



May 15, 1962

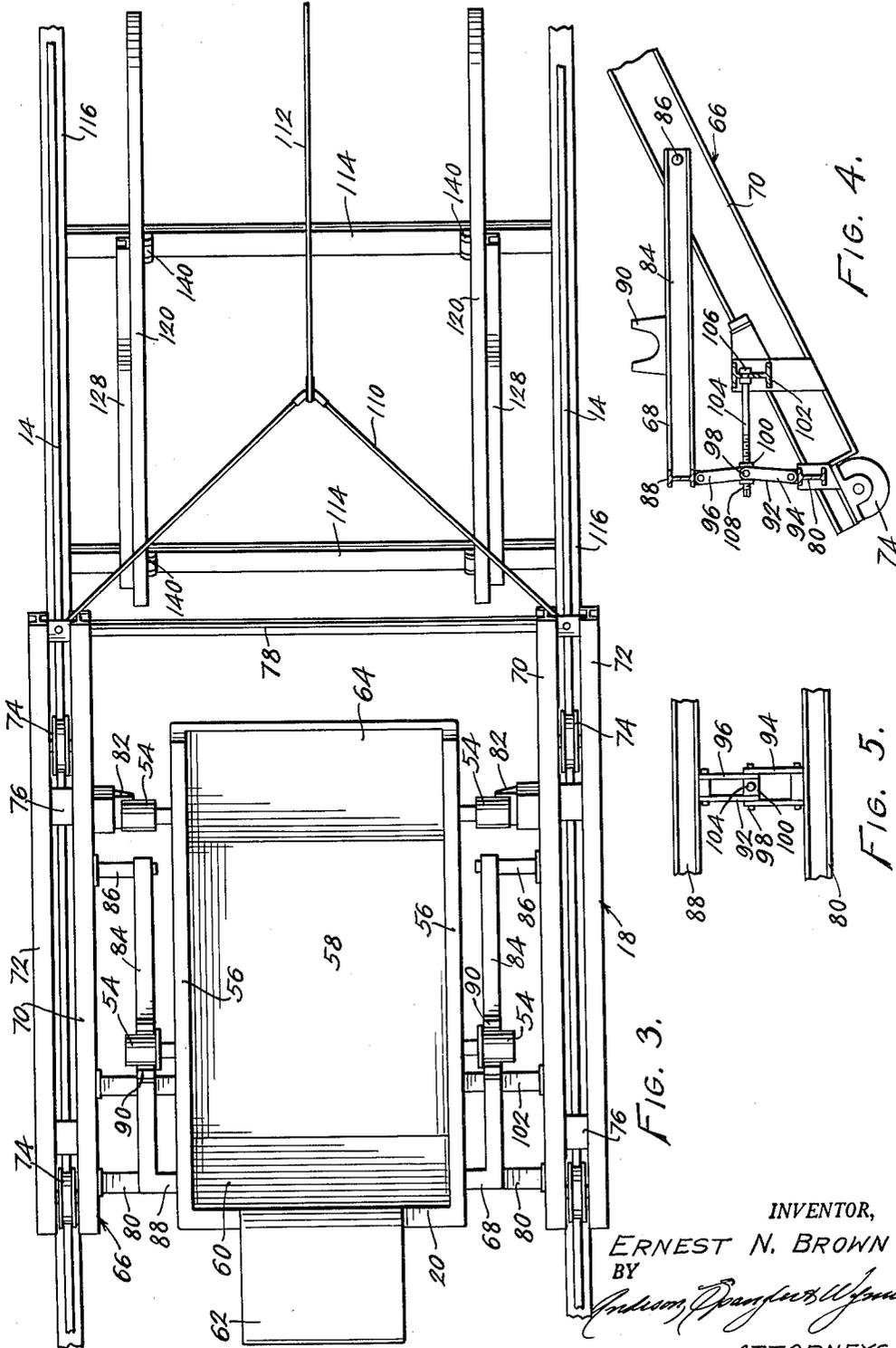
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3,034,669

APPARATUS FOR HAULING ORE IN OPEN PIT MINES

Filed Aug. 31, 1959

5 Sheets-Sheet 2



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APPARATUS FOR HAULING ORE IN OPEN PIT MINES

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5 Sheets-Sheet 3

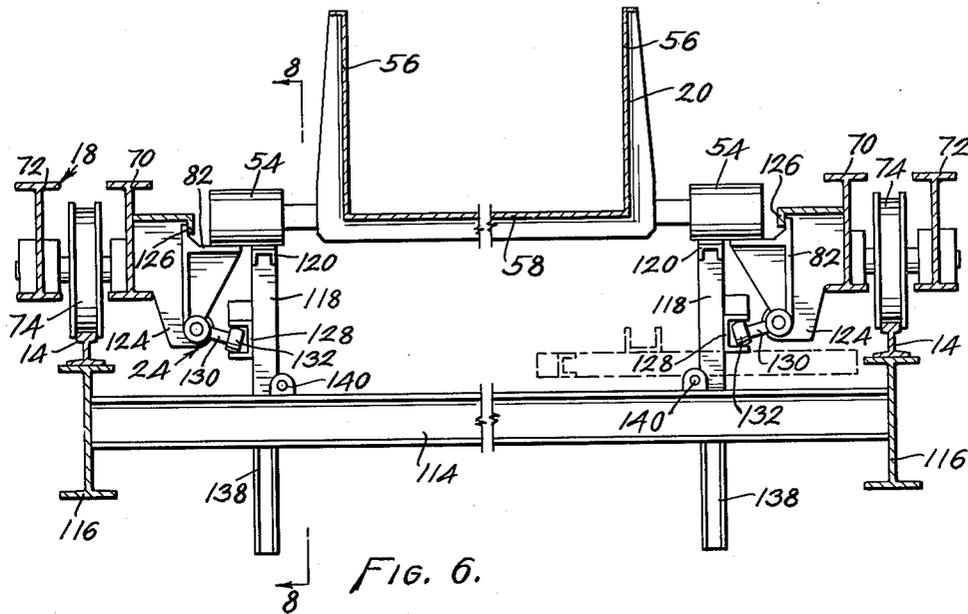


FIG. 6.

