A railroad car or train of cars has a series of work stations spaced longitudinally apart to successively perform predetermined work operations on the train track or bed as the train moves along the track. A metering wheel carried by the train in engagement with the railway is connected to means for measuring the distance traveled by the train, from a reference point at which the first work operation commenced at the first work station and selector means for actuating each of the remaining work stations after the train has traveled a distance substantially equal to the distance between it and the first work station.

The present invention relates generally to a continuous railway work apparatus and, more particularly, to the type of work apparatus having in-line working stations for performing successive work operations along the railway.

It is conventional to employ a railroad car or train of cars having specially prepared work stations spaced longitudinally along the track to perform certain work operations on the track or the bed as the train moves continuously along the track. Historically, one of the most widely accepted and successful operations of this type is the railway ballast cleaning operation wherein the specially prepared equipment is operative to scoop up the ballast along the shoulders of the railroad, clean the ballast of all foreign matter and dirt, and return the same to the railroad, all in one continuous operation, as described for example, in the patent to Speno 1,951,451, dated Mar. 20, 1934.

To briefly explain this operation and as can be seen in this prior patent, there are working stations along each side of the railroad so as to simultaneously work on both shoulders of the railroad. The scoop at the pick-up station is mounted for vertically shifting movement so that it can be carried in a retracted or traveling position above the roadbed during travel to and from the working site, and then can be lowered into operative engagement with the ballast when the cleaning operation is to be initiated.

In this early machine, as well as in other ballast cleaning machines of which I am aware, the operator must be relied upon to manually lower the scoop at the beginning of the operation and then to actuate the hopper gate at substantially the same reference point along the roadway so as to make the two related work operations coextensive. In other words, the operator must be relied upon to start the return of the cleaned and temporarily stored ballast in the hopper at the same reference point along the roadway at which the scoop started to work, i.e. the return operation must be initiated some fixed time after the beginning of the pick-up operation due to the spacing between the working stations.

Since the operating gangs of these machines are generally of the unskilled class of workmen, with little or no experience on the machines, it is desirable to rely upon such manual operations as little as possible, and this is especially true with regard to the starting and stopping functions if, on one hand, an unfilled portion of the shoulder is left due to operating the gate of the hopper too late, or, on the other hand, too much ballast is piled at the reference point due to the premature operation of said gate, undesirable weakening and/or poor drainage and appearance of the roadbed results. Indeed, it has been proven that even with a relatively skilled operator, generally the duties of constant adjustment of the operating means at the working stations so preoccupies him, that the opening or closing of the hopper gate and initiating other auxiliary functions in the precise manner desired to make a roadbed of even cross section is almost impossible.

Furthermore, the reliance on the manual operation of the scoop and the hopper to raise the same into the traveling position when an obstacle, such as a transverse roadway crossing or spur line, is approached, has the related disadvantage that if they are not raised in time, the engagement of the fixed obstacle during forward movement of the train is likely to cause extensive damage to the equipment, and in some cases might even result in injury to the operators on the train. This obviously unsatisfactory condition, as well as the others described above, is worsened in modern ballast cleaning machines due to the addition of other stations on the train to perform separate and additional work functions. For example, modern equipment presently in use includes a scraper behind the scoop to dislodge the packed ballast under the ends of the ties and a shoulder shaper behind the hopper to smooth out and shape the shoulder of clean ballast. Thus, like the scoop and the hopper, these operating means must be shifted from one position to the other, and operated at the reference point at which the scoop begins operation, in order to obtain a complete and satisfactory rejuvenation of the roadbed.

Although the particular problems just outlined of maintaining control over the operating parts of a continuous railway work apparatus are particularly acute in the ballast cleaning art, essentially the same problems are present in performing efficient operations in other related railway work arts, such as rail grinding wherein machines of the type shown in the patent to Speno et al., 2,779,161, issued Jan. 29, 1957, have gained wide acceptance. In this type of machine, the grinders are arranged in plurality of gangs spaced longitudinally along the length of the car and are operative to perform grinding operations on the top of the rail to smooth out and shape the profile. As in the ballast cleaning machines, the grinder units must be raised when obstacles, such as roadway crossings, are encountered and previously it has been necessary to rely on the operator to individually raise each unit in sequence as it approaches the obstacle. Obviously, this prior art arrangement has the same disadvantages associated with reliance on a manual control system in the ballast cleaning apparatus, as pointed out above. Most importantly in this respect, the proven inability of operators to raise all of the grinding units at the same reference point along the railroad results in the rails not receiving the full grinding of all of the grinding units thus rendering the grinding of the rails less uniform at these locations.

