

Feb. 9, 1943.

J. HARRINGTON

2,310,233

CONVEYER EXCAVATOR

Filed March 7, 1940

6 Sheets-Sheet 1

FIG. 1.

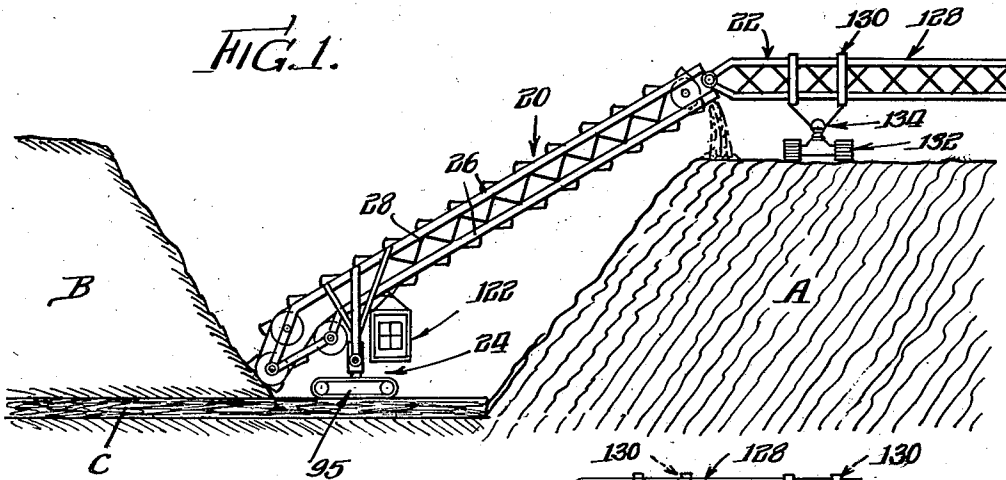


FIG. 2.

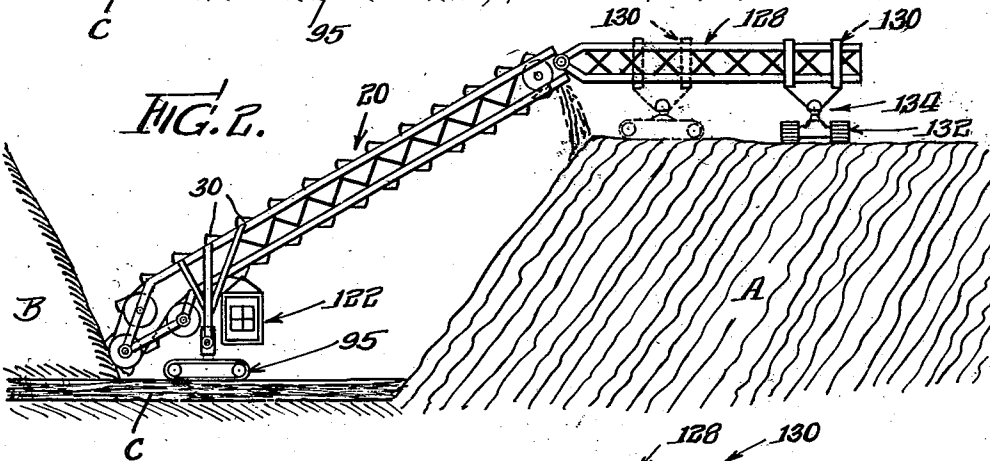
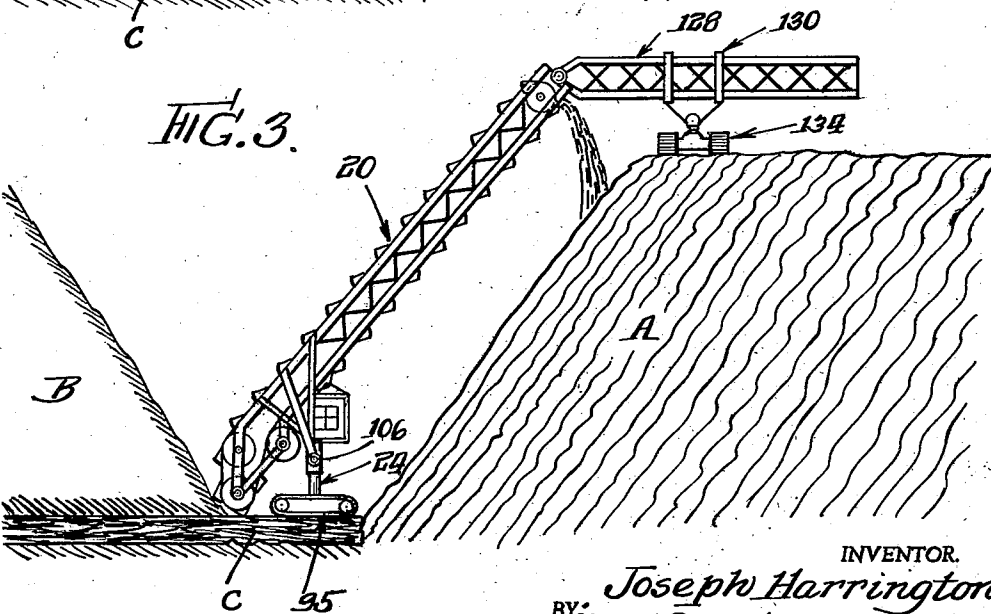


FIG. 3.



INVENTOR.

Joseph Harrington

BY:

Cox & Moore

ATTORNEYS.

Feb. 9, 1943.

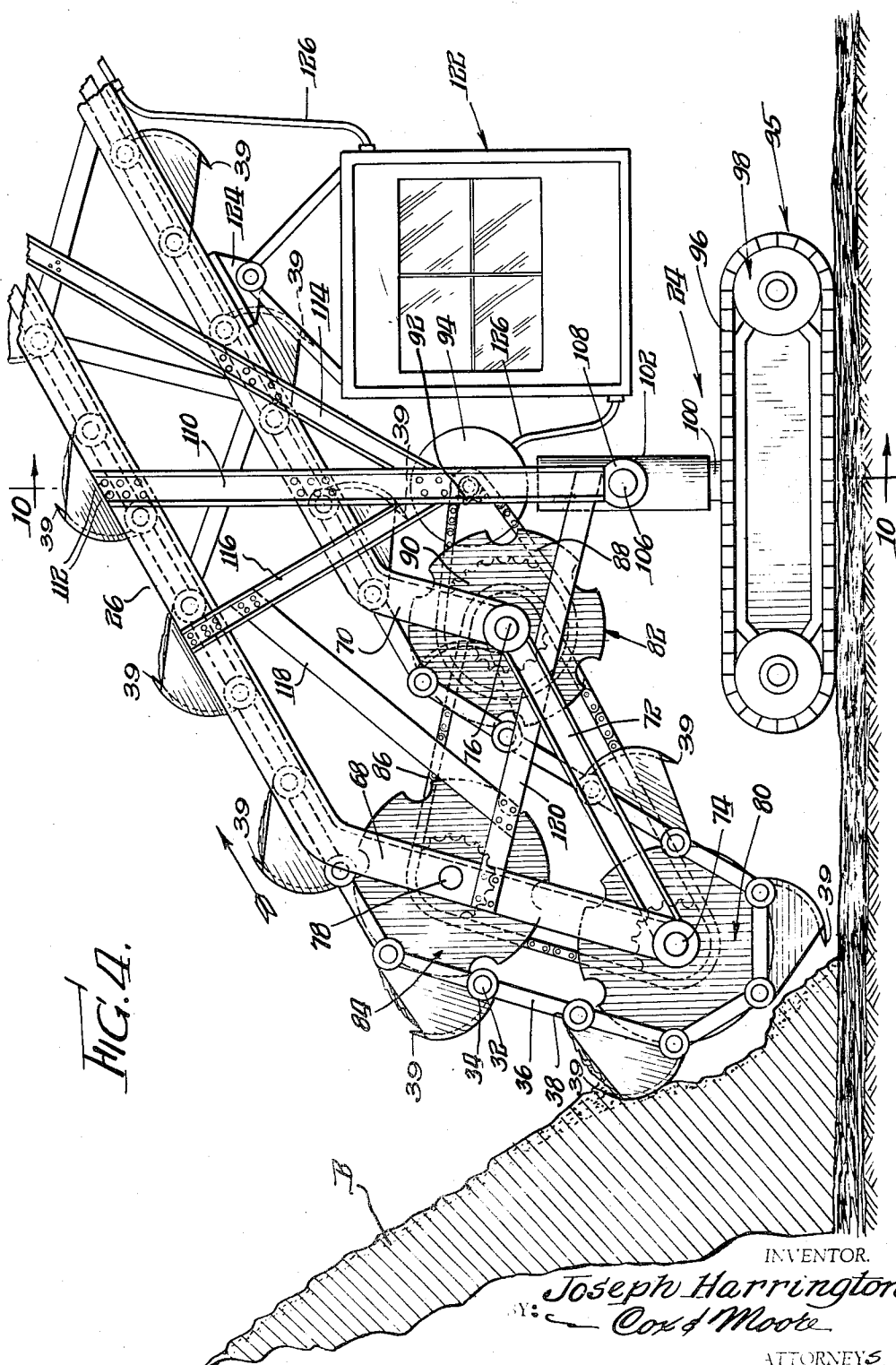
J. HARRINGTON

2,310,233

CONVEYER EXCAVATOR

Filed March 7, 1940

6 Sheets-Sheet 2



Feb. 9, 1943.

