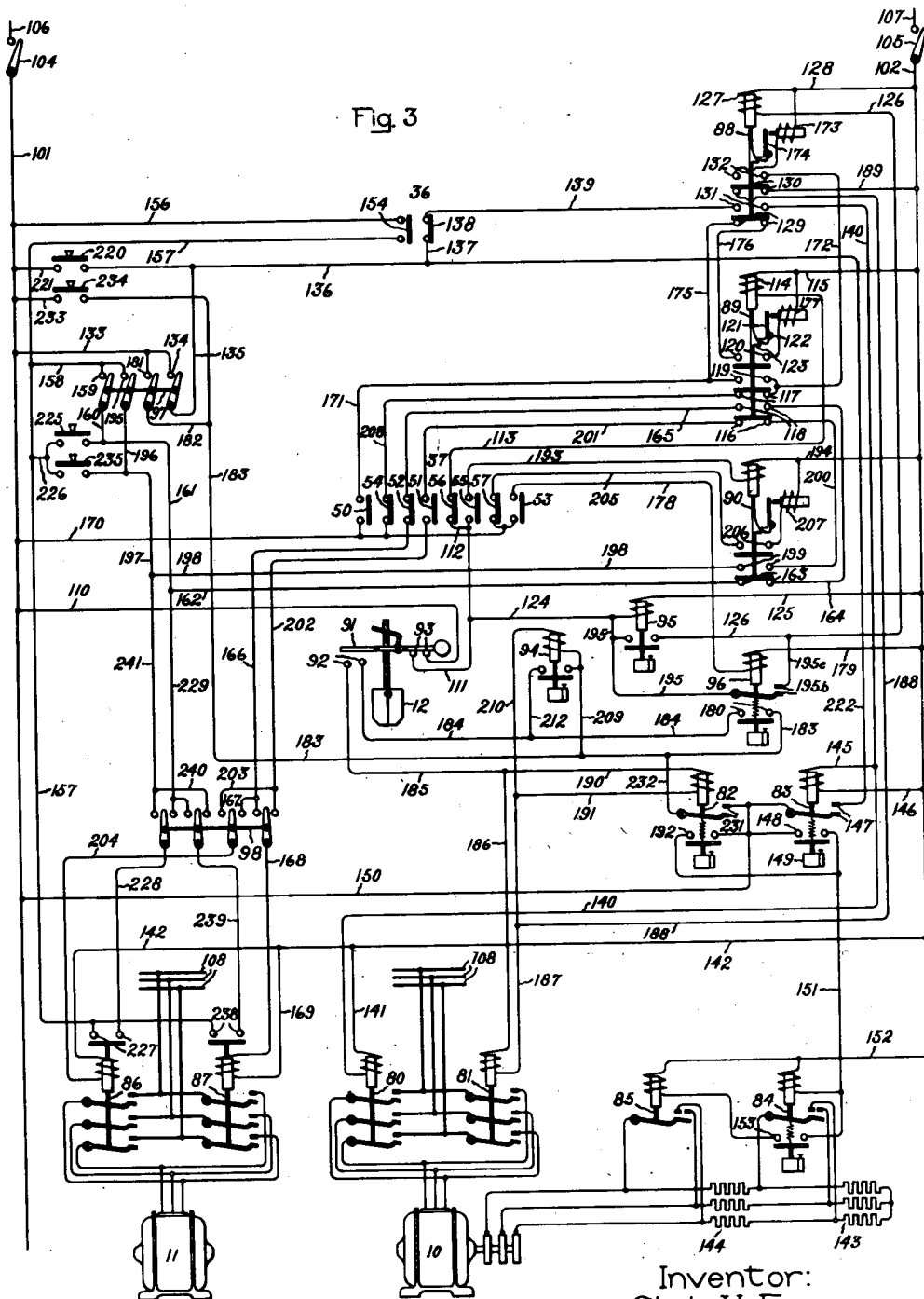
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CARRIER SYSTEM

Filed Jan. 23, 1932

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,072,747

CARRIER SYSTEM

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Application January 23, 1932, Serial No. 588,368

10 Claims. (Cl. 212-132)

My invention relates to carrier systems and has for an object the provision of a simple and reliable control system which may automatically or under manual control repeatedly carry out a predetermined cycle of operation.

My invention has general application to systems wherein a carrier is adapted to be set in operation, as for example at a loading station and thereafter travel to another station such as a dumping station where it is automatically reversed and brought back to the loading station. In coal handling systems of this type, it is the usual practice to have a plurality of storage silos arranged on either side of a loading pit into which the coal is first dumped from the railroad cars.

Heretofore track limit switches have been used to control the energization of the trolley and hoisting motors. The problem of wiring in limit switches of this type is difficult due to the relatively small space available on the track. Furthermore, every installation requires the large amount of field work necessary to the installation and to the wiring of the switches.

An important feature of my invention is its adaptability to existing installations, a minimum amount of wiring and initial adjustment being required. This feature of my invention is obtained by the use of geared limit switches so that duplicate control equipment may be used regardless of the number of silos or their location with respect to the loading pit.

In carrying out my invention in one form I provide a plurality of interlocking control circuits so that when one of the driving motors is energized for a particular movement of the carrier, the other motor may not be energized until the carrier has completed that particular movement. For example, when the hoisting motor is energized to hoist the bucket from the loading pit, the trolley motor cannot be energized. However, as soon as the bucket has been hoisted to the proper elevation above the silos or unloading stations, a position responsive switch serves to de-energize the hoisting motor and to energize the trolley motor. I further provide a geared limit switch having a group of contacts for stopping the bucket over the loading pit and a group of contacts for stopping the bucket over a silo. An adjustable connection between the respective groups of contacts varies the operation of the group of contacts for the silo with respect to the contacts for the pit so that any particular silo may be selected for the carrying out of the cycle irrespective of the number of silos or the distance between them.