Accordingly, one object of the present invention is to provide a continuous railway work apparatus having an improved control system wherein each operating means of the plurality of in-line working stations is brought into operation at substantially the same selected reference point along the railroad.

It is another object of the present invention to provide a continuous railway work apparatus which performs successive operations along said railway in a more efficient manner in that the initiation and termination of each operation is controlled automatically in accordance with the operation of the first in-line operating means.

In short, the apparatus of the invention comprises, in combination with the type of continuous railway work apparatus described herein, a system for automatically controlling the operation of working stations spaced along the railway so as to make a continuous operation of successive work operations performed on the railway track or bed, the system comprising:

- Means for determining the distance traveled by the train, from a reference point at which the first work operation commenced at the first work station.
- Selector means for actuating each of the remaining work stations after the train has traveled a distance substantially equal to the distance between it and the first work station.
- Automatic control means for operating the scoop and hopper when engaged with the train, the automatic control means including:
  - A means for actuating the scoop at a set position relative to the scoop-ahead point of the train, the set position being substantially the same reference point along the roadway as at which the scoop started to operate, i.e. the return operation must be initiated some fixed time after the beginning of the pick-up operation due to the spacing between the working stations;
  - A means for actuating the hopper gate at substantially the same reference point along the roadway as at which the scoop started to operate, i.e. the return operation must be initiated some fixed time after the beginning of the pick-up operation due to the spacing between the working stations.
apparatus described above, a metering wheel carried by the train and rotatably engaging the railway, a suitable conventional counter means connected to the metering wheel to measure the distance traveled by the train from the reference point at which the first in-line operating means was actuated, and selector means for actuating each of the remaining operating means after the train has traveled a distance substantially equal to the distance between the first working station and the working station in question on the train. In the particular embodiment illustrated for the purpose of disclosing the invention, there is provided a first counter which is actuated in response to the positioning of the scoop in operative engagement with the ballast along the roadbed, and this first counter, through the selector circuit of the device, thereafter causes each of the following operations to be performed at this reference point with respect to the railway. For example, when the stone hopper, which is near the back end of the train, approaches the point where the scoop, which is at the front of the train, began working, the gate of the stone hopper is opened thereby rendering the operations coextensive and providing a roadbed which is substantially homogeneous in cross section. Further, in accordance with the particular embodiment of the present invention illustrated, a second counter is provided for measuring the distance traveled by the train from the reference point where the scoop was first raised up into the traveling position above the roadbed so that the scoop stops so as a roadway crossing, may be bypassed in sequence by the remaining in-line operating means. This means that each of the remaining in-line operating means is allowed to continue working up to the reference point where the scoop was withdrawn, but not thereafter, and in the case of the stone hopper, prevents inadvertent discharge of ballast on the crossing, which has heretofore been a problem.

In accordance with an additional aspect of the present invention, the separate counters are capable of simultaneous counting operations and the selector incorporates memory means, which may be the control system through which allows the concurrent shifting of the operating means in opposite directions while maintaining the same in the proper sequence. Thus, the first in-line operating means can be automatically raised and lowered to bypass an obstruction even before the final in-line operating means has begun its upward shifting operation for the same purpose. As a result, any length of obstruction or roadway, including those shorter than the length of the operating train, may be bypassed without difficulty and without ceasing operation.

Each of the operating means is shifted by a hydraulic system which has an interface with the control system through suitable simple electromechanical relays, such as conventional electrical solenoids. Advantageously, the solenoids operate the hydraulic valves in such a manner that each valve can be actuated manually by the operator, or completely removed from operation without interrupting the remainder of the system.

As an additional step toward complete automation, the present invention contemplates that the first in-line operating means may be controlled by suitably positioned sensors, which may, for example, be operative to sense a change in condition of the railway that would necessitate the above described bypassing or shifting operation of the operating means. Also along these lines, the use of limit switches to automatically initiate the operation of the counters of the control system as well as to initiate the auxiliary work functions of the operating means, forms another feature of the present invention.

Thus, it is another object of the present invention to provide a railway work apparatus having a plurality of in-line operating stations that operate in automatic sequence in such a manner that each operation is coextensive with the other.

It is another, more specific object of the present invention to provide a railway work apparatus wherein the shifting of the operating means between a traveling position above the railway and a work position in operative relationship with said railway is initiated at a first reference point along a roadway working the shifting of the operating means at the remaining in-line stations after the train upon which the mounting stations are carried has traveled a distance equal to the spacing between the first in-line operating means and the operating means being shifted.