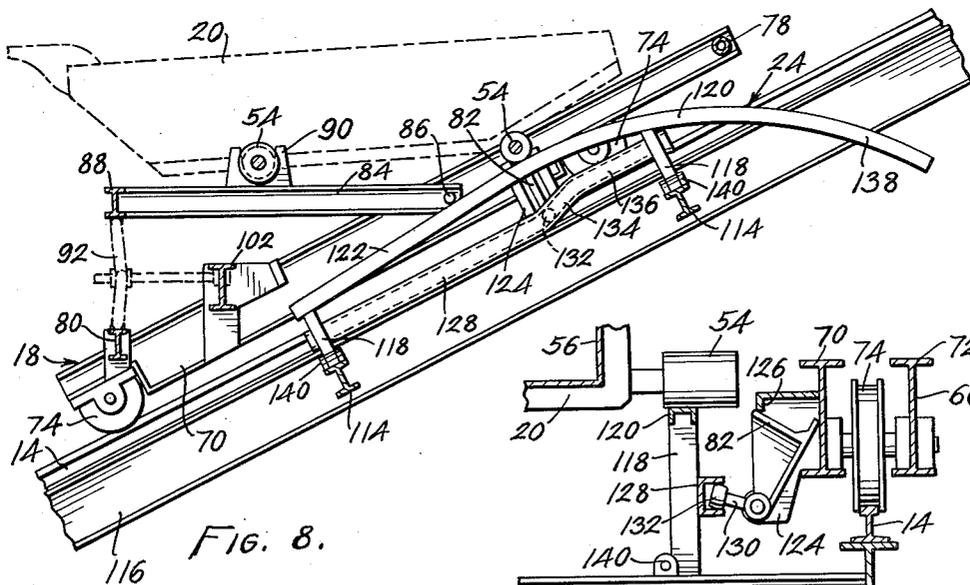


FIG. 8.

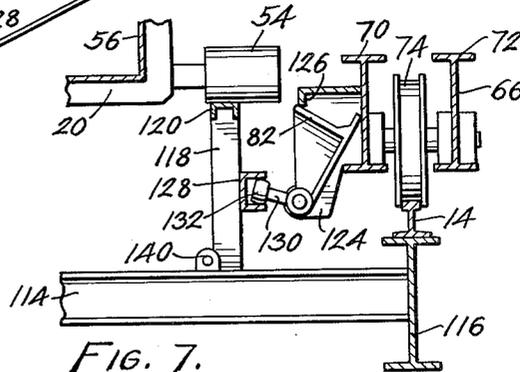


FIG. 7.

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APPARATUS FOR HAULING ORE IN OPEN PIT MINES

Filed Aug. 31, 1953

5 Sheets-Sheet 4

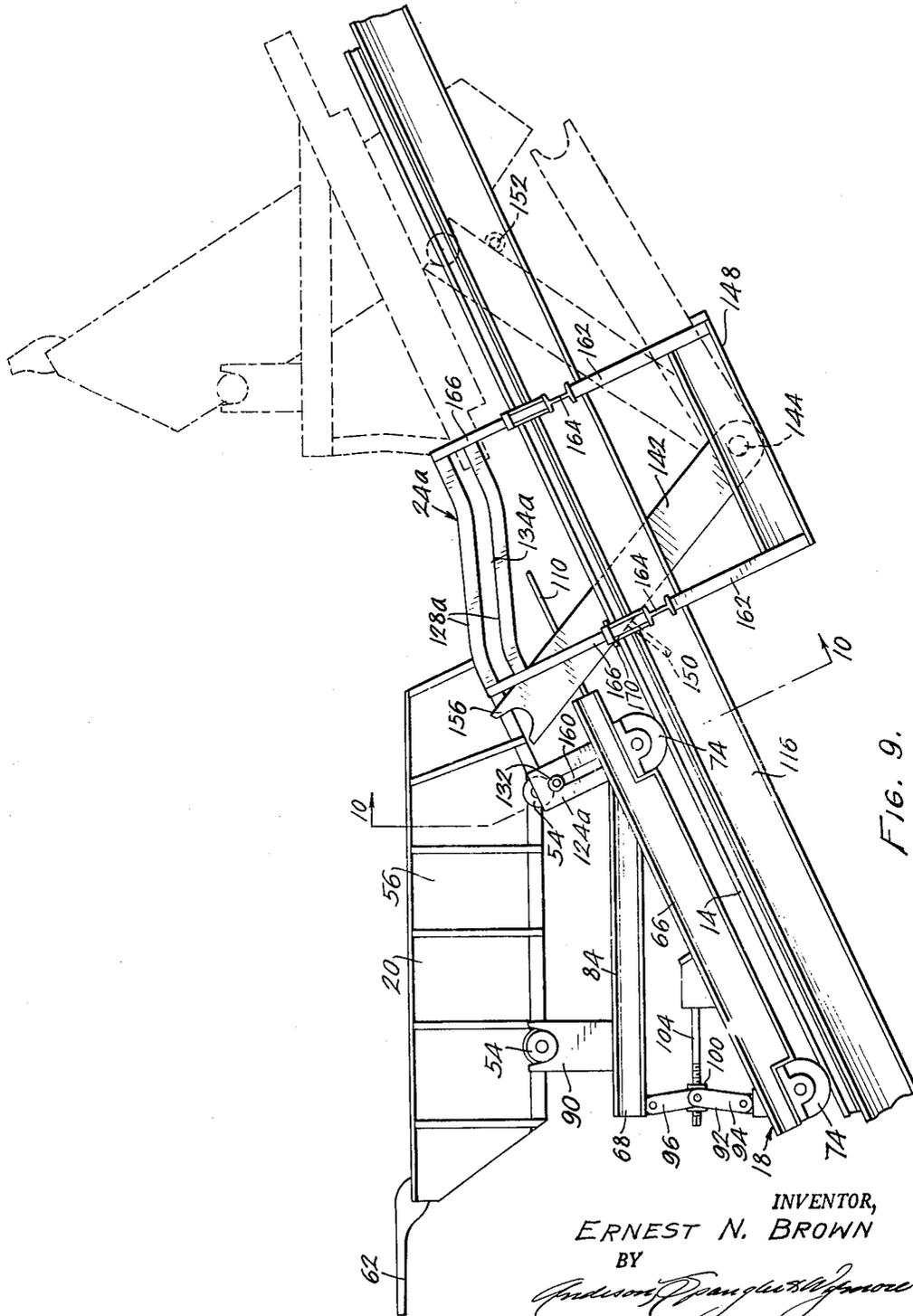


FIG. 9.

