United States Patent [19]

Deeter et al.

[11] **3,918,536**

[45] **Nov. 11, 1975**

[54] **AUGER SECTION HANDLING APPARATUS**

[75] Inventors: **Ronald C. Deeter**, Malvern; **John Pozniko**, Salem, both of Ohio

[73] Assignee: **The Salem Tool Company**, Salem, Ohio

[22] Filed: **Sept. 20, 1973**

[21] Appl. No.: **398,971**

[52] **U.S. Cl.** **175/85**; 173/164; 214/DIG. 2; 214/2.5; 299/56

[51] **Int. Cl.**[2] **E21B 19/14**

[58] **Field of Search** ..... 299/55, 56, 1; 173/164; 175/52, 85; 214/DIG. 2, 1 CM, 2.5

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Primary Examiner—Ernest R. Purser
Attorney, Agent, or Firm—Bosworth, Sessions & McCoy

[57] **ABSTRACT**

Auger apparatus, such as a coal mining machine, adapted to utilize one or more augers each formed of a string of auger sections of a diameter falling in a wide range. The disclosed apparatus comprises hoist apparatus for hoisting one auger section, or simultaneously a plurality of auger sections, to lift them from a storage rack at a side of the machine and place them in the auger strings or to remove them from the auger strings and place them in the storage rack. Such hoist apparatus comprising rails extending transversely of and above the direction of the augers in the machine, a bridge that travels on the rails, a trolley that travels on the bridge, and a lift member on the trolley that is adapted to be moved in an upright path relative to the trolley, the lift member having tongs at its bottom which may be adapted to grasp one auger section, or which may be adjusted as to number and spacing to grasp simultaneously a plurality of auger sections in predetermined spaced relation, so that the auger sections may be placed in the machine in the proper position with essentially no longitudinal or lateral movement relative to the trolley when it is properly positioned over the auger string or strings in the machine to locate accurately the sections in the machine so they can be automatically connected to the driving chucks of the machine and to other auger sections, and accurately to remove them from the machine and place them in a storage rack in positions where they may again be lifted and placed in the machine. The hoist apparatus makes it possible to use the auger machine to drill at substantial angles from the horizontal, because it can support the auger sections so they do not swing out of position when the machine is at an angle. The apparatus also includes a driving power train in which one or two auxiliary powertrain boxes are provided, two auxiliary boxes being used when two or more augers are to be driven, and one auxiliary box being used when only one auger is to be driven. The apparatus as a whole can be substantially shorter and closer to the ground than the apparatus of this type heretofore used, which required less excavating of the ledge adjacent the wall in which drilling is to occur, and makes possible easier transportation. The hoist apparatus provides increased safety for operators and makes possible the reduction in the number of operators needed to operate the machine.