It is another object of the present invention to provide a railway work apparatus of the type described wherein the operating means at the various in-line operating stations are controlled by a first counter to indicate the start of successive operations at a fixed reference point along the railway and a second counter to indicate the termination of said operations at another reference point along the railway.

It is another object of the present invention to provide a railway ballast cleaning apparatus wherein the ballast is continuously and automatically picked up, cleaned, and then delivered to the fixed reference point along the railway at which it was picked up, by pick-up and delivery stations spaced from each other on said apparatus.

It is another object of the present invention to provide a railway ballast cleaning apparatus having a pick-up station, a scraper station, a delivery station, and a shaper station positioned at spaced intervals and having operating means which are automatically vertically shifted between a traveling position and a working position at the same reference points along the railway.

Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the following detailed description, wherein I have shown and described only the preferred embodiment of the invention, simply by way of illustration of the best mode contemplated by me of carrying out my invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modification in various obvious respects, all without departing from the invention. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not as restrictive.

In the drawings:

FIGURE 1 is a schematic diagram of the entire control system constructed in accordance with the present invention, as applied to a railway ballast cleaning apparatus;

FIGURES 2a and 2b are schematic illustrations of the sequence of operation as the apparatus of FIGURE 1 approaches a highway crossing;

FIGURE 3 is a schematic illustration of the sequence of operation of the apparatus at the approximate midpoint of negotiating the highway crossing;

FIGURE 4 is a schematic illustration of the sequence of operation as the apparatus finishes passing over the highway crossing; and

FIGURE 5 is a schematic diagram of one operative embodiment of a selector circuit which is capable of use with the present invention.

With reference now to FIGURE 1 of the drawings, there is shown a continuous railway ballast cleaning apparatus comprising a first railway car 11 defining a pick-up station A and a scraper station B, and a second railway car 12 defining a delivery station C and a shaper station D. The railway cars 11, 12 are shown in purely schematic form with the side sills 13, 14, respectively, and a coupling 15 being shown for the purpose of generally denoting one arrangement suitable for mounting
the cleaning apparatus 10 for travel along rails R in the direction indicated by the arrow in this figure; it being understood that any number of cars might be appropriate to support the station A–D as required, and more or less working stations could be used as desired. The rails R are shown supported in a typical fashion by the cross ties T which are laid on the roadbed of stone ballast with a shoulder S sloping generally downwardly away from the ties T in a typical fashion.

As is conventional, to perform the pick-up operation at the pick-up station A, there is provided a scoop, generally designated by the reference numeral 20, which is carried for vertical shifting movement by a pair of vertical guide rails 21, 22. The guide rails 21, 22 can be of a suitable C-shaped construction in order to slidably embrace the mating dovetail slides 21a, 22a carried by the scoop 20 to thus allow the vertical movement required to shift the scoop 20 between the travel position illustrated in this figure, wherein said scoop 20 is disposed above the roadbed, and the work position (see Figure 2a) wherein the scoop is brought down into the ballast along the shoulder S for scooping up the ballast for cleaning.

The scoop 20 itself comprises a pair of side walls 23, 24 with a conventionally shaped scoop bottom 25. Just to the rear of the scoop bottom 25 is an inclined endless belt 26, which serves as a conveyor for the stone as it is picked up by the scoop bottom 25. The endless belt 26 is driven in a typical fashion by a rotary hydraulic motor 27 suitably positioned on the outer side wall 24 and performs the auxiliary work function of feeding the stone upwardly away from the bottom 25 to maintain a continuous pick-up operation as car 11 moves forward.

For the indicated purpose of shifting the scoop 20 in the vertical direction along the rails 21, 22, there is provided a hydraulic cylinder 30 which has a piston rod 31 suitably connected to the scoop 20. As illustrated in this figure, the cylinder 30 is of the conventional double acting type wherein hydraulic fluid is admissible to the opposite ends thereof through a pair of feeder lines 32, 33 from a typical two-position hydraulic valve 34 having an operating lever 34a. The hydraulic valve 34 receives hydraulic fluid under pressure from the centralized pressure source 35 via transfer line 36 for distribution through these feeder lines 32, 33 to thus effect the raising and lowering of the scoop 20. The valve 34 is remotely positioned at the center of control so that the handle 34a can be conveniently manipulated by the operator in the usual manner.