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APPARATUS FOR HAULING ORE IN OPEN PIT MINES

Filed Aug. 31, 1959

5 Sheets-Sheet 5

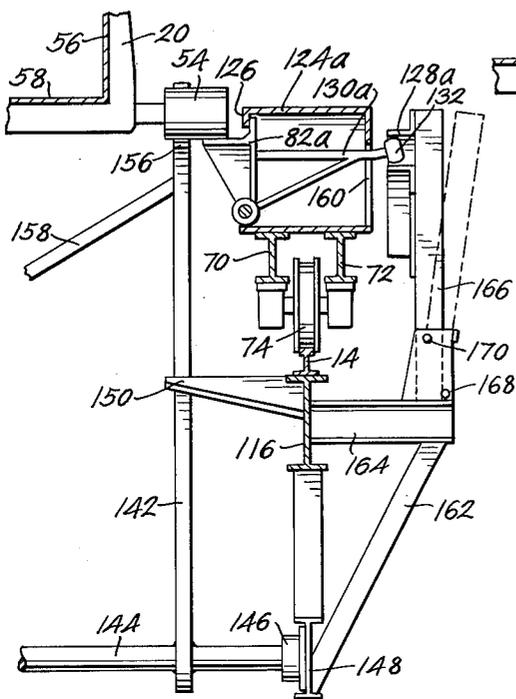


FIG. 10.

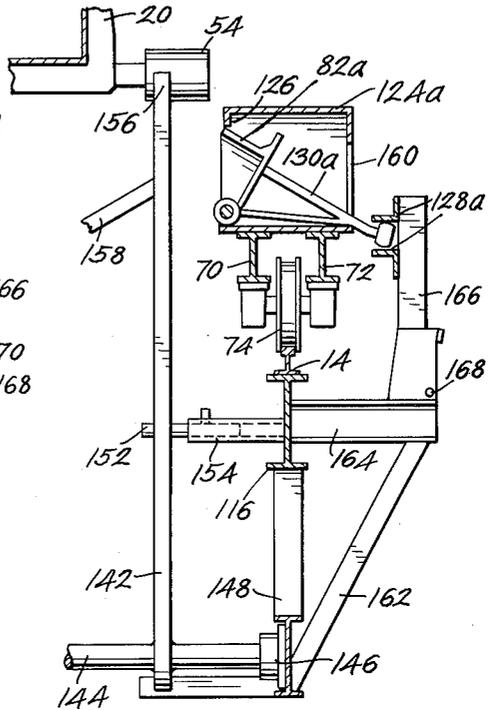


FIG. 11.

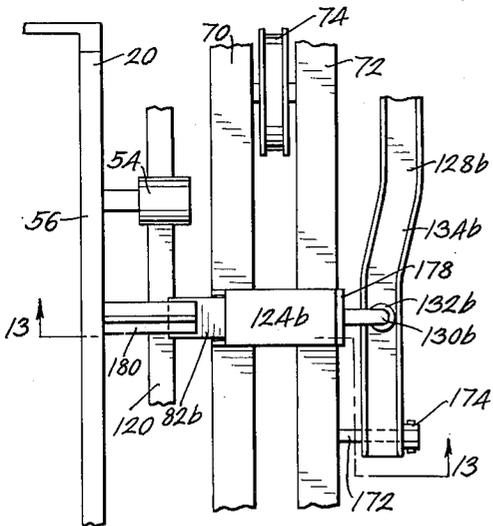


FIG. 12.

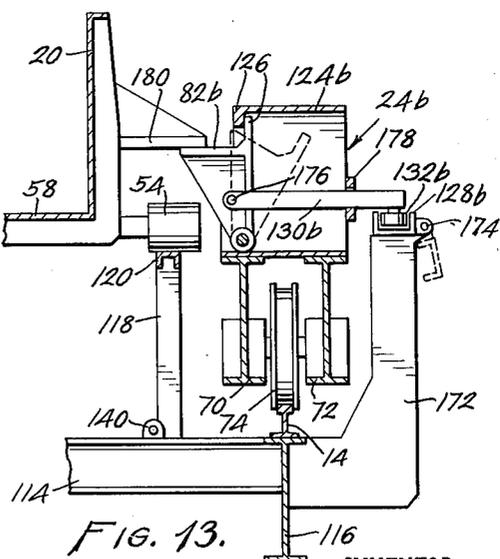


FIG. 13.

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1

3,034,669

**APPARATUS FOR HAULING ORE IN  
OPEN PIT MINES**

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Filed Aug. 31, 1959, Ser. No. 837,033  
17 Claims. (Cl. 214-104)

This invention relates to haulage systems for open pit mines and, more specifically, to mine skips together with the methods and apparatus used to load, haul and unload same.

In the ordinary open pit mining operation, the ore is taken from benches at varying levels below the pit rim and loaded into heavy-duty dump trucks which may have capacities of upwards of forty tons for haulage to loading stations at the foot of inclined trackage laid on the sloping walls of the pit. At each loading station, the ore or waste material is transferred from the dump truck to waiting mine skips which are used to haul it up the inclined tracks to a processing station located on the pit rim or one of the higher benches where it is unloaded automatically.

One of the most significant and serious problems encountered in an open pit mining operation of this type is the damage to the mine skips brought about when they are loaded from the dump trucks. It is not uncommon, for example, to handle single chunks of material weighing many tons and having minimum dimensions several feet in length although they are usually quite irregular in shape with sharp jagged edges and corners. Quite obviously, dropping loads such as this from a height of several feet at a loading station into the bottom of a mine skip can, and does, cause considerable damage resulting in substantial equipment repair, maintenance and replacement costs. There is also the important problem of equipment breakdowns in service that cause appreciable downtime, production losses and increased operating costs.

A number of different attempts have been made in the past to solve this problem, most of which involved the use of specially designed and reinforced skip buckets and carriages supposedly adapted to resist these tremendous loading shocks; however, up to the present time these units have met with only slight success and much still remains to be done by way of satisfying the needs of the mining industry in this area. Insofar as is known, all of the prior art open pit haulage systems and methods involve the step of transferring the newly-mined ore and overburden from the body of a truck or other vehicle to carriage-supported skip buckets mounted on inclined trackways. It has now been found in accordance with the teaching of the instant invention that the aforementioned difficulties can be almost completely overcome by the novel expedient of using the same unit as both the truck body and skip bucket thus eliminating the step of transferring material therebetween. A trunnion-supported truck body is removably mounted upon the bed of an ore truck and is loaded on one of the benches with the newly-mined ore and overburden in the conventional manner. The truck then moves to a loading station at the foot of the inclined trackway where large overhead traveling cranes mounted for transverse movement lift the truck body from the bed and set it down on a waiting skip carriage for transfer to the unloading station on the rim of the pit or at some higher bench along the track. The crane is used to lower an empty body on the truck for the next run. The loaded truck body, which is now functioning as a skip bucket, is pulled up the inclined trackway where it is dumped automatically into an ore bin underneath the unloading station. This haul-

2

age method, of course, completely eliminates the step of transferring the ore from the truck body to the skip bucket and the attendant damage to the equipment.