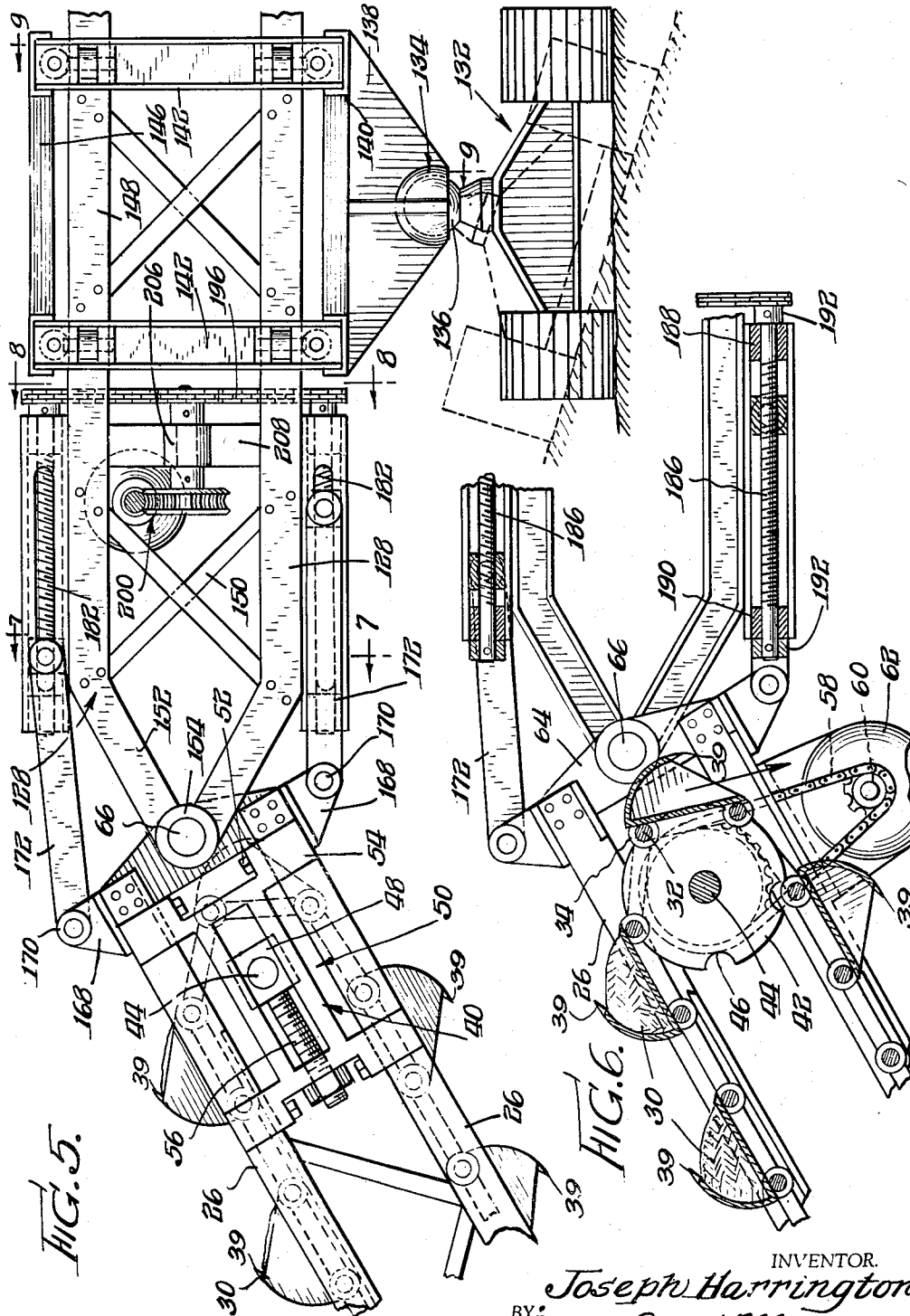
J. HARRINGTON

2,310,233

CONVEYER-EXCAVATOR

Filed March 7, 1940

6 Sheets-Sheet 3



INVENTOR.  
*Joseph Harrington*  
BY: *Cox & Moore*  
ATTORNEYS.

Feb. 9, 1943.

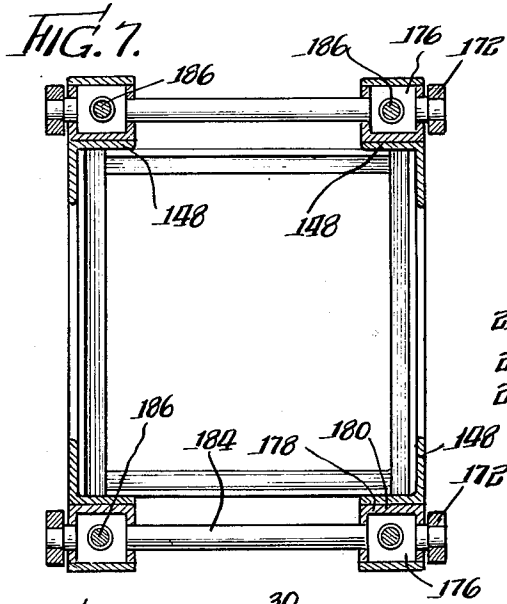
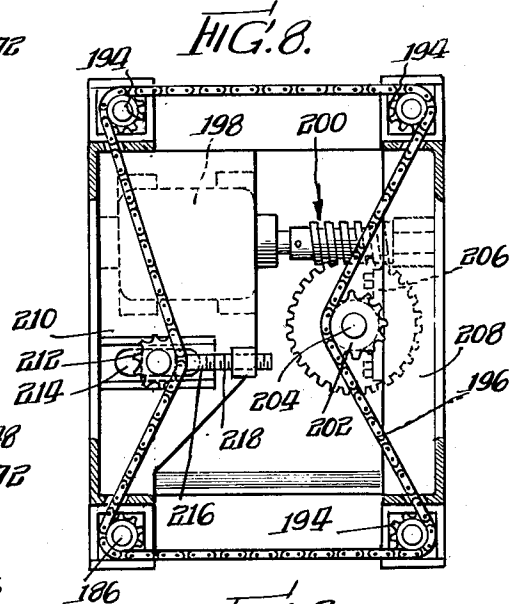
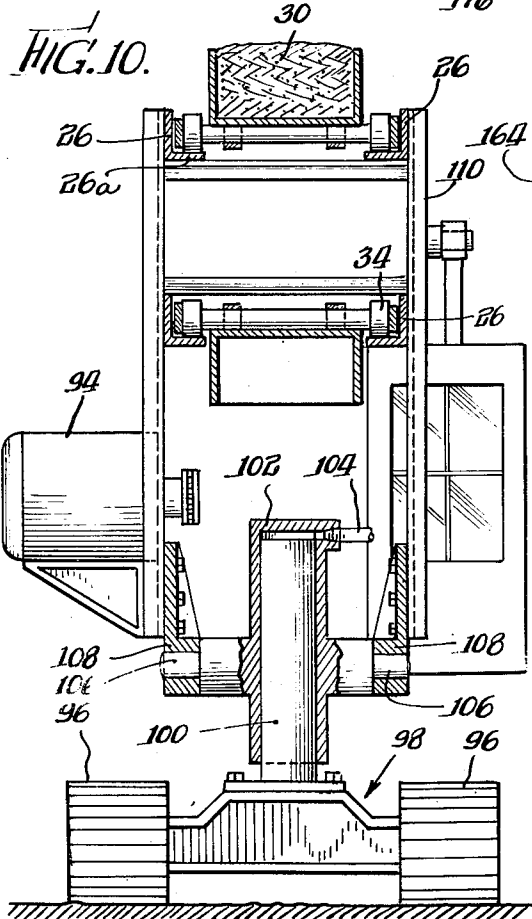
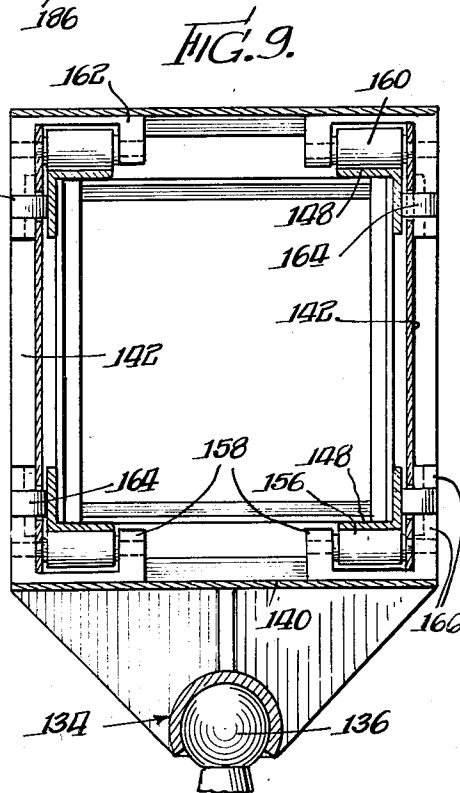
J. HARRINGTON