The construction of the remaining working stations B, C and D can be considered to be similar to the working station A in that each of the operating means at these stations is also adapted for vertical shifting movement. Accordingly, at the working station B a scraper 40 is mounted for vertical shifting movement by a hydraulic power cylinder 41 which is controlled by a hydraulic valve 42 having an operating lever 42a, which valve 42 receives pressurized hydraulic fluid from the source 35. Briefly, the scraper 40 comprises a main baffle plate 43 which is adapted to proceed along the ends of the cross ties T and scrape the ballast adjacent the cross ties T into the continuous ditch which has been previously formed by the scoop 20. To aid in this operation there or may be provided a hinged auxiliary deflector plate 44 which is capable of being shifted outwardly about forward hinge 45 by an auxiliary hydraulic power cylinder 46.

The discharge station C on the car 12 is constituted by a vertically shifting stone box or hopper 50 which is operable through a hydraulic power cylinder 51 controlled by a hydraulic valve 52 having an operating lever 52a, which valve 52 receives pressurized hydraulic fluid from a second centralized pressure source 53. The stone hopper 50 may be characterized by gate 55 which is hinged at 56 for outwardly swinging movement to allow discharge of the cleaned stone onto the shoulder S in response to the actuation of the auxiliary power cylinder 57. For a more complete disclosure of this operating means, reference may be made to my copending application, Ser. No. 608,430, filed Jan. 10, 1967, now U.S. Patent No. 3,571,826, granted Mar. 5, 1968.

The last operating station D at the shaper station D may comprise a shaper member 60 mounted for the same general type of shifting movement between the work position along the roadbed and a retracted travel position (as shown in Figure 1) by means of a hydraulic power cylinder 61 operated through the hydraulic valve 62 with lever 62a from the hydraulic pressure source 53. When the shaper member 60 is in the working position, it, of course, extends parallel to the shoulder S and is capable of auxiliary movement toward and away from the railway car 12 by means of an auxiliary power cylinder 65 by shifting of the mounting sleeves 66, 66a along the guides 67, 67a, respectively. A more complete disclosure of the particular operating means at the shaper station D can be found in my copending application entitled "Shoulder Shaper Assembly." Ser. No. 608,423, filed Jan. 10, 1967.

As briefly pointed out above, since the operations at the stations A–D are successive and each is necessary for proper cleaning of the ballast on the shoulder S, in accordance with the present invention the operating means at working stations A–D as just described, are raised and lowered at substantially the same reference point along the railway. To do this, there is provided a measuring or metering wheel 70 that is adapted to rotateably travel along the rail R or along the roadbed, if desired in response to the movement of the train of railway cars 11, 12 during the operation of the cleaning apparatus 10. The metering wheel 70 is preferably mounted for shifting movement toward and away from the operative position on the rail R by a suitable hydraulic cylinder 71, which is controlled by a hydraulic valve 72 having an operating lever 72a. Thus, when the lever 72a is in the full line or automatic position, as indicated in Figure 1, the wheel 70 will be lowered into operative engagement with the rail R whereby it will be rotated in the manner of any ordinary fifth wheel measuring device.

The metering wheel 70 is mechanically coupled by mechanical coupling means 74, which may take the form of a conventional rotary shaft, to a revolution counter assembly 75 to drive the same and thus indicate the distance being traveled by the cars 11, 12. The revolution counter assembly 75 is actuated each time the scoop 20 is either raised to the travel position or lowered to the work position in the shoulder S. More specifically, to initiate the revolution counter assembly 75 to count through either a lowering or raising cycle for shifting the operating means 40, 50, 60 into the work or traveling position, respectively, there is provided a two-position limit switch 77 connected to the counter assembly 75 by electric lines 77a; said switch 77 being operated in response to raised cam portion 78 of a cam rod 79 mounted on the top of the slide 21a (FIGURE 1) and thus movable with the scoop 20. It will be noted that the cam portion 78 serves to depress the feeler of the switch 77 into a first position just before the scoop 20 reaches the work position below the shoulder S on the lowering cycle. It follows that the switch 77 is moved to the second position just as the scoop 20 begins its upward movement on the raising cycle, which combination gives particularly good results, as will be seen later.