26 Claims, 22 Drawing Figures

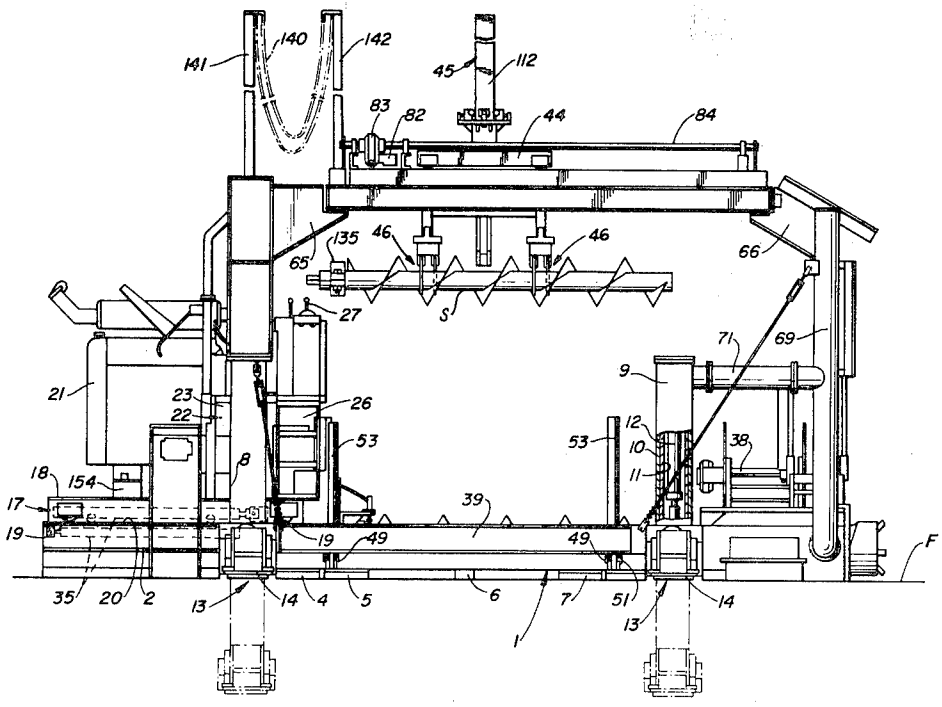
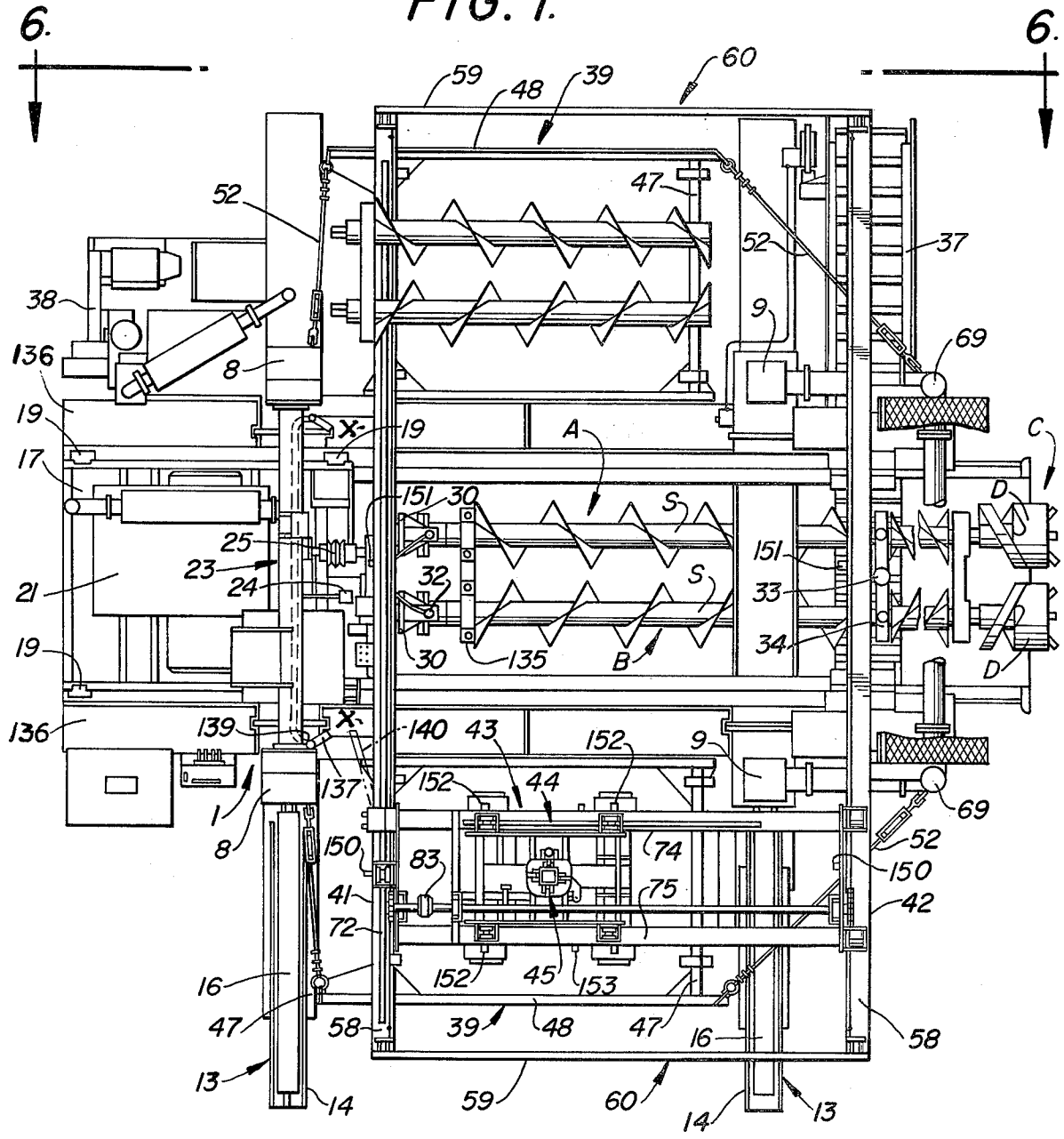


FIG. 1.