In the form of my invention shown the system may be operated continuously, the establishment and interruption of the control circuits being entirely automatic. The transfer from one control circuit to a second control circuit always depends upon the establishment of the prior control circuit and upon the position of the bucket with respect to the material handling apparatus. The system may also be operated manually. But for the manual control I retain the advantages of the interlocked circuits so that the operation is semi-automatic, that is to say, each movement of the bucket is initiated by the operation of a push button, but the bucket is automatically stopped as soon as the movement is completed.

For a more complete understanding of my invention, reference should now be had to the drawings, in which Fig. 1 shows a perspective view of a plurality of silos together with the driving motors controlled in accordance with my invention; Fig. 2 is a perspective view partly in section of an adjustable limit switch used for the selection of a particular silo which is to be filled; and Fig. 3 diagrammatically illustrates a control circuit embodying my invention as applied to the material handling apparatus shown in Fig. 1.

Referring now to Fig. 1, I have shown my invention in one form as applied to the control of a hoisting motor 10 and of a trolley motor 11 which motors serve to drive a material carrying bucket 12 through the predetermined cycle of operation. The bucket 12 is supported by a cable 13 and a carriage 14 mounted on a track or I-beam 15.

To provide for the hoisting and lowering of the bucket, the cable 13, secured at one end to the I-beam as indicated by the reference numeral 16, is threaded over a pulley 17 on the carriage, under a pulley 18 carried by the bucket, over a pulley 19 on the carriage, and over a pulley 20, suitably mounted on the supporting frame (not shown) of the carriage track 15, and thence to the cable drum 21 driven by the hoisting motor 10 through the gear 22.

To provide for traverse of the bucket 12 over the silos 23, 24, 25 and 26, an extension 28 of the carriage 14 is secured to the cable 27. This cable is wound over a cable drum 29 driven by the trolley motor 11 by means of the gear 30 and is threaded over pulleys 31 and 32 carried by the track support (not shown) and a pulley 33 mounted on the track or I-beam 15. It will be observed that the silos 23 and 24 are on the left hand side of the track 34 leading through the hatchway 35 to the loading pit (not shown) while the silos 25

and 26 are on the right hand side of the pit 35.

A hoisting limit switch 36 having normally open and normally closed contacts is geared to the hoisting cable drum 21; and similarly trolley limit switch 37 is geared to the cable drum 29. It will be observed that the trolley limit switch 37 shown in Fig. 2 consists of a plurality of lug carrying disks 38, 39, 40, 41, 42 and 43. Each disk, as for example, the disk 38, is provided with 10 holes 44 distributed about its periphery so that the lugs 45, 46 and 47 secured thereto may be adjusted to the desired angular position. The lug 45 serves to close the switch 51. It will be observed that the contact carrying member 58 15 is pivotally mounted on a shaft 59 so that when the lug 45 engages a small metal wheel 60 carried on the lower part of the armature, the armature is forced outwardly against a compression spring 61 closing the switch. The contacts 51 20 are latched to their closed position by means of a member 62 pivotally carried by a shaft 63 and biased upwardly against the notched lower end 58a of the armature 58 by means of a compression spring 64. The contacts are opened by either 25 the lug 46 or the lug 47 engaging the small wheel 65 carried by the member 62. The engagement of the small wheel with a lug causes the member 62 to disengage itself from the notched end 58a of the armature 58 so that the compression spring 30 61 operates the switch to its open position. It will of course be understood that the remaining contacts are similarly constructed and operated.

The selection of a silo into which coal or a like material is to be transported is accomplished 35 by the adjustment of the operating means for the two sets of contacts. For example, the relative angular position of the disks 38, 39 and 40 with respect to the disks 41, 42 and 43 is varied to change the time of operation of one group with 40 respect to the other. The latter group of contact operating disks serves to stop the traverse or trolley motion of the bucket whenever it reaches a position above the hatchway 35, while the former group of disks serves to stop the bucket over 45 a selected silo. During normal operation, the disks are driven directly by the shaft 66, rotated with the cable drum 29. It will be observed that the disks 38, 39 and 40 are rotated by reason of an adjustable driving connection which connection 50 comprises meshing gears 67, 68, 69 and 70. The gear 68 is secured to a shaft 71 supported in a tubular housing 72 which housing carries the gear 69. The shaft and housing are locked together by means of a wedge 73, the latter being 55 provided with a threaded bore for engagement with the end of the shaft 71. Therefore, it will be observed that if the wedge is released the housing 72 may be rotated to drive the gears 69 and 70 consequently varying the relative position 60 of the disks 38, 39 and 40 with respect to disks 41, 42 and 43. As shown, the indicator 74 indicates that the second silo 23 on the left of the pit (2L) is to receive coal. If the silo 24 is to be filled, the wedge 73 is rotated in a direction 65 so that the housing 72 may be rotated independently of the shaft 71. The indicating dial formed by the outwardly flaring extension 75 of the housing 72 is then rotated until the indicator 74 coincides with the position marked 1L. The relative 70 adjustment of the contact operating disks causes the bucket 12 to stop over the silo 24 instead of the silo 23.

Actually there are eight contacts on the trolley limit switch, additional contacts being provided 75 on each extremity of the assembly shown in Fig. 2.

For the purpose of simplifying the drawings the additional contacts have been omitted from this figure. The contacts 50, 51, 52 and 53 (Fig. 3) are adjustable with respect to the contacts 54, 55, 56 and 57.