The revolution counter assembly 75 may be interconnected through electric connections 82, 83 to a selector circuit 85 that serves to actuate the hydraulic power means for the operating means 40, 50, 60 in succession, as now to be generally described. Thus, the selector circuit 85 has built in diodes 86, 87, 88 upon which the actual physical distance between the scoop 20 and the remaining operating means 40, 50, 60 on the cars 11, 12 is set. In other words, since it is desired to shift the scraper...
operating means 40 at the same reference point as the scoop 20 is shifted, the dial 86 would be set to correspond to the actual distance between the stations A and B on the railway car 11, and in response to this, any time that the scoop 20 is shifted the scraper 40 will be shifted after the car 11 has proceeded through that distance, as measured by the metering wheel 70.

The selector circuit 85 is interconnected to the hydraulic power means for vertically shifting the operating means of stations B-D by double acting electrical relay solenoids 90, 91, 92, and corresponding electric lines 90a, 91a, 92a, respectively. The actuators of the solenoids are suitably connected to the respective levers 42a, 52a, 62a, to operate the valves 42, 52, 62 in response to the proper signal from the selector circuit 85, which signal is preferably of the directional pulse type whereby the operating levers 42a, 52a, 62a of the valves 42, 52, 62, respectively, are free to manually operated at a centralized operator's station for proportional control of the apparatus 10, as required during the operation.

To further automate the control of the ballast cleaning apparatus 10, there is provided a travel position sensor 95 and a work position sensor 96 at the pick-up station A, suitably operated and to the scoop 20 and connected to an actuator circuit 97 through electric lines 95a, 96a. The sensors 95, 96 are contemplated to be of any suitable construction to sense a reference point along the railway at which the shifting operations of the station A are desired to be initiated. For example, the sensors 95, 96 can be of the type to sense the condition of the rail, and more particularly, the condition of the roadbed or shoulder S so that upon a change in condition of said roadbed the shifting operation will be initiated. Additionally, it is contemplated that the sensors 95, 96 be of other well known types, such as the phototronic or proximity type so as to be capable of actuation at any reference point along the railway; either by detecting special pilot operators properly placed along the railway for this specific purpose, or by detecting actual components of the railway which are desired to be bypassed. In any event, the actuator circuit 97 is operative to activate a relay solenoid 98 connected to the handle 34a of the hydraulic valve 34 to properly shift the scoop 20 in response to these sensors 95, 96. For convenience, a scoop control switch 99 is provided so that the actuator circuit 97 may be deactivated if desired, whereupon the scoop 20 could be manually operated through the handle 34a.

It will be remembered that the motor M effects the continuous rotation of the endless belt 26 during the working period of the scoop 20 so that the ballast is continuously removed from said scoop 20 as the car 11 moves forward. In accordance with the present invention, a hydraulic limit switch 102, mounted at the operating station B, is adapted to actuate the auxiliary power cylinder 46 to automatically pivotally extend the deflector plate 44 when the scraper 40 has reached the work position in engagement with the ballast. Still another hydraulic limit switch 103, mounted at the operating station C, is adapted to actuate the auxiliary power cylinder 57 to pivotally open the gate 55 when the stone hopper 50 has reached the working position adjacent the shoulder S. If desired, a similar limit switch (not shown) could be provided for the auxiliary power cylinder 65 to extend the shaper 60 to the operative position away from the car 11 in response to said shaper 60 having been lowered to the work position from the travel position. It will be recognized that this arrangement of automatically initiating and terminating these auxiliary functions adds still another feature toward complete automation of the ballast cleaning operation of the present invention.

In operation of the apparatus 10 constructed in accordance with the present invention, it should now be evident that each of the operating means at the working stations A-D is automatically raised and lowered to bypass any obstruction that might appear along the railway. As indicated above, the most common of these obstructions are highway crossings where the road extends laterally across the railroad tracks and where, of course, there is no ballast to be cleared. Similarly, when a spur track or a signal structure occupies the shoulder S of the roadbed, the operating means of the stations A-D are to be raised automatically in sequence at a reference point immediately prior to the obstruction and automatically lowered at a reference point immediately following the obstruction to continue the cleaning operation.

To consider this, assume that the apparatus 10 is working, as shown in FIGURE 2a, and that the valves 72 and 99 are set in the automatic position so that the measuring wheel 70 is in operating position and the actuator circuit 97 is conditioned for operation, then when a highway crossing H is approached, the travel sensor 95 senses the same wherein the solenoid 95 is immediately operative to switch the lever 34a from the dotted line work position (FIGURE 2a) to the full line work position wherein the hydraulic cylinder 30 is actuated to initiate the raising of the scoop, as indicated by the arrow in this figure. It is noted that the sensor 95 is placed a sufficient distance X in front of the scoop 20 so that as this operation takes place while the train is continuously moving forward, the scoop 20 is assured of being removed from the roadbed to the dotted line work position (FIGURE 2a) well before the highway crossing H is reached. As the scoop 20 thus starts its upward movement toward the travel position, the limit switch 77 is switched by the cam portion 78 on the cam bar 79 moving clear of the holder of said switch 77 so as to initiate the operation of the counter 75 on the raising cycle.