It is, therefore, the principal object of the present invention to provide a novel and improved haulage system for open pit mines.

A second object of the invention of the class described is the provision of a method of hauling ore from open pit mines that completely eliminates the step of transferring ore from the ore truck to the mine skip.

A third object is to provide a specially-designed combination truck body and skip bucket for use with open pit mine haulage systems.

Another object of the invention is the provision of an improved automatic cam-actuated dumping mechanism for skip buckets.

Still another object is to provide a skip carriage that includes adjustable supports adapted to maintain the bed thereof in substantially horizontal position so that the ore buckets can be carried without spillage while traversing trackways of varying inclinations.

An additional objective of the claimed invention is to provide an overhead traveling crane system for use in transferring the combination truck bodies and skip buckets between the chassis of the ore trucks and the skip carriages.

Further objects of the invention are to provide an ore-hauling system for open pit mines which is economical in that it utilizes dual-purpose ore carriers, considerably lessens damage to equipment, reduces down-time for the repair, maintenance and replacement of damaged units, and lowers labor costs; a system of the type described that is more versatile than the prior art assemblies for this purpose; and, one that is rugged and fully adaptable to many different open pit mining operations.

Other objects will be in part apparent and in part pointed out specifically hereinafter in connection with the description of the drawings that follows, and in which:

FIGURE 1 is a side elevation, portions of which have been shown in section and other portions broken away to conserve space, illustrating the open pit ore-hauling system of the present invention including the loading and unloading stations, the inclined trackway extending therebetween, the skip buckets and carriage therefor, the traveling crane and the ore bin;

FIGURE 2 is side elevation of the combination truck body and skip bucket showing the near side removed and the bottom in section;

FIGURE 3 is a fragmentary top plan view to an enlarged scale showing the rail-mounted skip carriage with the ore bucket mounted thereon and the cable-hoist yoke used to haul the assembly up the trackway;

FIGURE 4 is a fragmentary elevation to an enlarged scale showing the leveling mechanism for the skip carriage;

FIGURE 5 is a fragmentary end elevation showing further details of the scissor assembly in the leveling mechanism of FIGURE 4;

FIGURE 6 is a transverse section to an enlarged scale taken along line 6-6 of FIGURE 1 showing the automatic cam-actuated dumping mechanism located adjacent the unloading station prior to the withdrawal of the trunnion supports;

FIGURE 7 is a fragmentary section similar to FIGURE 6 except that the cam has moved the trunnion supports out of the way preparatory to emptying the skip bucket into the ore bin;

FIGURE 8 is a longitudinal section taken along line 8-8 of FIGURE 6;

FIGURE 9 is a side elevation similar to FIGURE 1, but to an enlarged scale, showing a modified form of ore-bucket dumping mechanism wherein a different cam

3

design is utilized to retract the trunnion supports and a pivotally-mounted arm rather than a scroll is used to raise the trunnions free of their supports;

FIGURE 10 is a fragmentary section taken along line 10—10 of FIGURE 9 showing the trunnion supports in extended position prior to withdrawal thereof by the cam;

FIGURE 11 is a section similar to FIGURE 10 except that the cam has retracted the trunnion supports;

FIGURE 12 is a fragmentary top plan view to an enlarged scale showing a further modified form of dumping mechanism wherein a different type of retractable ore bucket support is used and engages a foot on the side of the bucket rather than the trunnion; and,

FIGURE 13 is a transverse section taken along line 13—13 of FIGURE 12 showing the ore bucket support in extended position in dotted lines along with the construction by which the cam for actuating the latter can be rendered inoperative if the ore bucket is to move on up to an unloading station at a higher level before being emptied.

Referring now to the drawings, and in particular to FIGURE 1 thereof, it will be seen that the ore haulage system for open pit mines of the present invention includes a loading station and an unloading station, both of which have been indicated in a general way by numerals 10 and 12, respectively. These stations are interconnected with one another by an inclined trackway 14 that is bedded along the sloping walls of the open pit mine. The loading station 10 is usually located at the lower end of the track-way on a so-called "bench" or ledge; however, it is entirely possible that two or more loading stations would be used at varying levels below the rim of the pit. The unloading station 12, on the other hand, is customarily located on the rim of the pit and includes some type of ore bin or hopper 16 of conventional design.

The inclined trackway 14 comprises at least one pair of parallel rails upon which is mounted a skip carriage that has been designated generally by numeral 18 and which will be described in detail presently. Preferably, two sets of tracks are used arranged in side-by-side relation, one carrying a loaded skip bucket 20 up to the ore bin while the other is returning an empty bucket to the loading station; however, a single-track system is also usable and has been illustrated for purposes of simplification. The wheeled carriages 18 with the ore buckets 20 supported thereon are hauled up the trackway by means of suitable winch mechanisms 22 located at the unloading station. Also, adjacent the unloading station, each pair of rails is provided with an automatic dumping mechanism indicated generally by numeral 24 and which is operative to empty the ore or skip buckets into the hopper 16. Several forms of the dumping mechanism 24 have been illustrated and will be described in detail hereinafter.

The skip buckets 20 comprise one of the most significant contributions of the present invention as they are also the truck bodies loaded at the mine face in addition to being the ore carriers of the inclined haulage system. Thus, the method and apparatus required to accomplish the transfer of these ore buckets 20 from the trucks to the skip carriages, in addition, constitute a novel aspect of the instant invention.

From an examination of FIGURE 1 it will be seen that the bench 26 at which the loading station 10 is located, includes a transversely extending overhead traveling crane assembly, indicated in a general way by numeral 28, which comprises a base of foundation 30, a plurality of uprights 32 supported on the base and interconnected by crossframe elements 34, upright rail supports 36 carrying rails 38 interconnecting the upper ends thereof, and a traveling crane 40 mounted on the rails for transverse rolling movement across the loading station. As illustrated, the traveling crane 40 is of the

4

gantry-type having a bridge 42 mounted on the rails, a hoisting unit 44 mounted on the bridge for rolling movement between the ends thereof, and a yoke 46 suspended from the snatch-blocks 48 of the hoisting unit. This yoke is provided with legs 50, the lower ends of which are formed to provide upwardly opening hooks 52 positioned and adapted to receive the trunnions 54 depending from the sides 56 of the skip buckets 20.