As shown in Fig. 3, the hoisting motor 10 is of the slip ring type while the trolley motor 11 is of the squirrel cage type. However, it is to be understood that the principles embodied in my motor control circuit are flexible enough to apply 10 to any type of motor drive and to d. c. motor drive as well as to a. c. motor drive. It is also to be understood that while I have discussed my invention in connection with a certain type of coal handling or storage equipment, it can also 15 be applied for any application having a similar duty cycle requirement.

The energization of the hoisting motor 10 is controlled by a hoisting switch 80 and lowering switch 81 together with a hoisting relay 83 and a lowering relay 82. The latter relays serve to energize the first and second accelerating contactors 84 and 85. Similarly, the energization 20 of the trolley motor 11 is determined by the direction controlling switches 86 and 87. The latched in sequence interlocking relays 88, 89 and 90 insure the continuance of the predetermined cycle by providing interlocking control circuits.

A slack cable switch 91 is arranged to open a pair of contacts 92 to deenergize the hoisting motor 10 whenever the bucket is lowered into engagement with the material within the silo or into the loading position in the pit. As the switch contacts 92 are opened, a second pair of contacts 93 are closed to initiate a reversal of 35 the hoisting motor so that the bucket is hoisted out of the silo. After being hoisted out of the silo, the bucket is trolleyed towards the loading hatchway 35. After the bucket is centered over the hatchway a time delay switch 94 delays the energization of the lowering circuit until the oscillations of the bucket have greatly diminished or stopped entirely. A time switch 95 delays the energization of the hoisting motor when the bucket reaches its loading position in the pit, so that it remains in the loading position a sufficient 40 time for the bucket to take on a load of coal. The time switch 96 serves to introduce a short interval of time after the bucket is stopped over a silo and before the lowering switch is energized so that the bucket will not be oscillating to any great extent as it is lowered into a silo. For manual operation the four pole single throw switch 97 is left open and for automatic 45 operation it is closed. A four pole double throw switch 98 is provided to reverse the relative energization of the trolley direction switches 86 and 87 depending on whether the bucket is to carry material to a right or left hand silo.

With the above understanding of the elements 60 and their organization with respect to each other in the system, the operation of the system itself and the function of the sequence relays 88, 89 and 90 with the hoisting limit switch 36 and the trolley limit switch 37 and the manner in which 65 they cooperate to provide interdependent circuits will be readily understood from the description which follows:

It will be assumed that the bucket 12 is in the loading position in the pit and that it is desired 70 to automatically operate the bucket 12 to transfer coal from the pit to the second left hand silo 23. Accordingly the four pole single throw switch 97 will be operated to its left hand position for the automatic operation of the system. 75

It will also be assumed that the supply lines 101 and 102 are connected by the line switches 104 and 105 to a suitable source of supply as indicated by the conductors 106 and 107. It will also be assumed that the hoisting motor 10 and the trolley motor 11 may be energized from a suitable source of three phase alternating current supply as is indicated by the supply lines 108. Inasmuch as it is desired to carry coal to the left hand silo 23, the four pole switch 98 is moved to its left hand position so that the bucket 12 will be driven to the left after it is hoisted from the pit instead of to the right, as would be the case if the switch 98 had been moved to its right hand position.

With the bucket in the loading pit, as soon as the supply lines 101 and 102 are energized by the closing of the line switches 104 and 105, the sequence relay 89 is operated to its latched position by reason of an energizing circuit which may be traced from supply line 101, conductor 110, contacts 93 of the slack cable switch 91, conductors 111 and 112, trolley limit switch contacts 56, conductor 113, operating coil 114 of the sequence relay 89, and by conductor 115 to the other supply line 102. The sequence switch 89 is thereupon operated to open its contacts 116 and 117 and to close its contacts 118, 119 and 120. It will be observed that as the relay 89 closes, a latching member 121 pivoted at 122 engages a shoulder 123 provided on the switch 89 so as to latch the relay 89 into position.

A second energizing circuit may be traced for the operating coil of the time relay 95 which relay controls the energization of the sequence relay 89. The former circuit may be traced from the supply line 101, conductor 110, contacts 93 of the slack cable switch 91, conductors 111 and 124 operating coil of time relay 95 and by conductor 125 to the other supply line 102. After a predetermined interval of time, corresponding to the time required for loading the bucket in the pit, the time relay 95 closes its contacts establishing an energizing circuit for the operating coil of the sequence relay 89 which circuit may be traced from supply line 101, conductor 110, contacts 93 of slack cable switch 91, conductors 111 and 124, contacts of the time relay 95, conductor 126, operating coil 127 of relay 89 and by conductor 128 to the other supply line 102. The sequence relay 89 is thereupon operated to open its contacts 129 and 130 and to close its contacts 131 and 132. This relay is latched into position in the same manner as described in connection with the sequence relay 89.

The closing of the contacts 131 of relay 89 completed an energizing circuit for the hoisting switch 80 which circuit may be traced from supply line 101, conductor 133, contacts 134 of switch 97, conductors 135, 136 and 137, hoisting limit switch 138, conductor 139, contacts 131, conductor 140, operating coil of the direction switch 80, and by conductors 141 and 142 to the other supply line 102.

It should here be observed that the completion of the latter circuit depends upon the relay 89 being in its latched position. It will also be observed that the circuit for the relay 89 was traced through the non-adjustable trolley limit switch contacts 56 and that the control circuit for the hoisting switch 80 was completed through the hoisting limit switch 138 and the contacts 131 of the sequence relay 89. This interlocking of circuits is an important feature of my invention and insures at all times the carrying out of the desired cycle of operations.