After the predetermined count, which has been set on dial 86 of the selector circuit 85, has been reached, the solenoid 90 will be activated to move the handle 42a of the hydraulic valve 42 from the dotted line position to the full line position of FIGURE 2b wherein the operating means of the scoop 20 are to be raised to the travel position. It is pointed out here that since the switch 77 was switched just as the scoop 20 begins its upward movement (note FIGURE 2a), then the operation of the scraper 40 at the station B has been coterminous with that of the scoop 20; i.e., the scraper 40 is actuated synchronously to the scoop 20, that is, the scraper 40 is similarly shifted to the travel position X at the same distance X from the highway crossing H which is to be bypassed.

As shown in FIGURE 3, the scoop 20 of the working station A is lowered into the full line working position in stepped progressions, as shown by the dotted line outlines in this figure, as soon as the sensor 96 denotes the end of the highway crossing H. During this movement over a distance Y, the scoop 20 has successfully worked itself into the shoulder S to the full working position whereupon the limit switch 77 is again switched by the cam portion 78 thereby sending a signal to the revolution counter assembly 75 to begin the lowering cycle for the remaining operating means at the working stations B-D. Thus, as shown in FIGURE 4, when the scraper 40 reaches the distance Y from the crossing H which is now the lowering reference point, it is lowered into work position and the ballast cleaning operation continues; the hopper 50 being lowered into position and the gate 55 opened at the same reference point moments later, and so on until all of the stations A-D are again actively operating on the shoulder S.

It will be noted that the lowering distance Y may, in some cases, be somewhat greater than the raising distance X due to the longer period of time for the scoop 20 to work itself into the ballast along the shoulder S. In either case, however, in accordance with the present invention, the operating means at the following working station will
be shifted at the same distances $X$, $Y$ from the highway crossing $H$ since the metering wheel $70$ controls this shifting in accordance with the information previously fed into the dial dials $86-88$. Furthermore, the selector circuit $85$ has built therein a suitable memory means which is operative to ensure that the shifting operations occur in sequence, even during the situation as shown in FIGURE 3, wherein the scoop $20$ has completed the bypass of the highway crossing $H$ by shifting to the travel position and back to the work position before the operating means at the work position has reached the highway crossing $H$.

A suitable operative embodiment of the memory means that incorporates such a memory arrangement is shown in FIGURE 5. For purposes of expediency of illustration and explanation, the system illustrated is directed to the simplified embodiment of a railway ballast cleaning apparatus having only two operating stations, that is, the pick-up station $A$ and the delivery station $C$. Thus, the two-position switch $77$ operates a pair of conventional counter units $75a$, $75b$, which form an integral part of the revolution counter assembly $75$; said counter unit $75a$ serving to count during the raising cycle, while said counter unit $75b$ is serving to independently count during the lowering cycle. Each counting unit $75a$, $75b$, $77$ preferably includes a conventional mechanical coupling switch $105$, $106$, respectively, which is operative to activate and deactivate the drive shafts $107$, $108$ in a conventional manner to initiate these counting cycles. Since the particular type of winding units $75a$, $75b$ actually employed is not critical, further description is deemed to be unnecessary; however, it is noted that the well known Veeder-Root counter, wherein a number of leads are available for connection to the selector circuit $85$, as shown in this figure, has been found to be suitable for the purpose.