2,310,233

CONVEYER EXCAVATOR

Filed March 7, 1940

6 Sheets-Sheet 4



INVENTOR.  
*Joseph Harrington*  
BY: *Cox & Moore*  
ATTORNEYS.

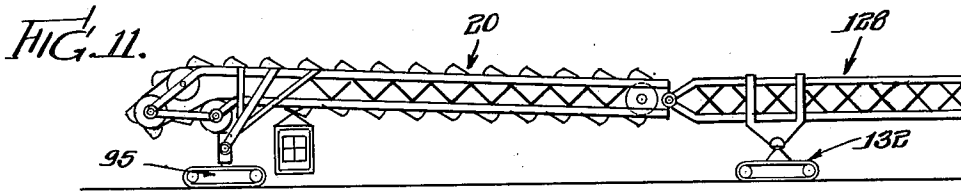
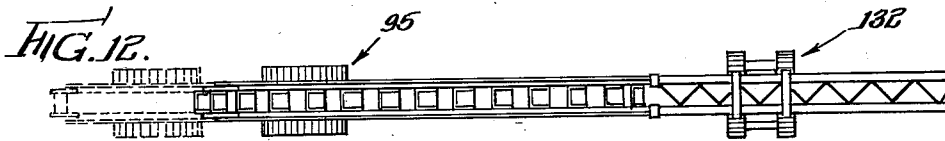
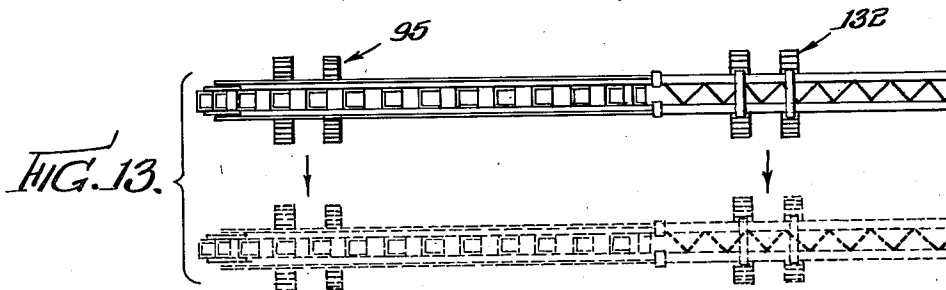
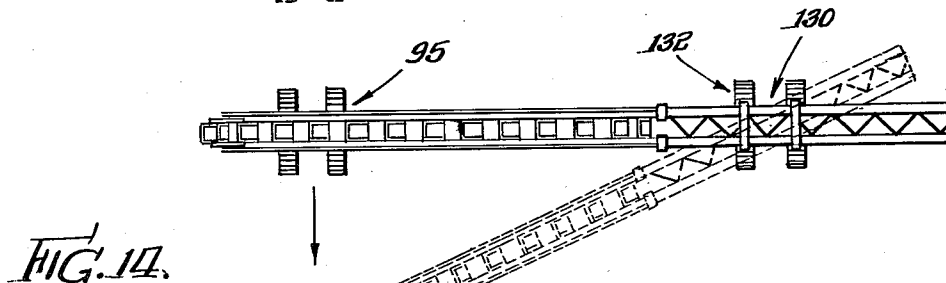
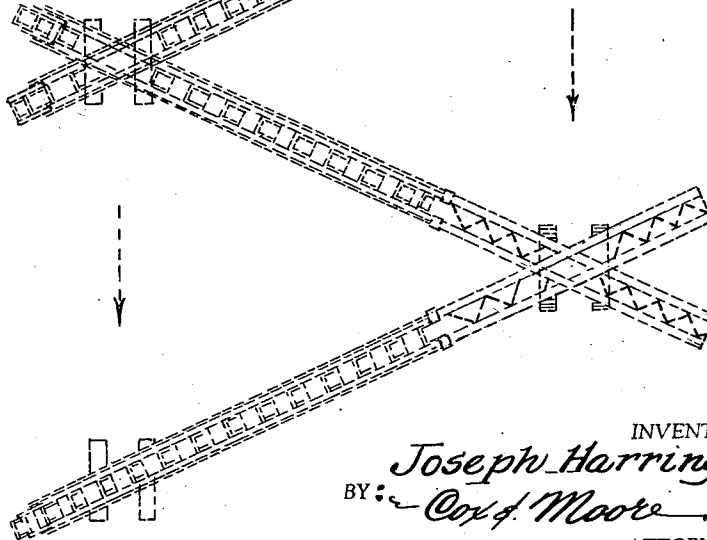
Feb. 9, 1943.

J. HARRINGTON  
CONVEYER EXCAVATOR

2,310,233

Filed March 7, 1940

- 6 Sheets-Sheet 5



INVENTOR.  
*Joseph Harrington*  
BY: *Cor & Moore*  
ATTORNEYS.

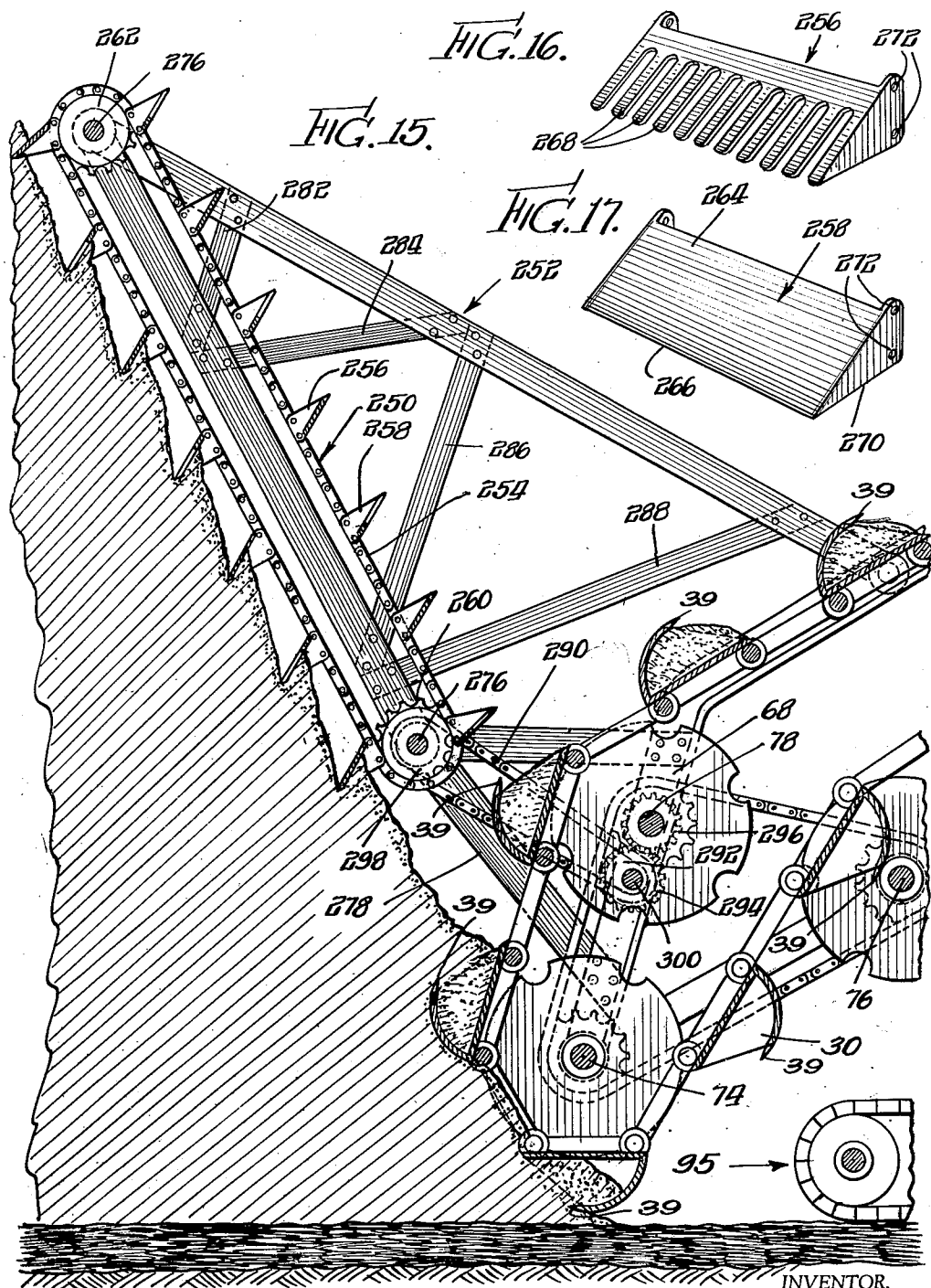
Feb. 9, 1943.