Continuing with the operation of my invention, the hoisting switch 80 is operated to its closed position to energize the hoisting motor 10 in a direction to hoist the bucket from the pit. Inasmuch as the resistances 143 and 144 are connected in the rotor circuit of the hoisting motor 10, the motor first rotates at low speed. However the operating coil of the time delay hoisting relay 83 is connected by means of conductors 145 and 146 in parallel with the operating coil of the direction switch 80, so that the hoisting relay 83 is energized simultaneously with the direction switch 80. The contacts 147 of the hoisting relay 83 are immediately closed but the closing of the contacts 148 is delayed by reason of a time delay 149. After a short interval of time the contacts 148 close to complete an energizing circuit for the first accelerating contactor 84. This circuit may be traced from the supply line 101, conductor 150, contacts 148, conductor 151, operating coil of the accelerating contactor 84 and by conductor 152 to the other supply line 102. The first accelerating contactor 84 thereupon closes to short circuit the resistors 143 from the rotor circuit of the motor 10 thereby causing the motor 10 to be accelerated to a higher speed. After a predetermined interval of time, the time delay contacts 153 of the contactor 84 are closed to complete a circuit for the second accelerating contactor 85. This circuit may be traced from supply line 101, conductor 150, contacts 148, conductor 151, contacts 153, operating coil of the accelerating contactor 85 and by conductor 152 to the other supply line 102. The second accelerating contactor 85 thereupon closes short circuiting the resistors 144 thereby causing the hoisting motor 10 to be accelerated to its high speed.

As the bucket 12 is hoisted to its trolleying position above the silos, the hoisting switch contacts 138 are operated to their open position while the hoisting limit switch contacts 154 are operated to their closed position. The opening of the hoisting limit switch contacts 138 deenergizes the hoisting switch 80, the hoisting motor 10, the hoisting relay 83, and the accelerating contactors 84 and 85.

The closing of the hoisting limit switch contacts 154 establishes an energizing circuit for the trolley direction switch 87, which circuit may be traced from supply line 101, conductor 156, hoisting limit switch contacts 154, conductors 157 and 158, contacts 159, conductors 160, 161 and 162, contacts 163 of the sequence relay 90, conductor 164, contacts 118 of the sequence relay 89, conductor 165, adjustable trolley limit switch contacts 52, conductor 166, switch 98, conductor 168, operating coil of the direction switch 87, and by conductors 169 and 142 to the other supply line 102. The direction switch 87 is thereupon operated to its closed position to energize the trolley motor 11 in a direction to drive the bucket over the left hand silo. It will again be observed that this control circuit depends on the positions of the sequence relays 89 and 90, the hoisting limit switch 154, and the adjustable trolley limit switch 55.

As the bucket 12 moves toward the selected silo, 23, the non-adjustable contacts 51, of the trolley limit switch 37 are operated and latched into their closed position while the contacts 54, 56 and 57 of this switch are opened. When the bucket 12 has been driven to a position over the selected silo 23, the contacts 50, 53 and 55 of the limit switch 37 are operated and latched into their closed circuit positions while the contacts 52 of this limit switch are opened. Inasmuch as the

energizing circuit for the direction switch 87 was completed through the adjustable limit switch contacts 52, the opening of these contacts immediately deenergizes the direction switch 87 thereby

5 deenergizing the trolley motor 11.

The closing of the adjustable trolley limit switch contacts 50 completed a trip circuit for the sequence relay 88. This circuit may be traced from supply line 101, conductor 170, limit switch

10 contacts 50, conductor 171, contacts 119, conductor 172, contacts 132, trip coil 173 and by conductor 128 to the other supply line 102. The trip coil thereupon withdraws the latching member 174 from its engagement with the shoulder

15 provided on the relay armature so that this relay is operated to its unlatched position. After the relay 88 has been tripped the trip coil of the sequence relay 89 is energized through a circuit which may be traced from supply line 101, conductor 170, limit switch contacts 50, conductor

20 171, conductor 175, contacts 129, conductor 176, contacts 120, trip coil 177 of the sequence relay 89 and by conductor 115 to the other supply line 102. The sequence relay 89 is thereupon operated

25 to open its contacts 118, 119 and 120 and to close its contacts 116 and 117.

The closing of the adjustable trolley limit switch contacts 53 completes an energizing circuit for the time delay relay 96 which may be

30 traced from supply line 101, conductor 170, limit switch contacts 53, conductor 178, operating coil of the time relay 96, and by conductor 179 to the other supply line 102. After a short interval of time which permits the bucket 12 to come to a

35 standstill, the contacts 180 are closed to complete an energizing circuit for the operating coil of the lowering switch 81. This circuit may be traced from supply line 101, conductor 133, contacts 181, conductors 182 and 183, contacts 180, conductor

40 184, contacts 92 of the slack cable switch 91 (which it will be remembered were closed when the bucket was hoisted from the pit), conductors 185 and 186, the operating coil of the lowering switch 81, conductors 187 and 188, contacts 130,

45 and by conductor 189 to the other supply line 102. The lowering switch 81 is thereupon operated to energize the hoisting motor 10 in a direction to lower the bucket into the selected silo 23. The operating coil of the lowering relay 82 is connected in parallel with the operating coil of direction switch 81 by conductors 190 and 191. Consequently after a predetermined interval of time the relay 82 closes its contacts 192 to energize

50 the first accelerating contactor 84, which in turn after a lapse of a predetermined interval of time, energizes the accelerating contactor 85 so that the motor 10 is accelerated from its low speed to its full speed.

As soon as the bucket 12 strikes the coal within the silo the slack cable switch 91 operates to open its contacts 92 and to close its contacts 93. The opening of this former contact serves to deenergize the lowering switch 81 which is operated to its open position to deenergize the hoisting

65 motor 10.