In the preferred embodiment of the invention, a pair of traveling cranes are used, one to carry the loaded ore buckets from the truck to the awaiting carriage at the loading station and the other to transfer the empty buckets on the second track from the carriage to the truck. Ordinarily, the truck will move into a stall on one side of the unloading station where the loaded body will be lifted from the chassis either by one of the traveling cranes or some other suitable apparatus for this purpose. The crane will then move over along side the inclined trackway in position to lower the loaded truck body or ore bucket onto the skip carriage as soon as the empty bucket is removed therefrom. The other crane is used to lift the empty body from the carriage and carry it to a waiting truck chassis where it is mounted for return to the mine. As soon as the empty body is removed from the carriage, the first-mentioned crane moves into position and lowers the full body thereon. In the meantime, the chassis of the truck that was last separated from its body will move around to the other side of the loading station and into a stall underneath the second crane from which it will receive an unloaded body. Of course, the number of sets of tracks, trucks, etc., will depend on the cycling time of these various operations for a particular mine which are in turn dependant upon the capacities of the various units, the distances between the working face of the mine and loading station, and the length of track that must be negotiated between the loading station and ore bin.

Now, referring to FIGURE 2 for a brief description of the ore bucket 20, it will be seen that it comprises generally a heavy-duty truck body having spaced sides 56, a bottom 58, a forwardly and upwardly inclined front end 60 with a cab shield 62 depending therefrom, and a rearwardly and upwardly inclined tail gate 64. Conventional truck bodies having capacities of upwards of forty tons may be used if modified to include the trunnions 54 depending from the sides thereof and suitable means for detachably connecting same to the chassis. Obviously, with the exception of the aforementioned modifications, a number of different truck body styles and designs could be used with equal success.

The skip carriage 18 can best be seen in FIGURES 3, 4 and 5 to which reference will now be had. A generally rectangular wheel-supported main frame 66 is mounted for rolling movement along the rails of the tracks in substantially parallel relation thereto although inclined with respect to the horizontal. The main frame, however, supports an adjustable frame 68 in position to carry the skip buckets 20 in substantially horizontal or level relation such that the contents thereof will not be spilled from the partially open tail end. In the specific form illustrated, main frame 66 includes inner and outer sideframe elements 70 and 72, respectively, arranged in spaced substantially parallel relation to one another with the wheels 74 journaled for rotation therebetween and at the front and rear ends thereof. Spacers 76 are preferably located at intervals throughout the length of the side frame elements to maintain a fixed spaced relation. Front and rear transverse elements 78 and 80, respectively, connect the side frame assemblies together and maintain the grooved wheels 74 in proper position to receive the rails. A pair of front trunnion saddles 82 depend from the inner side frame elements 70 of the main frame in opposed relation to one another and in position to receive the rear trunnions 54 that are located near the tailgate of the skip bucket or truck body. These trunnion saddles are fixed

although they define a transverse pivot axis for the rear end of the skip bucket as the front end thereof is raised and lowered with the adjustable frame of the skip carriage in a manner to be described shortly.

The adjustable frame 68 is generally U-shaped and is positioned within the confines of the main frame such that it opens toward the unloading station which, for the purposes of the present description, has been designated the front end of the skip carriage although the rear end of the skip bucket when referenced to the cab or driving compartment of the truck chassis. The spaced legs 84 of the adjustable frame have their front ends pivotally attached to pins 86 depending from the inner elements 70 of the main frame while the rear ends thereof are interconnected by a transverse element 88 positioned above the rear transverse element 80 of the main frame. Thus, the rear end of the adjustable frame 68 is free to swing up and down relative to the main frame 66 in order to maintain the desired level position of the ore bucket 20, the front end of which is supported on trunnions 54 that rest within rear trunnion saddles 90 carried by the legs of said adjustable frame aft of the pivot axis.

Actual leveling of the ore bucket is accomplished by means of a screw-actuated scissor-type linkage 92 interconnecting the transverse elements 80 and 88 of the main and adjustable frames. While it is obvious that such adjustment could be accomplished with various mechanisms, the particular one shown comprises links 94 and 96 having their adjacent ends pivotally attached for movement about a common axis to the ears 98 of a thrust collar 100 while the remote ends thereof are pivotally connected to the transverse elements 80 and 88, respectively, of the main and adjustable frames. An intermediate transverse frame element 102 interconnects the inner sideframe elements of the main frame and provides a fixed support for the front end of adjustment screw 104 that is mounted for rotation therein. The adjustment screw is provided with spaced abutments 106 located on opposite sides of the inch of frame element 102 that are adapted to prevent axial movement of the screw while the threaded end 108 thereof turns within the thrust collar 100 in a manner to open or close the scissor linkage thereby raising and lowering the adjustable frame. In actual practice, the foregoing adjustments to maintain the skip buckets in a level relation would only be made at rare intervals, once at the time the haulage system is installed and thereafter whenever the system is moved to a new location or the slope of the pit walls changes materially due to settling and working at different bench and ore bin levels.

As shown in FIGURE 3, a rope or cable yoke 110 is attached to the front corners of the main frame of the skip carriage while the central portion of the yoke is attached to the line 112 from the drum of the winch 22. As would be expected, winding line 112 onto the winch drum hauls the carriage and loaded skip bucket up the inclined track from the loading station to the unloading station where the bucket is automatically emptied into the ore bin. Of course, reversing this procedure lowers the empty bucket and carriage to the loading station for transfer to the truck chassis by means of the traveling crane.

Before proceeding with a detailed explanation of the several automatic dumping mechanisms that have been illustrated herein and which function to empty the skip buckets into the ore bin or hopper at the unloading station, it will be well to first examine the fundamental requirements common to each of these mechanisms. To begin with, the pairs of trunnions located near the front and rear ends of the skip buckets can easily be carrying loads in excess of twenty-five tons including both the truck body and ore. It is necessary in order to dump the skip buckets that the supports on the skip carriage that hold up the rear end of the skip bucket, namely, front trunnion saddles 82, be retracted in some manner. Before this can be accomplished, however, these front trunnion supports or saddles must first be unloaded; hence, some type of

auxiliary trunnion support having a cam surface adapted to lift the trunnions free of the retractable saddles is required and this usually takes the form of an arched track section or scroll. Then, once the front trunnion saddles are unloaded, a cam follower carried thereby operates within a second cam track of some type to retract the saddles and permit the skip bucket to dump as it traverses a downwardly curved portion of the first-mentioned arched track section or scroll. Of course, both of these camming mechanisms must be operative to return the skip bucket and retractable trunnion supports to their former positions after the dumping cycle has been completed preparatory to returning the empty skip bucket to the loading station. In addition to the above, it may be desirable to render both the dumping scroll and trunnion support retracting cam inoperative so that the loaded ore buckets can by-pass a given unloading station to be emptied at one located at a higher level on the inclined haulage-way. As the description proceeds, it will be found that the foregoing requirements are met in each of the automatic dumping systems illustrated herein.