J. HARRINGTON  
CONVEYER EXCAVATOR

2,310,233

Filed March 7, 1940

6 Sheets-Sheet 6



INVENTOR.  
*Joseph Harrington*  
BY: *Cox & Moore*  
ATTORNEYS.

## UNITED STATES PATENT OFFICE

2,310,233

## CONVEYOR-EXCAVATOR

Joseph Harrington, Riverside, Ill.

Application March 7, 1940, Serial No. 322,823

21 Claims. (Cl. 37—191)

The present invention relates to a conveyor and excavator and more particularly concerns an excavator for continuously handling large quantities of materials such as are moved or re-positioned in uncovering veins and deposits in open strip mining.

Where great quantities of material must be moved to uncover underlying deposits of coal, for example, it has in the past been necessary to employ excavators of enormous size involving a substantial investment and the limitations with respect to the depth and extent of cover which may be removed have necessarily been closely related to the permissible investment and the practical limits of size of the excavator. At points where the coal seam, for example, dips into the ground beyond the limits of utility of the excavator, the existing equipment is unable to handle the over-burden and the property must be abandoned.

The present invention, therefore, contemplates the provision of an improved conveyor and excavator adapted to uncover large quantities of material at an improved rate and capable of operating at substantially increased depth with a minimum investment.

It is an important object of the present invention, therefore, to provide a conveyor adapted to self-load and convey sand, gravel and like material to a discharge point elevated substantially above the point of removal as well as substantially laterally displaced and capable of operating equally as well upon relatively shallow excavations.

Yet more particularly the present invention contemplates the provision of a machine, as above, comprising excavating means movable into a loading engagement with the lower part of an excavation and operable in an inclined plane to an elevated point of discharge.

It is an important object of the present invention to provide an excavator and conveyor of the foregoing character substantially universally adjustable to all positions necessary to rapidly and economically excavate and discharge the product while supported for handling and conveying a great mass of material.

The present invention contemplates, therefore, the positive support of the excavator and conveyor adjacent both extremities for movement laterally and vertically into the material to be excavated and angularly shiftable to meet demands arising from the varying depth of the excavation, elevation of the spoil bank, and the like.

Another object of the present invention is to provide an excavator, as above, operable from within the excavation and supported at points adjacent the upper and lower extremities for complete stability, and contemplates a machine such as the foregoing which is laterally shiftable either as a unit or angularly about either point of support.

Yet another object of the present invention is to provide a machine of the foregoing type which may be conveyed and transported under its own power across country to relatively remote points and capable when moved upon highways of occupying a minimum space.

Yet other objects and advantages of the invention will be apparent from the following description, when taken in connection with the accompanying drawings, wherein

Fig. 1 is a plan view of a machine embodying the principles of the present invention and shown in operative relationship within the excavation of a strip mine.

Fig. 2 is a view the same as Fig. 1 and illustrating the progress of the device subsequent to a period of excavation.

Fig. 3 is a view the same as Figs. 1 and 2 illustrating the relative position of the parts when operating in an excavation of substantially increased depth.

Fig. 4 is a detail elevational view of the lower extremity of the machine shown in the foregoing figures.

Fig. 5 is a detail elevational view of the upper portion of the machine.

Fig. 6 is a view taken substantially at the same point as Fig. 5, but vertically and centrally through the unit showing the internal arrangement of the parts.

Fig. 7 is a sectional detail view taken upon the plane 7—7 of Fig. 5.

Fig. 8 is a sectional detail view taken through the device on the plane 8—8 of Fig. 5.

Fig. 9 is a sectional view taken centrally through the device on the plane 9—9 of Fig. 5.

Fig. 10 is a sectional detail view taken vertically through the machine on the plane 10—10 of Fig. 4.

Fig. 11 is an elevational view of the present device and is shown in the position which it assumes when being carried forward over level ground.

Fig. 12 is a plan view similar to Fig. 11 illustrating an alternative position of one of the tractors.

Fig. 13 is a plan view illustrating the disposi-

tion of the parts when shifting the machine laterally.

Fig. 14 is a plan view exemplifying another method of laterally shifting the present device to a new position.

Fig. 15 is an elevational view of the digging extremity of a modified form of construction embodying the principles of the present invention.

Figs. 16 and 17 are perspective views showing the scoops employed in the construction shown in Fig. 15.

Referring now to the figures of the drawings wherein I have disclosed one preferred form of construction exemplifying the principles of the present invention, it will be seen that Figs. 1 to 3 disclose a device comprising an inclined bridging conveyor 20 associated at its upper end with a cantilever support 22 and at its lower end with a lower supporting unit 24. For purposes of illustrating the numerous advantages of the present device, the upper bridging support is shown disposed upon a spoil bank exemplified by the reference numeral A with the lower support 24 arranged within an adjacent excavation defined within the spoil bank A, and a mass of over-burden B. For further purposes of illustration, C represents a seam adapted to be uncovered by the operation of the present excavator.

The bridging conveyor 20 is shown more clearly in Figs. 1 to 6 and 10 and comprises, in general, four longitudinally extending angle members 26 rectangularly disposed as shown in Fig. 10 and suitably integrally connected on all four sides by extensive truss work comprising a multiplicity of inter-connecting members 28. It will be appreciated that the length and proportions of the rigid conveyor may be varied within substantial limits, depending upon the purpose and adaptation of the device, and accordingly for many purposes additional truss construction may be necessary in order to confer the required rigidity, as will be understood by skilled engineers.

Attention is particularly directed to the fact that the longitudinal frame members 26 are so arranged (see Fig. 10) that their lateral webs or walls 26a extend inwardly from the lower margin of the vertical side webs and thus provide supporting tracks for a series of conveyor buckets 30. Each bucket, as shown in Figs. 4 to 6 and 10, has four integral, laterally extending trunnions 32 each rotatably mounting rollers 34. Each adjacent pair of buckets is joined by laterally spaced links 36 pivoted at each extremity 38 to the extremity of the trunnions 32. Accordingly, therefore, the series of buckets and connecting links provides an endless conveyor operable within the tracks formed by the bridging construction. I prefer to provide the digging or cutting lips of each of the buckets 30 with a series of hardened projections 39 to facilitate reception of the material by the buckets.

At the upper extremity, as shown in Figs. 5 and 6, the endless linkage passes over and engages a drive pulley construction 40 comprising a pair of disks 42 rigid with shaft 44 and disposed to peripherally receive the rollers 34. To this end the periphery of each disk is provided with spaced recesses 46 complementary to the cylindrical surface of the roller and spaced in accordance with the separation of the trunnion centers. The shaft 44 rotates within journals 48 longitudinally slidable in castings 50, as shown in Fig. 5, the castings being suitably recessed to guide the journals in a limited path of longitudinal movement, as shown. The pair of cast-

ings 50 are permanently secured by bolts to brackets 54 on the outer sides of each of the longitudinal frame members 26 of the bridging conveyor and accordingly contribute to the rigid structural inter-assembly of the frame. In order to adjustably determine the position of the rotating shaft 44, I have provided adjusting members 56 threadably engaged within the lower portion of the castings 50 and having suitable engageable head portions rotatable to accommodate the slack in the endless linkage.

The present invention further contemplates the provision of suitable drive means operative to move the endless linkage continuously and comprising a drive chain 58 operatively connected with a sprocket (not shown in detail) on shaft 44 and driven from a sprocket 60 on a suitable drive mechanism 62. The drive mechanism preferably comprises a suitable reducing gear mechanism actuated by an electric motor.