The closing of the contacts 93 of the slack cable switch 91 completes an energizing circuit for the sequence relay 88. This circuit may be traced from the supply line 101, conductor 110, contacts 93, conductors 111, 124 and 195, contacts

70 195b of the time switch 96, conductors 195c and 126, operating coil 127 of the sequence switch 88, and by conductor 128 to the other supply line 102. The sequence relay 88 is thereupon operated and

75 latched into position. A circuit is completed for

the hoisting switch 80 by the closing of the contacts 131 of the relay 88 which circuit may be traced from supply line 101, conductor 133, contacts 134, conductors 135, 136 and 137, limit switch 138, conductor 139, contacts 131, conductor 140, the operating coil of hoisting switch 80 and by conductors 141 and 142 to the other supply line 102. Consequent to the closing of the direction switch 80, the hoisting motor 10 is energized in a direction to hoist the bucket from the silo. As before the motor will first rotate at low speed and then be accelerated to its intermediate and full speeds due to the successive operation of relay 82 and the accelerating contactors 84 and 85.

As soon as the bucket 12 reaches a position above the silos, the limit switch contacts 138 are operated to their open position while the limit switch contacts 154 are closed. As before, the opening of the contacts 138 deenergizes the hoisting switch 80. The closing of the hoisting limit switch contacts 154 serves to complete an energizing circuit for the trolley direction switch 86 which circuit may be traced from supply line 101, conductor 156, limit switch 154, conductors 157 and 158, contacts 195, conductors 196, 197 and 198, contacts 199 of sequence relay 90, conductor 200, contacts 116 of sequence relay 89, conductor 201, trolley limit switch 51, conductors 202 and 203, conductor 204, operating coil of the direction switch 86, and by conductor 142 to the other supply line 102. The direction switch 86 is thereupon closed to energize the trolley motor 11 in a direction to move the bucket towards the loading pit.

As the bucket moves toward the pit 35, the trolley limit switch contacts 50, 53 and 55 are operated to their open positions while the adjustable contacts 52 are operated to their closed positions. When the bucket reaches a position directly over the pin, the trolley limit switch contacts 51 are operated to their open positions and the trolley limit switch contacts 54, 56 and 57 are operated to their closed positions. The opening of the non-adjustable contacts 51 deenergizes the direction switch 86 which switch opens to deenergize the trolley motor 11 thereby stopping the travel of the bucket. The closing of the non-adjustable contacts 57 completes an energizing circuit for the trip coil of the sequence relay 90 which circuit may be traced from supply line 101, conductor 170, limit switch 57, conductor 205, contacts 206, trip coil 207 of relay 90 and by conductor 194 to the other supply line 102.

The closing of the non-adjustable contacts 54 causes the energization of the trip coil of the sequence relay 88 through a circuit which may be traced from supply line 101, conductor 170, limit switch contacts 54, conductor 208, contacts 117, conductor 172, contacts 132, trip coil 173 of sequence switch 88 and by conductor 128 to the other supply line 102.

The tripping of the sequence relay 88 causes the contacts 130 to close thereby completing an energizing circuit for the operating coil of the time switch 94. This circuit may be traced from supply line 101, conductor 133, contacts 181, conductors 182, 183 and 209, operating coil of time switch 94, conductors 210 and 188, contacts 130 of sequence relay 88 and by conductor 189 to the other side of the supply line 102. After a predetermined interval of time has elapsed, the contacts of the time delay switch 94 close to energize the lowering switch 81.

This interval of time is introduced in order

that the bucket 12 may cease its oscillations thereby insuring the vertical lowering of the bucket. The guide members 211 secured to the bucket may then accurately engage the guide rail 34 leading through the hatchway 35 to the pit.

The energizing circuit for the lowering switch 81 may be traced from supply line 101 conductor 133, contacts 181, conductors 182, 183 and 288, contacts of time switch 94, conductors 212 and 184, contacts 92 of the slack cable switch, conductors 185 and 186 operating coil of the lowering switch 81, conductor 187 and 188, contacts 130 and by conductor 189 to the other supply line 102. As soon as the lowering switch 81 closes, the hoisting motor 10 is energized to lower the bucket into the pit. As before, however, the lowering relay 82 and the accelerating contactors 84 and 85 are successively operated to short circuit the motor secondary resistors 143 and 144. As the bucket reaches the loading position in the pit, the slack cable switch 91 is operated to open its contacts 92 and to close its contacts 93. The opening of the former contacts deenergizes the direction switch 81 while the closing of the latter contacts completes an energizing circuit for the time delay relay 95. This circuit may be traced from the supply line 101, conductor 110, contacts 93, conductor 111 and 124, operating coil of time switch 95 and by conductor 125 to the other supply line 102. As was mentioned above, this time interval is interposed to insure sufficient time for the loading of the bucket within the pit.

It will be remembered that at this point the present description of the operation was begun. It will therefore be understood that the operations described above are again carried out, and that this cycle of operation will automatically continue as long as may be desired.

By releasing the wedge 73 and by rotating the hand wheel 75 until the pointer 74 indicates 1L or the first left-hand silo 24, the cycle of operation will be carried out as described above and the bucket 12 will serve to transport coal or like material into the silo 24. The difference in the relative adjustment of the trolley limit switches 50, 52, 53 and 55 with respect to the limit switches 51, 54, 56 and 57 serves merely to cause each switch of the first group to be operated when the bucket reaches the position over the silo 24.

If either of the right-hand silos 25 or 26 should be selected, it becomes necessary to operate the four pole double throw switch 98 to its right-hand position. The switch 98 serves to reverse the relative energization of the direction switches 86 and 87 with respect to their former operation so that the bucket 12 will be moved to the right after it comes up from the pit and will be returned to the pit after it has unloaded into one or the other of the selected silos 25 or 26.