Specifically, with reference to FIGURES 6, 7 and 8, the first form of automatic unloading or dumping mechanism 24 will now be described in detail. At each unloading station, transverse frame elements 114 interconnect the beams 116 upon which the rails 14 are mounted. These transverse elements 114 provide a base for the foldable or otherwise demountable upright scroll supports 118 that carry the dumping scroll 120. One dumping scroll 120 is located on each side of the center of the track in parallel relation to the rails but in longitudinal alignment with the pair of trunnions 54 located on the rear end of the truck body. The lead or downhill section 122 of the scroll 120 is upwardly inclined at a greater inclination than the rails starting from a low point beneath the trunnion path. Therefore, as the ore bucket enters the unloading station, the rear pair of trunnions move onto the downhill section 122 of dumping scroll 120 and are lifted thereby off of their supports 82 which form a part of the carriage. It is this condition which has been illustrated in FIGURE 6.

Now, as the trunnions progress up the lead section of the dumping scroll and are lifted free of their supports, these supports become unloaded so that they can be moved out of the way. The inner side frame members 70 of the skip carriage are provided with brackets 124 to which the trunnion supports 82 are attached for pivotal rocking movement between the extended position of FIGURE 6 and the retracted position of FIGURE 7. Stops 126 are provided on opposed surfaces of the brackets and trunnion supports positioned and adapted to maintain the latter in extended position while loaded as in FIGURE 6.

Movement of the trunnion supports between extended and retracted positions is accomplished by means of a cam track 128 located underneath the dumping scroll on upright scroll supports 118 and a rocker arm 130 carried by the trunnion supports with a cam follower 132 on the free end thereof that rides in the cam track. The cam track includes an upwardly inclined section 134 (FIGURE 8) of a generally channel-shaped cross section which is operative to lift the rocker arm 130 as the cam follower moves through the channel thereby tilting the trunnion support from its extended to its retracted position. The inclined section 134 of the cam track is positioned substantially underneath the high point of the dumping scroll 120 so that it is operative to rock the trunnion supports from underneath the trunnions only when the former have been unloaded. Once the trunnion supports have moved from beneath the trunnions, the uphill or terminal section 136 of the cam track once again assumes a parallel relation to the rails thereby holding the trunnion support in retracted position while the dumping operation is completed.

Now, after the trunnion supports have been retracted, the rear pair of trunnions that have been supported thereby proceed to roll along the uphill or terminal section

138 of the dumping scroll 120 which curves downwardly between the rails. This, of course, lowers the rear end of the skip bucket as the front or downhill end thereof pivots about the rear set of trunnions cradled in fixed trunnion supports 90 causing the ore to be discharged over the tailgate 64 into the ore bin as clearly shown by dotted lines in FIGURE 1. Note in this connection that the cam follower 132 and the rear trunnions 54 do not leave the cam track and dumping scroll 120 during the unloading operation.

After the load has been discharged into the ore bin, the winch is reversed by the winch operator permitting the ore bucket to return down the trackway to the loading station. Obviously, as the ore bucket reverses direction the dumping scroll will again lift the rear end thereof and the cam track will move the trunnion supports back into extended position beneath the rear trunnions for the return trip.

Note, also, that in this particular embodiment of the invention both the dumping scroll 120 and the cam track 128 are carried by the upright support elements 118 which are hingedly attached to the transverse frame elements 114 by means of hinge elements 140. Thus, by folding the dumping scroll and cam track into the dotted line position of FIGURE 6, the dumping mechanism can be rendered completely inoperative allowing the ore bucket to by-pass the unloading station and proceed to another located at a higher bench level or on the pit rim. Such a feature would be quite useful, for example, if separate unloading stations and bins were used for overburden and mine run ore.

The second unloading or dumping assembly 24a of the present invention has been illustrated in FIGURES 9, 10 and 11 to which reference will now be had. This embodiment of the invention differs from the one just described in two principal aspects, namely, the substitution of a pair of rocker arms 142 for the dumping scroll and the relocation of the cam track 128a on the outside of the rails 14. Transverse elements 114 at the unloading station are eliminated and replaced by a transverse shaft 144 journaled for rotation within bearings 146 carried by a suitable auxiliary frame structure depending from rail supports 116 and which has been designated in its entirety by numeral 148 as the particular design thereof is of no patentable significance. A fixed stop 150 is attached to each of the rail supports 116 extending inwardly therefrom in position to engage rocker arm 142 and retain same in the proper location to pick up the rear trunnions of the ore bucket. In addition, a retractable stop 152 also depends from each of the rail supports ahead or upgrade of the fixed stop and in position to limit the forward travel of the rocker arm. Stop 152 is mounted for telescoping movement within a tubular element 154 projecting inwardly from the rail support as clearly shown in FIGURE 11. When stop 152 is retracted or telescoped within tube 154, arm 142 can be lowered to the dot-dash line lowest position of FIGURE 9 and thus be rendered inoperative so that the ore bucket can by-pass the unloading station without being dumped for the reasons that have already been described.

With the rocker arms 142 located as shown in full lines in FIGURE 9, the forked upper end thereof 156 is in position to receive the rear pair of trunnions of the ore bucket as it proceeds up the trackway. Once the arms 142 have picked up the trunnions, they rock forwardly raising the rear end of the ore bucket off of the trunnion supports 82a at the front end of the skip carriage thus freeing them for movement into retracted position. Suitable cross braces 158 preferably interconnect the rocker arms for simultaneous movement so that the ore bucket will not become skewed in relation to the rails.

The trunnion supports 82a are changed very little except that the rocker arms 130a are elongated and extend outwardly therefrom rather than inwardly as in the FIGURES 6-8 embodiment. These trunnion supports 82a are mounted for swinging movement between the ex-

tended position of FIGURE 10 and the retracted position of FIGURE 11 within the slightly modified trunnion support brackets 124a. The trunnion supports and brackets therefor still include the stops 126 operative to maintain the extended position of the former when under load. The outside of the trunnion support brackets 124a is provided with an upwardly ranging slot 160 positioned and adapted to receive the rocker arm 130a for up and down movement.

The cam track 128a is mounted on the outside of the rails in this embodiment and is supported by an auxiliary frame structure that depends from the rail supports and includes struts 162, main support elements 164 and tilt-able uprights 166. Uprights 166 are hingedly attached to the main supports by hinge connections 168 that provide for swinging movement thereof between the full line operative position of FIGURES 10 and 11 and the dotted line inoperative position of FIGURE 10. A retaining pin 170 interconnects one of the uprights 166 with its associated hinge connection 168 to maintain the former in operative position except when it is desirable to have the ore bucket by-pass the unloading station without being dumped.