To determine the system of FIGURE 5, assume that the condition exists wherein the operating means of the working station $A$ is to be shifted following the shifting of the operating means of the working station $C$ after the ballast cleaning apparatus $10$ has traveled a distance of twenty-six feet (the fixed distance between the two stations on the cars $11$, $12$). Then the dial $87$ is manually adjusted so that the number twenty-six appears on both counter units $75a$, $75b$, as shown. If the limit switch $77$ is positioned indicating the start of a raising cycle, the switch $105$ is closed thereby causing rotation of the shaft $107$. When the numeral twenty-six is reached, a first selector means, generally designated by the reference numeral $115$, is completed to a source of potential $120$ through the electrical leads $121$, $122$, the relay solenoid $91$, and a single impulse relay $123$. Due to the direction of the winding of the lead $122$ in the solenoid $91$, the current in said lead $122$ causes the armature of said solenoid $91$ to be shifted to the left, as viewed in FIGURE 5, to move the handle $52a$ to the travel position, as shown. After the circuit $115$ has thus been operated, the single impulse relay $123$ holds said circuit $115$ open until such time as it has been completely recycled by lowering and then again raising the scoop $20$ and counting to the required number. The mechanical coupling switch $105$ disconnects coupling $74$ and shaft $107$ only after the counter unit $75a$ has completed counting a full raising cycle (in this case, twenty-six feet) whereby the switch $105$ is reset for the next raising cycle, which means that the scoop can be lowered thus repositioning the limit switch $77$ before the lever $52a$ is shifted as described to raise the hopper $50$. This deactivation of switch $105$ is preferably accomplished through a feed back signal transmitted through lines $124$, $125$ connected to the leads $121$, $122$.

Conversely, if the limit switch is positioned to indicate the start of a lowering cycle, a second selector circuit, generally designated by the reference numeral $129$, is activated after the counter unit $75b$ has reached the predetermined count, thereby connecting potential source $130$ through electrical lines $131$, $132$ and a single impulse relay $133$; the line $132$ forming an additional winding of the relay solenoid $91$ directed in the opposite direction from the line $122$ in the circuit $115$. Thus, in accordance with the present invention, upon activation of the circuit $129$ as described, the armature of the solenoid $91$ shifts to the right thereby carrying the lever $52a$ to the work position and causing the shifting of the hopper $50$ to the work position and the opening of the gate $55$ to discharge the cleaned stone. As in the counter unit $75a$, the switch $106$ disconnects shaft $108$ and resets the counter unit $75b$ in response to a feed back signal through lines $135$, $136$ after a full cycle has been completed so that another raising cycle can be initiated before the hopper $50$ has been actually lowered and opened.

It will be realized that with this arrangement of two separate circuits $115$, $129$, and with the windings in the relay solenoid $91$ being wound in opposite directions, the operating means at the working station $C$ is actuated in sequence on the proper cycle in response to the shifting of the scoop $20$. For connecting each of the other operating means at the working stations $B$, $D$, it will be understood that separate counter units (not shown) could be connected to shafts $140$, $141$ of the counter units $75a$, $75b$ and separate selector circuits provided so that the operation is the same as explained with regard to the operating means of the delivery station $C$; the switches $105$, $106$ being connected to terminate each cycle only after the last of such circuits has been fired.

Accordingly, it will be realized that the present invention has provided a novel apparatus wherein the operating means at each of the in-line operating stations $A$, $B$, $C$, $D$ automatically operate on the roadbed in sequence and are shifted between their operative and inoperative positions when an obstruction is presented along the railway or when the ballast cleaning operation is to be initiated or terminated. This arrangement thus provides advantages heretofore not found in the prior art and provides great improvements in terms of efficiency of operation. Further, the apparatus is relatively simple in construction and can be easily adapted to any modern day railway device of the type described, including not only the ballast cleaning apparatus specifically illustrated and explained herein, but also apparatus, such as rail grinders of the type having a plurality of grinder heads to be raised in the same stepped fashion, as mentioned above.

In this disclosure, there is shown and described only the preferred embodiment of the invention, but, as will be appreciated, it is to be understood that the invention is capable of various changes or modifications within the scope of the inventive concept as expressed by the accompanying claims.

For example, it will be realized that even though the revolution counter assembly $75$ having the plurality of Veeder-Root counter units $75a$, $75b$ with the corresponding number of selector circuits $115$, $129$ of the preferred embodiment disclosed above gives particularly good results, a single counter and a single selector circuit with a built-in memory device may be utilized to accomplish the same desirable results in accordance with the broad aspects of this invention; the only requirement being that the counter be capable of performing plural counting operations simultaneously and the selector and memory circuit be capable of controlling each of the operating means $A$-$D$ in sequence regardless of the position of the others.