Under certain conditions of operation it may be desirable to control the motors 10 and 11 manually. The transfer from automatic operation to manual control is accomplished by opening the four pole switch 97. The manual operation of my control system is semi-automatic, that is to say, each motion which is carried out by the bucket 12 is controlled by a push button. However, the bucket is stopped automatically at the end of each particular movement of the bucket so that the operator is only required to press a button to initiate the carrying out of a certain fraction of the cycle of operation. The sequence relays as before serve to establish the

interdependent control circuits so that the bucket 12 may be safely operated through the predetermined cycle.

It will again be assumed that the bucket 12 is at the loading position within the pit and that the control supply lines 101 and 102 are energized as well as the supply lines 108 for the motors 10 and 11. It will also be assumed that the right hand silo 26 has been selected for the cycle of operation. Consequently, the four pole switch 98 will be operated to its right hand position.

With the bucket in the loading position an energizing circuit is completed for the sequence relay 89, which circuit may be traced from the supply line 101, conductor 110, contacts 93 of the slack cable limit switch 91, conductors 111 and 112, trolley limit switch 56, conductor 113, operating coil 114 of sequence relay 89, and by conductor 115 to the other supply line 102. The sequence relay 89 is thereupon operated to its latched position.

It will be observed that the time relay 95 is energized through a circuit which may be traced from supply line 101, conductor 110, contacts 93 of the slack cable switch 91, conductors 111 and 124, operating coil of the time relay 95 and by conductor 125 to the other supply line 102. After a predetermined interval of time the contacts of the time relay 95 are closed, serving to energize the operating coil of the sequence relay 88 through a circuit which may be traced from supply line 101, conductor 110, contacts 93 of the slack cable switch, conductors 111, 124 and 195, contacts of the time relay 95, conductor 126, operating coil 127 of the sequence relay 88, and by conductor 128 to the other supply line 102. The sequence relay 88 is thereupon operated to its latched position.

After the operation of the relays 88, 89 and 95 and not before this time, the normally open hoisting push button 220 becomes effective to complete an energizing circuit for the hoisting switch 80.

It will be assumed that the push button 220 is momentarily depressed to complete an energizing circuit which may be traced from supply line 101, conductor 221, push button switch 220, conductors 136, 137, hoisting switch 138, conductor 139, contacts 131 of the sequence relay 88, conductor 140, operating coil of the hoisting switch 80 and by conductors 141 and 142 to the other supply line 102. The hoisting switch 80 is thereupon operated to energize the hoisting motor 10. The relay 83 whose operating coil is connected in parallel with the operating coil of the direction switch is also operated to close its contacts 147 to complete a holding circuit for the direction switch 80, which circuit may be traced from supply line 101, conductor 150, contacts 147 of relay 83, conductors 222 and 137, hoisting limit switch 138, conductor 139, contacts 131, conductors 140 and 145, operating coil of the relay 83 and by conductor 146 to the other supply line 102. As before the time delay contacts 148 of the relay 83 serve to energize the first accelerating contactor 84 which in turn through its time delay contact 153 energizes the second accelerating contactor 85. Consequently, the motor 10 is progressively accelerated from its low speed to its full speed. As soon as the bucket 12 is hoisted to a position above the silos, the limit switch 138 is opened and the limit switch 154 is closed. The opening of the former switch deenergizes direction switch 80, stopping the hoisting motor 10. The closing of the hoist-

ing limit switch 154 renders the push button 225 effective to complete an energizing circuit for the direction switch 86 so that the trolley motor 11 may be energized in a direction to drive the bucket to the right and towards the selected silo 26. This circuit may be traced from supply line 101, conductor 156, hoisting limit switch 154, conductor 157, conductor 226, push button 225, conductors 161 and 162, contacts 163 of the sequence relay 90, conductor 164, contacts 118 of sequence relay 89, conductor 165, trolley limit switch 52, conductors 166 and 167, conductor 204, operating coil of direction switch 86 and by conductor 142 to the other supply line 102. A holding circuit for the operating coil of the direction switch 86 is completed by the closing of the contacts 227 operated with the direction switch 86, which circuit may be traced from supply line 101, conductor 156, hoisting limit switch 154, conductor 157, contacts 227, conductor 228, switch 98, conductors 229 and 162, contacts 163, conductor 164, contacts 118, conductor 165, trolley limit switch 52, conductors 166 and 167, switch 98, conductors 204, operating coil of direction switch 86, and by conductor 142 to the other supply line 102.

As soon as the bucket 12 moves toward the silo 26 the trolley limit switch 51 is operated and latched into its closed positions while limit switches 54, 56 and 57 are operated to their open positions. When the bucket 12 has been driven to a position over the selected silo 26, the contacts 50, 53 and 55 of the trolley limit switch 37 are operated and latched into their closed positions while the switch 52 is opened. The opening of the limit switch 52 deenergizes the direction switch 86 consequently stopping the trolley motor 11. As described for the automatic operation of my system, the closing of the trolley limit switch 50 serves to energize the trip coil 173 of the sequence relay 88 which relay is operated to its unlatched position. After the sequence relay 88 has been tripped, the trip coil 177 of the sequence relay 89 is energized so that this relay is operated to its unlatched position.

The closing of the trolley limit switch 53 completes an energizing circuit for the time delay relay 96 which may be traced from supply line 101, conductor 170, limit switch 53, conductor 178, operating coil of the time relay 96 and by conductor 179 to the other supply line 102. After a short interval of time the contacts 180 of the time switch are closed.