The upper extremity of the bridging conveyor additionally comprises laterally opposed connecting members 64 receiving a laterally extending pivot pin or shaft 66 for supporting the upper extremity thereof, as will hereinafter appear more in detail.

At the lower extremity of the bridging conveyor the frame members 26 terminate in downwardly inclined parallel arms 68 and 70 permitting the lower portion of the endless digging linkage to extend into close proximity with the floor of the excavation, the extremities of the arms 68 and 70 being joined by rigid spacers 72. The points of inter-connection of the arms 68 and 70 with the frame members 72, as well as the point intermediate of the arm 68, are provided with journals for laterally disposed shafts 74, 76 and 78 mounting drive pulley constructions substantially identical with that located at the upper extremity of the bridging conveyor designated respectively by the reference numerals 80 and 84. Each of the three shafts 74, 76 and 78 mounts a sprocket engageable with a continuous drive chain 86 for synchronous rotation. This chain is driven from an idler sprocket 82 by means of a second drive chain 88 in turn driving idler sprocket 82 on shaft 76. Shaft 76 is rotatable with idler sprocket 82. Chain 88 is in turn driven from sprocket 92 connected with a driving mechanism 94. As in the case of the driving mechanism at the upper extremity of the bridging structure, the means 94 preferably comprises a reduction gear mechanism driven by a suitable drive motor and it is preferably contemplated that the two drive motors be of a character adapted to be operated in synchronism or at a constant rate, and operable co-incidentally to maintain the movement of the endless linkage.

Attention is particularly directed to the fact that the drive pulley 82 has its upper periphery in alignment with the lower one of the longitudinal frame members 26, whereas the pulley assembly 84 is in peripheral alignment with the upper frame member 26 and thereby is operable to receive and direct the bucket chain on the supporting track construction provided therefor. Between pulleys 80 and 82 the bucket linkage moves downwardly past the frame members 72 which are preferably free from inward projections to permit passage of the chain. It is particularly important to note that in passing about the lower pulley construction 80 the buckets are disposed and supported in a position where they are adapted to dig into the bank

B and pass upwardly to gouge out a charge of gravel and immediately assume an angular position for retaining the charge as the buckets move upwardly along the bridging conveyor.

The lower support 24 comprises a self-powered vehicle or tractor 95 comprising a pair of spaced, endless tracks 96 mounted on a suitable supporting means indicated generally by the reference numeral 98, and adapted to be driven by suitable motive drive means comprised within the tractor unit and not shown herein. Since such tractor constructions are known to those skilled in the art, it is thought sufficient to point out that the present invention contemplates the provision of a tractor unit having independent reversible drive means for each of the tractor belts 96, whereby the entire unit is universally shiftable in the plane of the ground upon which it is supported. Thus the device may be moved either forwardly or rearwardly and, by oppositely actuating the two tracks 96, may be moved rotationally to any angular position. In order to permit and facilitate the last-named movement, the remainder of the structure is mounted upon the tractor by means of a hydraulic cylinder and piston construction comprising a lower piston and plunger 100 extending vertically from the central portion of the tractor and received within a hydraulic cylinder 102 (Figs. 4 and 10). In addition to permitting pivotal movement of the tractor with respect to the structure thereabove, the foregoing means is adapted for controlled elevational disposition of the parts supported by the tractor and, to this end, it will be noted that the cylinder 102 is enclosed at its upper end to receive hydraulic fluid through a conduit 104.

The present invention contemplates, therefore, the supply of hydraulic fluid under predetermined pressure in predetermined quantities to dispose the cylinder 102 at any desired elevational position with respect to its plunger 100 and while the hydraulic control means has not been shown in detail, it will be understood by those skilled in the art that it may be disposed in any convenient position and placed under the control of an operator as will hereinafter more fully appear. A pair of trunnions 106 extending laterally from the cylinder 102 engage journals 108 at the lower extremity of a pair of vertical columns 110. It is to be particularly noted that the columns 110 comprise channel members rigidly angularly fixed to the opposite lateral sides of the bridging conveyor frame, as at 112 (see Figs. 4 and 10). Additional bars 114, 116, 118 and 120 rigid with the column 110 project outwardly into fixed engagement with the respective frame members 26, 68, 70 and 72, as clearly shown in Fig. 4, whereby the column and remainder of the frame are rigidly angularly disposed, as shown. It will thus be seen that the lower extremity of the conveying excavator is supported upon pivot means 106 shiftable vertically with respect to the tractor or pedestal and the tractor accordingly is supported and adapted to receive the vertically imposed load, irrespective of the relative angular arrangement of the inclined conveyor belt.

As shown in Fig. 4, a control cab 122 is suspended from journal brackets 124 for housing the control equipment for actuating the tractor and the aforementioned driving mechanisms, as well as other driving and control elements, to be hereinafter described in greater detail. Power and control conduits 126 extend between the cab 122 and the necessary terminal points.

Attention is now particularly directed to the construction supporting the upper extremity of the bridging conveyor, as shown in greater detail in Figs. 5 to 9. The upper support, indicated generally by the reference numeral 22, comprises a cantilever arm or truss construction 128 laterally shiftable in an embracing cage construction disposed upon a tractor construction 132. The tractor or vehicle 132 is substantially identical in construction with the lower tractor 95 and is similarly constructed for universal control in the plane of the supporting surface upon which it is arranged. To further facilitate adaptation to irregular terrain, the tractor unit is interconnected with the super-arranged cage by ball and socket means 134, the ball section 136 of which is rigidly mounted upon the tractor and engageable within a lower base casting 138 of the cage. It will be seen that the cage comprises a pair of laterally extending channels 140 to the lateral extremities of which are affixed vertical projecting channels 142. Upper transverse channels facing downwardly are welded to the upper extremities of the vertical channels 142 and, together with spacing truss members 146 welded directly thereto, complete a rectangular frame or enclosure for receiving the shiftable cantilever arm 128.

The beam 128 comprises four rectangularly disposed angle members 148 extensively connected by rigid spacers 150 disposed in truss fashion to rigidify the arm against appreciable strain and distortion. At the left-hand-most extremity, as viewed in Figs. 5 and 6, it will be noted that the lateral angle members 148 converge inwardly as at 152 toward the pivot shaft 66 mounted on the upper extremity of the bridging conveyor unit, and are integrally joined at spaced journals 154. Accordingly, therefore, the bridging conveyor and cantilever supporting beam 128 are pivotally connected at their extremities.

In passing through the embracing cage or yoke the cantilever beam 148 is supported for longitudinal movement by a series of rollers shown more clearly in Figs. 5 and 9. The lower series of rollers 156 is pivotally disposed for receiving the lower angle members 148 and mounted for rotation between journal brackets 158 and the adjacent vertically extending channels 142. The journal brackets 148 are welded rigidly within the lower channels 140. Upper rollers 160 contact with the upper webs of the upper angle members 148 and are similarly journaled for rotation between the lateral, upwardly extending channels 142 and journal brackets 162. I have further provided lateral rollers 164 in the upstanding channels 142 and journaled within blocks 166 welded into the outwardly facing recess of the channels.

It should be particularly noted that the central web of the channels is relieved adjacent the rollers 164 so that the inner periphery of each roller projects inwardly into abutment with the vertical side web of each adjacent angle member 148. Accordingly, therefore, the cantilever beam unit is engaged solely by freely rotatable rollers disposed to support the beam for free longitudinal movement in either direction while positively constraining it within the rectangular cage against movement laterally or angularly. As a result of the foregoing, it will be seen that the bridging conveyor is shiftable horizontally with respect to the upper supporting unit 132. The movement of the lower supporting unit 24 may be universally effected without shifting the upper

tractor 132. That is to say, horizontal fore and aft movement of the lower tractor 95 merely results in shifting of the upper supporting beam 128 longitudinally within its supporting housing. Relative vertical movement of the lower extremity of the bridging conveyor as by actuation of the lower elevational control or by disposition of the lower tractor 95 at a relatively varying level merely results in a corresponding angular re-arrangement of the inclined bridging conveyor and a compensatory longitudinal shifting of the upper supporting beam 128. Likewise lateral shifting of the lower tractor 95 is compensated for by re-arrangement of the upper ball and socket connection 134.