The cam tracks 124a are, of course, reversed from those previously described by reason of their being mounted on the outside rather than the inside of the rails. Thus the inclined section 134a thereof (FIGURE 9) slopes downwardly and forwardly to accomplish retraction of the trunnion supports rather than upwardly. Here again, the inclined medial section 134a of the cam track 128a becomes operative to retract the trunnion supports only after the rocker arms 142 have raised the tail end of the ore bucket.

Once the trunnion supports have been retracted into the position shown in FIGURE 11, the rocker arms 142 swing forwardly and downwardly to the intermediate dot dash line position of FIGURE 9 where they engage the retractable stop 152 and lower the rear end of the ore body to the dumping position that is also shown by dot dash lines in FIGURE 9. The ore bucket again pivots about the front pair of trunnions cradled in trunnion supports 90 and discharges the contents over the sloping tailgate 64 into the ore bin. As before reversal of the skip carriage places the rear pair of trunnions back on the trunnion supports which have been returned to extended position by the cam track.

Finally, FIGURES 12 and 13 show the third form of dumping assembly 24b that differs from the two already described in that it includes a further modified form of cam track 128b and associated elements. The dumping scroll 120 and hinged support 118 therefore are the same as in the first modification of FIGURES 6-8; however, the cam track 128b is not carried thereby but is mounted on the top of a pair of cam track support brackets 172 that depend from the rail supports 116 for swinging movement between the full-line operative position of FIGURES 12 and 13 and the dotted line in operative position of FIGURE 13 by reason of the hinged connection 174 therebetween. As shown, cam track 128b comprises an upturned channel adapted to receive cam followers 132b mounted on the free end of arm 130b. This arm 130b, instead of being attached to the support for the ore bucket 82b in fixed relation thereto, is pivotally mounted on a pivot pin 176 so that it can slide in and out axially through a guide member 178 in the bracket 124b to move support 82b between its extended and retracted positions shown in FIGURE 13 by full and dotted lines. Note that bracket 82b while it has substantially the same design as bracket 82a of the FIGURES 9-11 modification, does not support the rear pair of trunnions on the ore bucket, but instead, holds up the bucket by means of brackets 180 that extend outwardly from the sides thereof. Of course, as these trunnions ride up on the dumping scroll and lift the tail end of the ore bucket, the brackets 82b are unloaded, as before, for

hinged movement into retracted position. Brackets 124b and supports 82b are likewise operatively interconnected by the stops 126 which cooperate with one another to maintain said brackets in extended position when loaded.

In this instance, the medial section 134b of the cam track is angularly offset laterally rather than up or down to accomplish movement of the support 82b between its extended and retracted positions as the cam follower 132b rolls within the cam track and operates arm 130b. Once again, the dumping mechanism can be rendered inoperative so that the ore bucket can move onto a more elevated unloading station by the simple expedient of folding down the dumping scroll 120 and swinging the cam track 128b out of the way.

Having thus described the several useful and novel features of the instant open pit mine haulage system along with the methods and apparatus used therewith, it will be apparent that the many worthwhile objectives for which they were designed have been achieved. Although but a few embodiments of the present invention have been illustrated and described in connection with the accompanying drawings, I realize that many changes and modifications therein are possible for those skilled in the art within the broad teaching hereof; hence, it is my intention that the scope of protection afforded hereby shall be limited only insofar as said limitations are expressly set forth in the appended claims.

What is claimed is:

1. In an ore haulage system of the type used in open pit mines and the like which includes, an inclined trackway laid on the sloping walls of the pit, a loading station on the inclined trackway near the working face of the mine, an unloading station including an ore bin located on the trackway above the loading station, a wheeled carriage mounted on the trackway for movement between the loading and unloading stations and hoist means located at the unloading station and operatively connected to the carriage for moving same up and down the trackway, the improved ore transfer assembly which comprises truck-type vehicles having a wheeled chassis movable between the working face and loading station, a detachable open topped ore receptacle providing a combination truck body for use on the truck chassis and an ore bucket for use on the truck-mounted carriage, and a travelling crane positioned at the loading station and adapted to transfer the ore receptacle between the chassis and carriage for movement thereon to the unloading station where the ore is dumped into the ore bin in which the ore receptacles are provided with front and rear pairs of trunnions projecting from the sides thereof and adapted to support the same on the truck chassis, and the wheeled carriage includes a supporting frame having front and rear trunnion supporting means depending therefrom positioned to receive the trunnions on the ore receptacles and adapted to maintain the latter in substantially level relation while traversing the inclined trackway where the front pair of trunnion supports on the carriage are adapted to receive the rear pair of trunnions on the ore receptacle for pivotal movement therein and the rear pair of trunnion supports on the carriage are movable from an extended position in supporting relation to the front pair of trunnions on the ore receptacle to a retracted position disengaged therefrom that permits the rear end of said receptacle to be lowered thereby emptying its contents and means for retracting said rear trunnion supports and lowering the rear end of said receptacle.

2. An ore haulage system of the type used in open pit mines and the like which comprises, an inclined trackway laid on the sloping walls of the pit, a loading station on the inclined trackway near the working face of the mine, an unloading station including an ore bin located on the trackway above the loading station, a wheeled carriage having front and rear pairs of trunnion supports mounted on the trackway for movement between

the loading and unloading stations, hoist means operatively connected to the carriage for moving same up and down the trackway, truck-type vehicles movable between the working face and loading station, each vehicle having a wheeled chassis provided with front and rear pairs of trunnion supports, an open-topped ore receptacle having front and rear pairs of trunnions detachably mountable on the trunnion supports of both the truck chassis and wheeled carriage, and means comprising a travelling crane located at the loading station and adapted to transfer the ore receptacles between said chassis and carriage wherein the front pair of trunnion supports on the carriage is adapted to receive the rear pair of trunnions on the ore receptacle for pivotal movement therein and the rear pair of trunnion supports on the carriage are movable from an extended position in supporting relation to the front pair of trunnions on the ore receptacle to a retracted position disengaged therefrom, means acting on the rear trunnion supports to move same to a retracted position and means adapted to support and lower the front pair of trunnions when the rear trunnion supports are retracted permitting the rear end of said receptacle to be lowered thereby emptying its contents.