The push button 234 is now effective to complete an energizing circuit for the lowering switch 81, which circuit may be traced from supply line 101, conductor 233, push button 234, conductor 183, contacts 180 of the time relay 96, conductor 184, contacts 92 of the slack cable switch 91, conductors 185 and 186, operating coil of the lowering switch 81, conductors 187 and 188, contacts 130 of sequence relay 88, and by conductor 189 to the other supply line 102. It will be remembered that the operating coil of lowering relay 82 is connected in parallel with the operating coil of the lowering switch 81 by conductors 190 and 191. Consequently, the lowering switch 81 and the lowering relay 82 are both operated to their closed positions. The contacts 231 of the relay 82 immediately close to complete the holding circuit for the lowering switch 81, which circuit may be traced from supply line 101, conductor 150, contacts 231, conductors 232 and 183, contacts 180, conductor 184, contacts 92 of the slack cable switch, conductors 185 and 186, operating coil of lowering switch

81, conductors 187 and 188, contacts 130 and by conductor 189 to the other supply line 102.

After a short interval of time the contacts 192 of the hoisting relay 82 close to energize the first accelerating contactor 84 which in turn after a short interval of time, energizes by means of its contacts 153 the second accelerating contactor 85. The hoisting motor 10 therefore is accelerated to its full speed.

As soon as the bucket 12 strikes the coal within the silo, the slack cable switch 91 operates to open its contacts 92 and to close its contacts 93. The opening of the former contacts serve to deenergize the lowering switch 81 and the lowering relay 82, which switches are thereupon operated to their open positions to deenergize the hoisting motor 10.

The closing of the contacts 93 of the slack cable switch 91 completes an energizing circuit for the sequence relay 88 which circuit may be traced from supply line 101, conductor 110, contacts 93 of the slack cable switch, conductors 111, 124 and 195, contacts 195b of the time switch 96 and by conductors 195c, 126, operating coil 127 of the sequence relay 88 and by conductor 128 to the other supply line 102. The sequence relay 88 is thereby operated and latched into position. The sequence relay 90 is also operated and latched into position by reason of an energizing circuit which may be traced from supply line 101, conductor 110, contacts 93 of the slack cable switch, conductor 111, limit switch 55, conductor 193, operating coil of relay 90 and by conductor 194 to the other supply line 102.

The push button 220 is now effective to complete an energizing circuit for the hoisting switch 80, which circuit may be traced from supply line 101, conductor 221, push button 220, conductors 136 and 137, hoisting limit switch 138, conductor 139, contacts 131, sequence relay 88, conductor 140, operating coil of hoisting switch 80 and by conductors 141 and 142 to the other supply line 102. As before the hoisting relay 83 immediately closes its contacts 147, establishing a holding circuit for the operating coil of the hoisting switch 80. After an interval of time the contacts 148 of the hoisting relay close to cause the successive energization of the first and second accelerating contactors 84 and 85 so that the hoisting motor 10 is accelerated to its full speed.

As soon as the bucket 12 reaches the position above the silos, the limit switch 138 is operated to its open position while the limit switch 154 is closed. As before, the opening of the limit switch 138 deenergizes the hoisting switch 80. The closing of the hoisting limit switch 154 renders the push button 235 effective for the energization of the trolley direction switch 87. Depressing the push button 235 completes an energizing circuit for this switch which may be traced from supply line 101, conductor 226, push button 235, conductors 197, 198, contacts 199, conductor 200, contactor 116 of sequence relay 89, conductor 201, trolley limit switch 51, conductor 202, switch 98, conductor 168, operating coil of the direction switch 87 and by conductors 169 and 142 to the other supply line 102. A holding circuit is established for the direction switch 87 by closing of the contacts 238 operated with the direction switch 87, which holding circuit may be traced from supply line 101, conductor 156, hoisting limit switch 154, conductor 157, contacts 238, conductor 239, switch 98, conductors 240, 241 and 198, contacts 199, sequence

relay 90, conductor 200, contacts 116, conductor 201, trolley limit switch 51, conductor 202, switch 98, conductor 100, operating coil of direction switch 87, and by conductors 100 and 142 to the other supply line 102.

As soon as the trolley motor 11 drives the bucket towards the loading pit, the trolley switches 50, 53 and 55 are operated to their open positions while the switch 52 is operated to its closed position. When the bucket reaches a position directly over the pit, the trolley switch 51 is operated to its open position while the switches 54, 56 and 57 are operated to their closed positions.

As in the case of the automatic operation, the closing of the trolley limit switch 54 energizes the trip coil 173 of the sequence relay 88, while the closing of the limit switch 57 energizes the trip coil of the sequence relay 90 so that both sequence relays are operated to their unlatched positions. As soon as the sequence relay 88 closes its contacts 130, an energizing circuit is completed for the operating coil of the time switch 94. After a predetermined interval of time, this switch closes its contacts rendering the push button 234 effective for initiating the lowering operation of the bucket 12. This circuit may be traced from supply line 101, conductor 233, push button 234, conductors 183, 200, contacts of the time delay switch 94, conductors 212 and 184, contacts 92 of the slack cable switch 91, conductors 185 and 186, operating coil of direction switch 81, conductors 187 and 188, contacts 130 of sequence relay 88 and by conductor 189 to the other supply line 102. A holding circuit for the lowering switch 81 is again completed by the operation of the lowering relay 82, and the accelerating contactors are successfully operated to accelerate the motor 10 to its full speed.

As the bucket reaches the loading position in the pit, the slack cable switch 91 is operated to open its contacts 92 and to close its contacts 93. It will be remembered that the opening of the former contacts deenergizes the direction switch 81, while the closing of the latter contacts completes an energizing circuit for the time delay relay 95. At the same time the hoist limit switch 138 is operated to its closed position while the hoisting limit switch 154 is operated to its open position.

The complete cycle of operation has again been described and the circuits traced for the semi-automatic operation of my system. It will be observed that a control circuit for an operation cannot be completed until the previous movement of the bucket has been completely carried out. That is to say, the energization of each control circuit is dependent upon the previous control circuit which has been energized and also upon the completion of the movement of the bucket. This interlocking of circuits provides a practically foolproof system so that even an unskilled operator may safely operate the coal handling system.