Attention is particularly directed to the fact that I have in the present embodiment provided a structure capable of pre-determining and fixing the relative angular disposition of the inclined bridging conveyor unit and the upper supporting beam. The means in question comprises a pair of brackets 168 permanently mounted on the upper and lower surfaces at the upper extremity of the rigid conveyor and providing journals 170 pivotally receiving the extremities of links 172. The opposite extremity of each link pivotally engages a trunnion projecting laterally from a shiftable block 176. As clearly shown in Fig. 7, there are four links disposed laterally adjacent each corner of the rectangular supporting beam 128 and the corresponding blocks 176 are mounted within guideways provided upon the supporting beam. More particularly, each guideway comprises an outwardly facing channel member 178 having its central web welded flatwise as at 180 against the adjacent web of one of the angle frame members 148 and longitudinally slotted on the side webs as at 182 to receive outwardly projecting trunnions 174 and a laterally extending bar 184 which projects between opposed, laterally spaced blocks 176 to maintain them in lateral alignment.

Each block is bored and internally threaded to receive a helically threaded bar 186 disposed longitudinally and centrally of each of the channel guides for advancing the blocks 176 therein. It should be noted (see Fig. 6) that each of the threaded bars is journaled within a pair of blocks 188 and 190 welded within channel recesses of either extremity thereof and the bar mounts collars 192 at either extremity to longitudinally fix it in the position shown. Each of the four bars 186 mounts on its right hand extremity, as viewed in the figure, a sprocket or pinion 194 engageable within continuous sprocket chain 196 for movement in the same rotational direction. As shown in Figs. 5 and 8, the sprocket chain is adapted to be driven by a drive motor 198 acting through a worm and pinion drive 200 to rotate a drive sprocket wheel 202 on shaft 204. As clearly shown in Figs. 5 and 8, the shaft 204 for the sprocket 202 and the worm wheel is rotatably journaled in a bracket 206 on a vertically extending spacing frame member 208 extending between vertically disposed, longitudinally extending angle members 148. As clearly seen in Fig. 8, an opposed, vertically extending frame member 210 mounts the motor 198 and also a slack take-up mechanism comprising a laterally shiftable sprocket 212 engaging the sprocket chain 196 (Fig. 8). This sprocket 212 is mounted for adjustable lateral reciprocation in a slot 214 under the control of a threaded adjustment member 216 threadedly received by a fixed projecting lug 218.

The upper and lower threaded bars 186 are provided with oppositely disposed threads. Thus, for example, if the upper bars 186 are provided with right hand threads, the threads in the lower bars are disposed in a relative left-hand direction. Accordingly, therefore, as the sprockets are rotated in the same direction and at the same speed under the influence of the drive motor 198, the upper and lower shiftable blocks 176 progress relatively oppositely at a predetermined rate of advance. Since the pivot 66 joining the upper extremity of the bridging conveyor to its supporting beam is disposed medially between the opposed journals 170, it will be apparent that during actuation of the motor 198 the links 172 act to change the angular relative position between the pivotally joined members. This means is available to assist and facilitate the angular shifting of the parts when such is deemed necessary by the operator at various times in the use of the device.

From the foregoing it will be evident that the present invention provides an excavating device capable of operating in an improved manner. Thus, applied to strip mining which is particularly adapted to illustrate the many features of the present device, the machine may be relatively located with respect to the excavation, as illustrated in Fig. 1 of the drawings. Thus it will be seen that the tractor 132 is disposed on the upper surface of the spoil pile A in a predetermined, fixed position with the shiftable beam 128 extending toward the edge thereof. The lower tractor 95 is disposed upon the floor of the excavation so that the inclined bridging conveyor is supported thereby and also at the pivot 66 on its upper extremity. It will be accordingly seen that the lower extremity of the bucket conveyor is disposed in close adjacency to the floor of the excavation and against the un-removed wall of over-burden B. Initiation of movement of the bucket conveyor in digging direction by energization of the drive mechanisms 94 and/or 62, it will be seen, causes the buckets to successively dig into the gravel B and convey their contents progressively upwardly to their upward limit of travel, whereupon they invert, as shown in Figs. 5 and 6, to dump their contents upon the upper rim of the spoil pile A. It will be appreciated from the foregoing that the drive mechanism of the lower tractor 95 may be continually energized to urge the tractor forwardly against the gravel bank as the removal thereof progresses.

As the lower tractor moves forwardly or rearwardly it carries with it the bridging conveyor unit and the slidable supporting beam 128 which moves extensively within the yoke or supporting cage 130. The device may be laterally shifted by merely reversely actuating the tracks 96 of the lower tractor to bring the tractor into any laterally facing position. As the lower end of the device is then progressed laterally, the upper end may be permitted to pivot about the universal connection 134 and the upper track 36 may maintain its original position or be moved laterally either co-incidentally with the lower tractor or subsequently thereto. The universal connection 134 has the additional advantage of permitting the lower tractor to follow irregularities in the terrain upon which it rests and likewise permits independent elevation or lowering of the lower extremity of the conveyor with respect to its tractor 95 by control of the hydraulic elevational cylinder and piston construction 100 and 102 hereinabove described. In other words, as the

lower or left-hand-most extremity of the device, as viewed in Figs. 1 to 3, varies its elevation, the entire assembly pivots about the pivot means 134 as a center.

From the foregoing it will be evident that the upper supporting beam 128 is preferably disposed in a horizontal plane or thereabouts and if, following vertical re-adjustment of the lower extremity of the conveyor, the beam assumes an unfavorable angle with respect to the terrain, proper adjustment is available by actuation of the drive motor 198 to relatively angularly shift the beams about the pivot 66. Thus as the angular relation of the bridging conveyor 20 with respect to its supporting beam 128 is positively changed, the foregoing units re-adjust themselves with relation to their respective supporting pivot points 106 and 134 and the beam 128 shifts longitudinally in its support yoke 130 to compensate for the angular variation.

Accordingly, therefore, in adaptation to the specific excavating problem exemplified, it will be seen that the device starts from the position illustrated in Fig. 1 to progressively remove the gravel bank B just above the seam C. As the conveyor is progressed forwardly into the bank B the supporting beam 128 shifts longitudinally outwardly in its supporting cage or yoke, the upper tractor 132 maintaining the position shown. When the removal of the bank B has progressed to the point illustrated in Fig. 2, the beam 128 will have relatively shifted in its support to the position shown in Fig. 2. The tractor 134 is now shifted to the dotted line position in Fig. 2 riding longitudinally of the supporting beam 128 to a position more closely adjacent the rim of the spoil bank and the progress of digging continues as usual.

I have illustrated in Fig. 3 the wide adaptability of the present invention to excavations of extreme depth as well as all intermediate depths substantially below the crest of the spoil bank. Attention is directed to the fact that when disposed in the position shown in Fig. 3, the lower hydraulic cylinder control must be located in a relatively elevated position above the tractor to compensate for the increased angular elevation of the bridging conveyor 20 which tends to bring the lower or digging extremity into closer proximity to the bottom of the excavation.

It will be apparent from the foregoing that if the obtuse angle between the part 20 and the part 128, as viewed in Fig. 3, is increased, the lower end of the conveyor is shifted upwardly, whereupon the operator merely lowers the elevational mechanism comprising the hydraulic cylinder to bring the buckets into the desired proximity with the top surface of the coal seam. This elevational control moreover compensates for normal irregularities in the floor of the excavation and is particularly useful in connection with the stripping of coal seams, enabling the excavator to follow closely the upper surface of the seam and remove the over-burden therefrom.

It will be appreciated from the above that all of the foregoing means are at the control of the operator in the cab 122 and are individually or coincidentally operable to effect full utilization of all the features of the present invention.

From the above disclosure it will be apparent that the present device may be shifted and rearranged at will and is capable of being transported to relatively remote points over level ground. Thus I have shown in Fig. 11 the disposition of the parts of the device for movement

over flat surfaces. It will be seen therein that the beam 128 and the digging conveyor 20 are disposed in general alignment whereby the forward extremity of the conveyor is elevated above the ground surface. In this position the tractor units 95 and 132 track each other and, when actuated forwardly, provide the motive power for transportation. It will be seen that the instant device occupies thereby only a relatively limited lateral space. The plan view of Fig. 12 represents the position of the parts with the excavator located within an excavation of the character exemplified in Fig. 1. When so disposed, it will be seen that the rearmost tractor 132 extends transversely to better resist shifting in the direction of forward movement of the digging conveyor. It will be understood that as digging progresses the shiftable portions of the machine progress toward the dotted line position in Fig. 12. In Fig. 13 the tractors 95 and 132 both extend laterally of the conveyor for shifting the entire machine in a lateral direction. Thus the dotted line position illustrated in Fig. 13 represents the displacement effected after a predetermined coincidental actuation of the two tractors in the direction represented by the arrows.

As stated above, the present invention provides a construction, either support of which is independently shiftable as an independent vehicular unit. Fig. 14 exemplifies the steps in the method of advance followed by alternately actuating one of the tractor units and then the other. Thus the upper dotted line position of the unit is effected when the vehicular support 95 is shifted through a predetermined distance in the direction of the arrow, it being noted that the extremity of the beam 128 has been caused to slide longitudinally through the embracing yoke. Subsequently the rearward tractor 132 may be moved in the same direction to bring the device to the second dotted line position indicated and lateral progress may be effected through any desired number of steps in this fashion.