3. An ore haulage system of the type used in open pit mines and the like which comprises, an inclined trackway laid on the sloping walls of the pit, a loading station on the inclined trackway near the working face of the mine, an unloading station including an ore bin located on the trackway above the loading station, a wheeled carriage having front and rear pairs of trunnion supports mounted on the trackway for movement between the loading and unloading stations, hoist means operatively connected to the carriage for moving same up and down the trackway, truck-type vehicles movable between the working face and loading station, each vehicle having a wheeled chassis provided with front and rear pairs of trunnion supports, an open-topped ore receptacle having front and rear pairs of trunnions detachably mountable on the trunnion supports of both the truck chassis and wheeled carriage, and means comprising a travelling crane located at the loading station and adapted to transfer the ore receptacles between said chassis and carriage wherein the front pair of trunnion supports on the carriage is adapted to receive the rear pair of trunnions on the ore receptacle for pivotal movement therein and the rear pair of trunnion supports on the carriage are movable from an extended position in supporting relation to the front pair of trunnions on the ore receptacle to a retracted position disengaged therefrom permitting the rear end of said receptacle to be lowered thereby emptying its contents and wherein the unloading station includes an automatic dumping assembly operative to lower the rear end of the loaded ore receptacle and empty the contents thereof into the ore bin, said dumping assembly including a dumping scroll having an upwardly inclined section on the downhill end thereof positioned in alignment with the rear pair of trunnions and adapted to raise same thus elevating the rear end of said receptacle so that the rear pair of trunnion supports on the carriage are unloaded, a cam follower depending from each of said rear pair of trunnion supports operative upon actuation to move the latter between extended and retracted positions, a cam track positioned in alignment with one of the cam followers and adapted to actuate same following unloading of said rear pair of trunnion supports operatively associated therewith, and a downwardly curving arcuate section on the uphill end of the dumping scroll positioned and adapted to receive the rear pair of trunnions and lower the rear end of the ore receptacle following movement of said rear pair of trunnion supports from extended to retracted position.

4. An ore haulage system of the type used in open pit mines and the like which comprises, an inclined trackway laid on the sloping walls of the pit, a loading station on

the inclined trackway near the working face of the mine, an unloading station including an ore bin located on the trackway above the loading station, a wheeled carriage having front and rear pairs of trunnion supports mounted on the trackway for movement between the loading and unloading stations, hoist means operatively connected to the carriage for moving same up and down the trackway, truck-type vehicles movable between the working face and loading station, each vehicle having a wheeled chassis provided with front and rear pairs of trunnion supports, an open-topped ore receptacle having front and rear pairs of trunnions detachably mountable on the trunnion supports of both the truck chassis and wheeled carriage, and means comprising a travelling crane located at the loading station and adapted to transfer the ore receptacles between said chassis and carriage wherein the carriage includes a frame carrying both pairs of trunnion supports and mounted to receive and maintain the ore receptacle in substantially level position while traversing the inclined trackway, the uphill end of the frame being hingedly connected to the corresponding end of the wheeled carriage and jack means interconnecting the downhill ends thereof, said jack means being operative upon actuation to vary the angular relation between said carriage and frame.

5. The ore haulage system as set forth in claim 1 in which, a transverse trackway intersects the inclined trackway at the loading station, and the traveling crane is of the Gantry-type mounted for movement along said transverse trackway.

6. The ore haulage system as set forth in claim 5 in which, the transverse trackway extends on opposite sides of the loading station, and one Gantry-type traveling crane is mounted on the transverse trackway of each side of the unloading station.

7. The ore haulage system as set forth in claim 5 in which, two inclined trackways are provided in side-by-side substantially parallel relation each of which has a separate loading station, unloading station, hoist means and wheeled carriage, the transverse trackway intersects both loading stations and extends laterally therefrom, and a separate traveling crane is mounted on the transverse trackway in position to pick up and deliver ore receptacles to and from each of the loading stations.

8. The ore haulage system as set forth in claim 6 in which each of the cranes is provided with a sling having upwardly opening hooks located and adapted to receive both the front and rear pairs of trunnions for lifting and transporting the ore receptacle between the chassis and carriage.

9. The ore haulage system as set forth in claim 2 in which the carriage includes a frame carrying both pairs of trunnion supports and mounted to receive and maintain the ore receptacle in substantially level position while traversing the inclined trackway.

10. The ore haulage system as set forth in claim 3 in which, the rear pair of trunnion supports is hingedly mounted on the carriage for rockable movement about a substantially longitudinal axis, the cam follower includes a rocker arm having one end fixedly attached to said rear trunnion support associated therewith and a roller on the other end, and the cam track includes a channel-shaped section positioned to receive the roller and angularly disposed relative to the direction of movement of the carriage such that the rocker arm is tilted as said roller traverses said channel-shaped section.

11. The ore haulage system as set forth in claim 3 in which stop means interconnect the rear trunnion supports with the carriage, said stop means being operative to maintain said rear trunnion supports in extended position when loaded.

12. The ore haulage system as set forth in claim 3 in which the cam track and dumping scroll are each operatively associated with the trackway for movement between an operative position wherein the ore receptacle will be emptied during its passage toward the unloading station and an inoperative position that allows said ore receptacle to bypass said unloading station without being dumped.

13. The ore haulage system as set forth in claim 3 in which, the rear pair of trunnion supports is hingedly mounted on the carriage for rockable movement about a substantially longitudinal axis, the cam follower comprises an arm mounted for reciprocal movement with one end thereof pivotally attached to said rear trunnion support operatively associated therewith and the other end provided with a roller journaled for rotation about an axis substantially normal to the axis of reciprocal movement, and the cam track included a channel-shaped section positioned to receive the roller and angularly disposed relative to the direction of movement of the carriage such that said arm is moved in the direction of its length as said roller traverses said channel-shaped section.

14. The ore haulage system as set forth in claim 4 in which the jack means comprises a scissor-type linkage having a pair of pivotally interconnected links with the opposite ends thereof pivotally attached to the frame and carriage, and a screw operatively connected to the common pivotal connection between the links and to a retaining element fixed in relation to the latter whereby rotation of said screw within said retaining means operates to vary the angular relation between said links.

15. The ore haulage system as set forth in claim 11 in which, the rocker arm projects inwardly from the rear trunnion support associated therewith, and the channel-shaped section of the cam track is upwardly inclined at a steeper angle than the angle of inclination of the trackway.

16. The ore haulage system as set forth in claim 11 in which, the rocker arm projects outwardly from the rear trunnion support associated therewith, and the channel-shaped section of the cam track is downwardly inclined in a direction opposite to the angle of inclination of the trackway.

17. The ore haulage system as set forth in claim 13 in which the cam track lies in a plane substantially parallel to the slope of the pitwall along the trackway.

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