While I have shown a particular embodiment of my invention, it will be understood of course that I do not wish to be limited thereto, since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An electrically operated system for a device arranged to be driven through a predetermined

cycle of operations between one position and a selected one of several positions spaced apart from said one position, comprising driving means for said device, a group of contacts for controlling the operation of said driving means, operating means for said group of contacts for operating said contacts, a second group of contacts for controlling the operation of said driving means, operating means for said second group of contacts, and an adjustable connecting means between said groups of contacts for selecting one of said several positions for the carrying out of said cycle.

2. A material handling system having a carrier arranged to be operated in a predetermined cycle from a loading station to and from one of a plurality of unloading stations, means for driving said carrier, a trolley limit switch having a plurality of non-adjustable switches for stopping said carrier over said loading station and a plurality of adjustable switches for stopping said carrier over an unloading station, and means for changing the time of operation of said latter switches with respect to said former switches so that any one of said unloading stations may be selected for the carrying out of said cycle.

3. In combination with a device arranged to be operated in a predetermined cycle along a restricted path from one position to and from a selected one of several other positions, of motor means for driving said device, control means responsive to movements of said device for controlling said motor means, the said control means including a control element for stopping said device at said one position and a control element for stopping said device at a selected one of said other positions, and adjustable connecting means between said control elements for changing the time of operation of an element so that any one of said positions can be selected for the carrying out of said cycle.

4. In a carrier system having a device arranged to be operated from a loading station to and from one of a plurality of unloading stations, means for driving said carrier, a limit switch having a set of contacts for stopping said device over said loading station and a second set of contacts for stopping said carrier over an unloading station, an operating means for each of said sets of contacts, and means for changing the time of operation of said first set of contacts with respect to said second set of contacts comprising a driving shaft responsive to movements of said device connected to one of said operating means, and gears adjustably connecting said other of said operating means to said one of said operating means.

5. A material handling system having a carrier arranged to be operated in a predetermined cycle from a loading station to and from one of a plurality of unloading stations, a motor for driving said carrier, a trolley limit switch having a plurality of non-adjustable contacts operated in response to rotation of said motor for stopping said carrier over said loading station, a plurality of adjustable contacts for stopping said carrier over an unloading station, and means for changing the time of operation of said latter contacts with respect to said former contacts comprising a gear for operating said adjustable contacts, a second gear arranged for rotation with said non-adjustable contacts, a pair of gears each of which is arranged in meshing relation with said first and second gears and friction means for connecting said pair of gears

together and for permitting the relative adjustment of said adjustable contacts with respect to said non-adjustable contacts whereby any one of said unloading stations may be selected for the carrying out of said cycle.

6. In combination with a control system for a device arranged to be operated in a predetermined cycle from a loading station to and from one of a plurality of unloading stations, a trolley limit switch having a plurality of non-adjustable contacts for stopping said carrier at said loading station and a plurality of adjustable contacts for stopping said carrier at an unloading station, each of said contacts comprising a contact member biased to one position, means for holding said member in another position against its bias, and means for operating said member to said one position upon a predetermined movement of said means in said one direction and upon a predetermined movement of said means in the other direction for releasing said member, and means for changing the time of operation of said latter contacts with respect to said former contacts so that any one of said unloading stations may be selected for the carrying out of said cycle.

7. A material handling system having a carrier arranged to be operated in a predetermined cycle from a loading station to and from one of a plurality of unloading stations, electrical motor means for driving said carrier, a trolley limit switch having a plurality of contacts for stopping said carrier over said loading station, a plurality of contacts for stopping said carrier over an unloading station, means for relatively adjusting said contacts to change the time of operation of said latter contacts with respect to said former contacts so that any one of said unloading stations may be selected for the carrying out of said cycle, a plurality of sequence relays, latching means for each of said relays, a tripping coil for each of said relays for releasing said latch, and an energizing circuit for each of said tripping coils arranged to be completed by said limit switch contacts.

8. A material handling system having a carrier arranged to be operated in a predetermined cycle from a loading station to and from one of a plurality of unloading stations located to the right and to the left of said loading station, a trolley motor for driving said carrier, a trolley

limit switch having a plurality of non-adjustable contacts for stopping said carrier over said loading station and a plurality of adjustable contacts for stopping said carrier over an unloading station, means for changing the time of operation of said latter contacts with respect to said former contacts so that any one of said unloading stations may be selected for the carrying out of said cycle, and circuit controlling means associated with said trolley limit switch for selectively determining the movement of said carrier to the right or to the left of said loading station.

9. A control system for a device arranged to be operated in a predetermined cycle from one position to and from a selected one of several other positions, comprising a motor for driving said device, a limit switch having two groups of circuit controlling contacts, operating means for each of said groups, means for mechanically connecting the operating means of one group for operation in response to movements of said device, adjustable connecting means for connecting the operating means of said other group to the operating means of said first group so that the operation of said other group with respect to said first group may be varied to select one of said several positions for the carrying out of said cycle.

10. An electrical system for driving a device through a selected one of a plurality of predetermined cycles of operations, comprising driving means for said device, a group of circuit controlling devices for controlling the operation of said driving means during a first portion of said cycle, connecting means between said circuit controlling devices and said driving means whereby said circuit controlling devices are actuated by said driving means, a second group of circuit controlling devices for controlling the operation of said driving means during a second portion of said cycle, a second connecting means connecting said second group of circuit controlling devices to said first group whereby said second group is actuated by said driving means, and adjusting means forming a part of said second connecting means for adjusting said second group of controlling devices independently of said first group to select a different second portion for the cycle of operations.

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