It should be particularly noted that the present device is unimpeded by rough terrain and is operatively disposable upon surfaces which are irregular or shifting. The dotted line representation in Fig. 5 of the vehicular member 132 illustrates the self adaptability of the member to surfaces of varying inclination.

It will be apparent from the foregoing that the present invention provides an excavating device having the capacity of continually removing and shifting gravel or cover at a rate hitherto impractical with devices involving a comparable investment. While in the case of prior excavating devices with which I am familiar the depth of operation soon reaches an impractical limit, the present device provides for widely increased utility and is capable of excavating to a depth hitherto considered impractical. While the foregoing structure illustrates one preferred form of the machine, it will be readily understood by those skilled in the art that the proportions thereof may be varied within wide limits in accordance with the specific excavating problem. It is furthermore of importance to note that the present type of conveyor, in employing a multiplicity of relatively closely spaced scoops or buckets continually digging into the gravel pile, maintains an extremely large excavating capacity without the employment of excessively large or heavy equipment. It is furthermore of important practical significance that in operation the device deposits the spoil material evenly and regularly

so that the top surface of the spoil bank is relatively level and regular, leaving the property available for further utilization subsequent to the completion of the mining operation, for example. In accordance with many of the operations with which I am familiar, the excavator necessarily deposits its product in irregular heaps upon the spoil pile.

I have disclosed in Fig. 15 a modified adaptation of the present invention preferable for excavation of material which is compacted and poorly adapted to maintain a suitable angle of repose above the digging point. To prevent undercutting by the digging machinery and disastrous release of the overlying material, I have provided a feeding and scraping construction acting on the face of the bank and comprising an endless scraper construction 250 mounted on a frame 252 and driven from the lower drive means for the endless digging belt. The endless scraper comprises a series of links 254 pivotally connected to scrapers 256 and 258. Links 254 comprise preferably sprocket chains disposed adjacent the lateral side surfaces of the scrapers and fastened over spaced sprockets 260 and 262. The scrapers, as shown more clearly in Figs. 16 and 17, possess an inclined wall 264 terminating in a transversely disposed scraping edge 266 and it should be particularly noted that the unit 256 shown in Fig. 16 is so formed as to provide a rake-like series of digging or scraping fingers 268 adapted to loosen the gravel and render it suitable for positive removal by the scraper 258 shown in Fig. 17. The edges of the scrapers and the fingers 268 may preferably be formed of hard material such as manganese steel. Side walls 270 of the scraper units provide journals 272 for the linkage of the endless belt. It should be particularly noted that the digger units shown in Figs. 16 and 17 are alternately disposed along the endless chain 250 whereby they cooperate to alternately loosen the surface of the material and to positively carry it downwardly.

The frame 252 comprises a pair of laterally disposed channels providing journals at their opposite extremities for transverse shafts 276 upon which are mounted the sprockets 260 and 262. The lower ends of the channels 274 are rigidly secured to frame members 278 and connected to the section 68 of the main frame of the bridging conveyor. A pair of channels connect with the upper portion of the channels 274 and with the outer surfaces of the bridging conveyor frame at a remotely spaced point to dispose the endless scraping unit at a predetermined angle of inclination. Additional framing members 282, 284, 286 and 288 between the channels 274 complete the frame. The endless scraper belt is driven through a sprocket chain 290 engaging a drive sprocket 292 rotatable with a gear 294 engaging a gear 296 keyed on the shaft 78. The chain 290 in turn drives a sprocket 298 rotatable with shaft 276 and with the lower sprockets 260. It will be seen that the drive sprocket 292 and the gear 294 are rotatable on a shaft 300 laterally projecting from one side of the main bridging conveyor frame, as clearly shown in the figure.

From the foregoing it will be apparent that in operation the scraping conveyor is normally driven in the direction counterclockwise and, therefore, operates to drag the overlying material downwardly into the vicinity of the main buckets 30. It is to be noted moreover that the scraper unit is disposed at a favorable angle of repose to prevent avalanches of material.

It will further be apparent that any equivalent may be employed for locating the scraping unit in the angular position shown. Thus, for example, the present invention contemplates as one of the preferred modifications the pivotal disposition of the chain support channels 274 upon the supporting frame members 278 and the substitution of a suitable extensible cable for the rigid frame members 282, 284, 286 and 288. Thus, in such a construction, it will be seen that the endless scraper construction is pivotal about its lower extremity and the cable carried from the upper portion of the bridging conveyor or any other suitable point will permit the scraper unit to assume a fixed angular position and any suitable tackle may be employed to predetermine the length of the supporting cable in order to predetermine the proper angle of repose.

From the foregoing it will be appreciated that in many equivalent installations of the present invention it will be advisable to additionally brace and rigidify the parts against flexure and torsion and such modification is within the skill of a capable engineer conversant with the principles of the foregoing invention.

Changes may be made in the form, construction and arrangement of the parts without departing from the spirit of the invention or sacrificing any of its attendant advantages, the form herein described being a preferred embodiment for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. In an excavating device of the class described, digging means adapted to operate in a plane inclined to the horizontal for receiving excavated material at a lower level at its lower portion and conveying said material to a vertically spaced upper level, self propelled tractor means mounted for movement upon the material of the lower level for supporting the lower portion of said digging means at substantially said lower level, means for supporting the upper portion of said digging means, said lower support being horizontally shiftable on the material of said lower level for shifting said digging means, said upper support shiftable mounting said digging means for relative lateral shifting movement with respect to the upper support in response to the shifting of the lower support.

2. In an excavating device of the class described for removing overburden from a coal stratum and for delivering the overburden to a spoil bank, digging means adapted to operate in an inclined plane for receiving excavated material at its lower portion and conveying said material to a vertically spaced discharge position, means shiftable mounted on said coal stratum for supporting the lower portion of said digging means on the stratum of coal from which the overburden is being removed, means supporting the upper portion of said digging means on the top of said spoil bank, said lower support being horizontally shiftable on said coal stratum for shifting said digging means, said upper support shiftable mounting said digging means for relative lateral shifting movement with respect to the upper support in response to the shifting of the lower support, and pivot means between said upper support and the shiftable mounting means operative to permit the lower portion of the digging means to angularly shift about the upper support.

3. In an excavating device of the class described, elongated means adapted to operate in an inclined plane and having digging means operable

at the forward end and including mechanism for receiving material to be excavated from a lower level and for conveying said material longitudinally to the opposite end of said elongated means and for discharging said material at an upper level, means disposed at the forward end of said elongated means for supporting the digging means directly from and upon the material of the lower level, means for supporting the upper portion of said elongated means, said lower support being movably supported directly upon the material of the lower level and horizontally shiftable therealong for shifting said digging means, said upper support shiftable mounting the discharge end of said elongated means for relative lateral shifting movement with respect to the upper support in response to the shifting of the lower support, said upper and lower supports each comprising a single pivot and including means operable to permit the lower portion of the digging means vertically to shift about the upper pivot as a center.

4. In an excavating device of the class described, elongated conveying means adapted to operate in an inclined plane for receiving excavated material at its lower portion and conveying said material longitudinally thereof to a vertically spaced discharge position, a lower support for the forward end of said conveying means, an upper support for the upper end of said conveying means with respect to which the conveying means is laterally shiftable, said upper support permitting angular movement of the conveying means thereabout, and said lower support being movable directly upon and supported by the material to be excavated and being connected to said conveying means for moving the conveying means therewith.

5. In an excavating device of the class described, elongated digging and conveying means adapted to operate in an inclined plane for receiving excavated material at its lower portion and conveying said material to a vertically spaced discharge position, a lower support comprising a movable vehicle operatively connected to the end of said digging and conveying means for shifting the digging and conveying means upon the supporting surface of the ground below the surface being dug, an upper supporting means operatively connected to the upper end of said digging means and comprising a supporting beam, means mounting said supporting beam for movement in a longitudinal direction, and means pivotally supporting said mounting means.

6. In an excavating device of the class described, an elongated rigid frame adapted to operate in an inclined plane means operative at the lower forward end of said frame for receiving excavated material at its lower portion and conveying said material to the opposite end of said frame, a lower support comprising a movable vehicle operatively connected to the lower forward end of said frame for shifting the digging means upon the supporting surface of the ground, an upper supporting means operatively connected to the upper portion of said frame and comprising a supporting beam, means mounting said supporting beam for movement in a longitudinal direction, and means universally pivotally supporting said mounting means.