I claim:

1. In a continuous railway work apparatus including car means movable along the rails, a plurality of in-line working stations spaced longitudinally along said car means, operating means positioned at each of said stations for performing successive operations along said railway, power means for vertically shifting said operating means between a traveling position above said railway and a work position in operative relationship with said railway, the improvement comprising control means for actuating
the power means for shifting the first in-line operating means from one of said positions to the other at a selected reference point along said railway, metering means carried by said car means and operatively associated with said railway, counter means connected to said metering means for measuring the distance traveled by said car means from said reference point in response to the shifting of said first in-line operating means, and selector means connected to said counter means for actuating said power means for shifting each of the remaining operating means in succession in accordance with said distance, said distance being substantially equal to the distance between said first in-line operating means and the operating means being shifted, whereby each of said remaining operating means is also shifted at said reference point along said railway whereby rendering said operations coextensive with respect to said reference point.

2. The combination of claim 1 wherein said metering means includes a metering wheel rotatably engaging a rail of said railway, said counter means includes first and second revolution counters, said first and second revolution counters being responsive to the shifting of said first in-line operating means to said traveling and work positions, respectively, said first and second revolution counters being capable of simultaneous counting operations and wherein said selector means includes first and second circuits for actuation in response to said first and second revolution counters, respectively, whereby the successive shifting of said remaining operating means to said traveling and work positions occurs following the respective shifting of said first in-line operating means.

3. The combination of claim 1 wherein said power means includes for each operating means a double acting hydraulic cylinder, a hydraulic pressure source and a valve means for connecting said pressure source to said hydraulic cylinder and wherein said selector means includes an electrical relay solenoid for actuating the respective valve means.

4. The combination of claim 3 wherein at least one of said operating means includes auxiliary work means for assisting said operating means in performing the respective operations, and trip means for actuating said auxiliary work means in response to the shifting of the associated operating means into the work position.

5. The combination of claim 4 wherein said control means further includes first and second electrical sensor members mounted adjacent the front and rear ends of said first in-line operating means, said first and second sensor members being responsive to the condition of said railway, and an actuator circuit connected to said sensor members, said electrical relay solenoid for said first in-line operating means being responsive to said actuator circuit.

6. In a continuous railway ballast cleaning apparatus including car means movable along the rails, a ballast pick-up station positioned at the front of said car means and a ballast delivery station positioned at the rear of said car means, a ballast scoop and a ballast hopper having a discharge gate positioned in-line at said pick-up and delivery stations, respectively, first hydraulic cylinder means for vertically shifting said scoop between a traveling position above said ballast and a work position in engagement with the ballast, second hydraulic cylinder means for operating said gate of said hopper, the improvement comprising control means for actuating the first hydraulic cylinder means for shifting the scoop from one of said positions to the other at a selected reference point along said railway, a metering wheel carried by said car means and rotatably engaging said railway, revolution counter means connected to said metering wheel for denoting the distance traveled by said car means from said reference point in response to the shifting of said scoop, and selector means connected to said counter means for actuating said second hydraulic cylinder means to operate said gate of said hopper in accordance with said distance, said distance being substantially equal to the distance between said scoop and said hopper, whereby said gate is operated at said reference point along said railway thereby rendering the ballast pick-up and delivery operations coextensive with respect to said reference point.

7. The combination of claim 6 wherein is further provided a ballast scraper station positioned between said pick-up station and said delivery station and a shoulder shaper station positioned to the rear of said delivery station, a scraper member and a shaper member at the respective stations, third and fourth hydraulic cylinder means for vertically shifting said scraper and said shaper members, respectively, between the traveling and the work positions, said selector means being operative to actuate said third and fourth hydraulic cylinder means in accordance with the distance between the scoop and the member being shifted and in proper sequence with the shifting of said scoop and the operation of said gate of said hopper, whereby said scraper and shaper members are also shifted from one of said positions to the other at said reference point along said railway.

8. The combination of claim 7 wherein is further provided a fifth hydraulic cylinder means for vertically shifting said hopper between the traveling and the work positions in response to said selector means in accordance with said distance between said scoop and said hopper.

9. The combination of claim 6 wherein is further provided a second revolution counter means for measuring said distance in response to the shifting of said scoop from said other position to said one position, said first and second revolution counter means being capable of simultaneous counting operations and wherein said selector means comprises first and second circuits for actuation in response to said first and second counter means, respectively, whereby the operation of said gate occurs in sequence following the shifting of said scoop in the respective direction.

References Cited

UNITED STATES PATENTS

3,230,895 1/1966 Stewart ___________________________ 104—7
3,274,952 9/1966 Fekete ___________________________ 104—7
2,842,069 7/1958 McWilliams _______________________ 171—16

ROBERT E. PULFREY, Primary Examiner.
EUGENE H. EICKHOLT, Assistant Examiner.

U.S. Cl. X.R.

171—16; 104—7