7. In an excavating device of the class described, elongated rigid means adapted to operate in an inclined plane and having an endless series of spaced digging and conveying means movable therealong for receiving excavated material at the

forward end of said rigid means and conveying said material to the upper end of said rigid means, a lower support comprising a movable vehicle operatively connected to the front end of said elongated means for shifting the digging means upon the supporting surface of the ground, an upper supporting means operatively connected to the upper portion of said digging means and comprising a supporting beam, means mounting said supporting beam for movement in a longitudinal direction, means universally pivotally supporting said mounting means, and pivot means operatively interconnecting said movable vehicle and digging means.

8. A digging and conveying means operable to load and convey material through a predetermined path to a vertically and laterally spaced point of discharge, a pair of self-powered vehicular members, one of said vehicular members operatively supporting each extremity of said digger and conveyor member and one of said vehicular members being supported at the elevation above which the overburden is being removed and the other of said vehicular members being supported at the elevation of substantially the top of the spoil bank, said digger and conveyor member being pivotally connected to one of said vehicular means for movement therewith and being extensibly connected to the other vehicular means for relative lateral movement in supported relationship.

9. A digging and conveying means operable to load and convey material through a predetermined path to a vertically and laterally spaced point of discharge, a pair of self-powered vehicular members, one of said vehicular members operatively supporting each extremity of said digger and conveyor member and one of said vehicular members being supported at the elevation above which the overburden is being removed and the other of said vehicular members being supported at the elevation of substantially the top of the spoil bank, said digger and conveyor member being fixedly connected to one of said vehicular means for movement therewith and being extensibly connected to the other vehicular means for relative lateral movement in supported relationship, said other vehicular means comprising pivot means pivotally supporting said digger and conveyor member for angular movement with respect to the ground.

10. A digging and conveying means operable to load and convey material through a predetermined path to a vertically and laterally spaced point of discharge, a pair of self-powered vehicular members, one of said vehicular members operatively supporting each extremity of said digger and conveyor member, said digger and conveyor member being fixedly connected to one of said vehicular means for movement therewith and being extensibly connected to the other vehicular means for relative lateral movement in supported relationship, said first-mentioned vehicular means comprising pivot means pivotally supporting said digger and conveyor member for angular movement with respect to the ground, and said first named vehicular means having pivotal interconnection with the digger and conveyor member operative to support the digger and conveyor member at a plurality of angular inclinations.

11. A digging and conveying means operable to load and convey material through a predetermined path to a vertically and laterally spaced point of discharge, a pair of self-powered ve-

hicular members, one of said vehicular members operatively supporting each extremity of said digger and conveyor member, said digger and conveyor member being fixedly connected to one of said vehicular means for movement therewith and being extensibly connected to the other vehicular means for relative horizontal movement while vertically supported thereby, said other vehicular means comprising universal pivot means pivotally supporting said digger and conveyor member for relative angular movement with respect thereto.

12. A digging and conveying means operable to load and convey material through a predetermined path to a vertically and laterally spaced point of discharge, a pair of self-powered vehicular members, one of said vehicular members operatively supporting each extremity of said digger and conveyor member, said digger and conveyor member being fixedly connected to one of said vehicular means for movement therewith and being extensibly connected to the other vehicular means for relative horizontal movement while vertically supported thereby, said extensible means comprising a member interconnected with said self-powered vehicular means for fixed support thereby and being longitudinally shiftable in a relative direction, means connecting said supporting member to said digger and conveyor member, and adjustable means for fixing the angular relationship between said supporting and conveyor members.

13. Conveying means operable to load and convey material from a lower level through a predetermined path to a vertically and laterally spaced upper level of discharge, a pair of self-powered vehicular members, each of said vehicular members operatively supporting an extremity of said conveyor means, one of said vehicular members being movable along and supported by the material of the lower level and the other vehicular member being movable along and supported by the material of the upper level, said vehicular members comprising means for pivotally supporting the conveying means with respect to each vehicular member, one of said vehicular means comprising a vertically adjustable conveyor support operable to elevate the extremity of the conveying means with respect to said other vehicle.

14. A digger and conveyor member operable in an inclined longitudinally extending path to load and convey material to a vertically and laterally remote point, said digger and conveyor member being supported adjacent its lower extremity by a self-powered vehicular means, pivot means interconnecting said member and said vehicular means, a supporting beam for the upper extremity for said digging and conveying member, adjustable means rigidly fixing the angular inclination of said member with respect to said supporting beam, an upper self-powered vehicular means, guide means on said vehicular means engaging said supporting beam for movement in a direction longitudinally of the guide means, and pivot means connecting said guide means to said upper vehicular means for relative movement about a substantially horizontal axis.

15. A digger and conveyor member operable in a longitudinally extending path to load and convey material to a vertically and laterally remote point, said digger and conveyor member being supported adjacent its forward extremity by a self-powered vehicular means, pivot means interconnecting said member and said vehicular means, a supporting beam engaging adjacent the rear extremity of said digging and conveying

member, adjustable means rigidly fixing the angular inclination of said member with respect to said supporting beam, a second self-powered vehicular means, a guideway on said second vehicular means engaging said supporting beam for movement in a direction longitudinally of the guideway, universal pivot means connecting said guideway to said second vehicular means, and adjustable, vertically extensible means between said first-mentioned vehicular means and said conveyor member and operable to vertically adjust the adjacent extremity of the member.

16. A digger and conveyor member operable in a longitudinally extending path to load and convey material to a vertically and laterally remote point, said digger and conveyor member being supported adjacent one extremity by a self-powered vehicular means, pivot means interconnecting said member and said vehicular means, a supporting beam engaging adjacent the other extremity of said digging and conveying member, adjustable means rigidly fixing the angular inclination of said member with respect to said supporting beam, a second self-powered vehicular means, a guideway on said vehicular means engaging said supporting beam for movement in a direction longitudinally of the guideway, universal pivot means connecting said guideway to said second vehicular means, and adjustable, vertically extensible means between said first-mentioned vehicular means and said conveyor member and operable to vertically adjust the adjacent extremity of the member, said first-mentioned vehicular means being pivotal with respect to said conveyor member about a vertical axis.

17. In a device of the class described, the combination of an elongated conveyor, a mobile support for said conveyor, means connecting said mobile support and said conveyor including pivot means between said mobile support and the forward end of the conveyor, adjustable means for raising and lowering said forward end of the conveyor with respect to said mobile support, a mobile mounting for the rear end of said conveyor, said mounting including a propellable truck, a cantilever arm longitudinally shiftable mounted on said truck and operatively supporting the rear portion of said conveyor, and means forming a pivot connection between said arm and the conveyor.

18. An apparatus for the removal of overburden to a remotely located spoil pile, comprising a first movable vehicle adapted to be disposed on top of the spoil pile, a cantilever beam, a bridging conveyor pivotally connected to one end of said cantilever beam, means pivotally mounting said beam on the first mobile vehicle, means for also shiftable mounting said beam relatively to its vehicular support whereby said beam may be shifted relatively to said support in a direction longitudinally of said beam, a second movable vehicle adapted to be disposed at the base of and confronting the overburden to be removed, and means pivotally supporting the forward end of said bridging conveyor from said second vehicle whereby said bridging conveyor is disposed in a downwardly inclined position relative to said cantilever beam when a portion of said overburden has been removed.

19. An apparatus of the character described comprising in combination a bridging conveyor, a first tractor, an elongated cantilever beam pivoted on said tractor, said beam being longitudinally movable relative to said tractor, the rear end of said bridging conveyor being pivoted to the for-

ward end of said beam, a second tractor, means for pivotally supporting the forward end of said bridging conveyor on said second tractor, and means for raising and lowering the forward end of said bridging conveyor relative to said second tractor. 5

20. An elongated bridging conveyor and an elongated cantilever beam pivoted together at adjacent ends thereof, mobile means for mounting the beam at the top of a spoil pile, a second 10 mobile means for mounting the forward end of the bridging conveyor at a substantially lower level than the level of the spoil pile, said two mobile means constituting the sole support for said conveyor and beam, and said conveyor in- 15 cluding digging and conveying means adapted to dig overburden disposed spaced from and oppo-

site the spoil pile and to convey the dug material upwardly and deposit it onto the spoil pile.

21. In a device of the class described in combination an elongated bridging member, digging and conveying means movable longitudinally thereof whereby to convey dug material substantially from one end to the other end thereof, an elongated support pivoted about a horizontal axis to the discharge end of said bridging member, a mobile mounting means for one end of said bridging member, and a mobile mounting means for said elongated support, and mounting means associated with said second mentioned means and said elongated support whereby said support may move longitudinally relative to its mounting means.

JOSEPH HARRINGTON.