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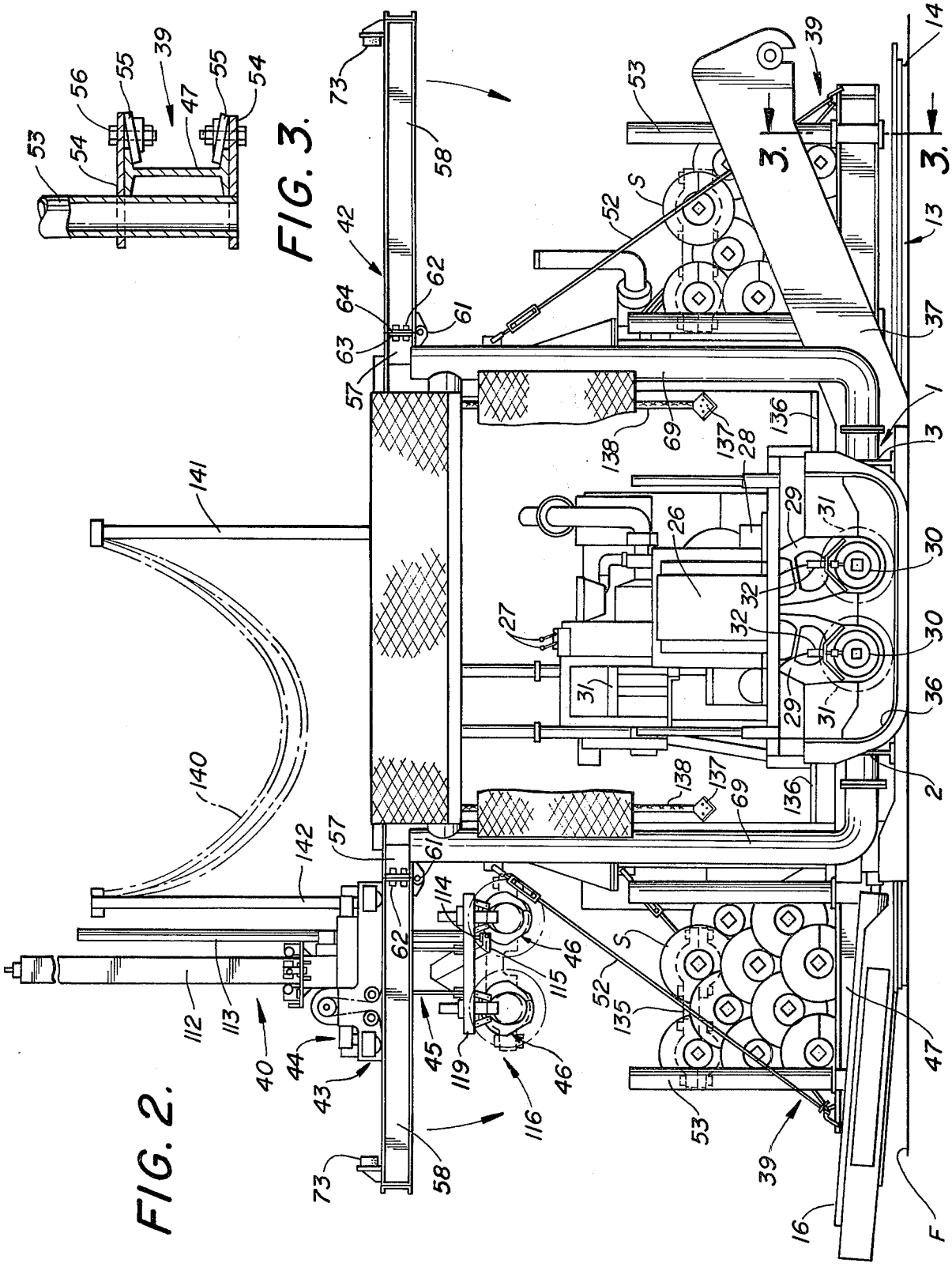
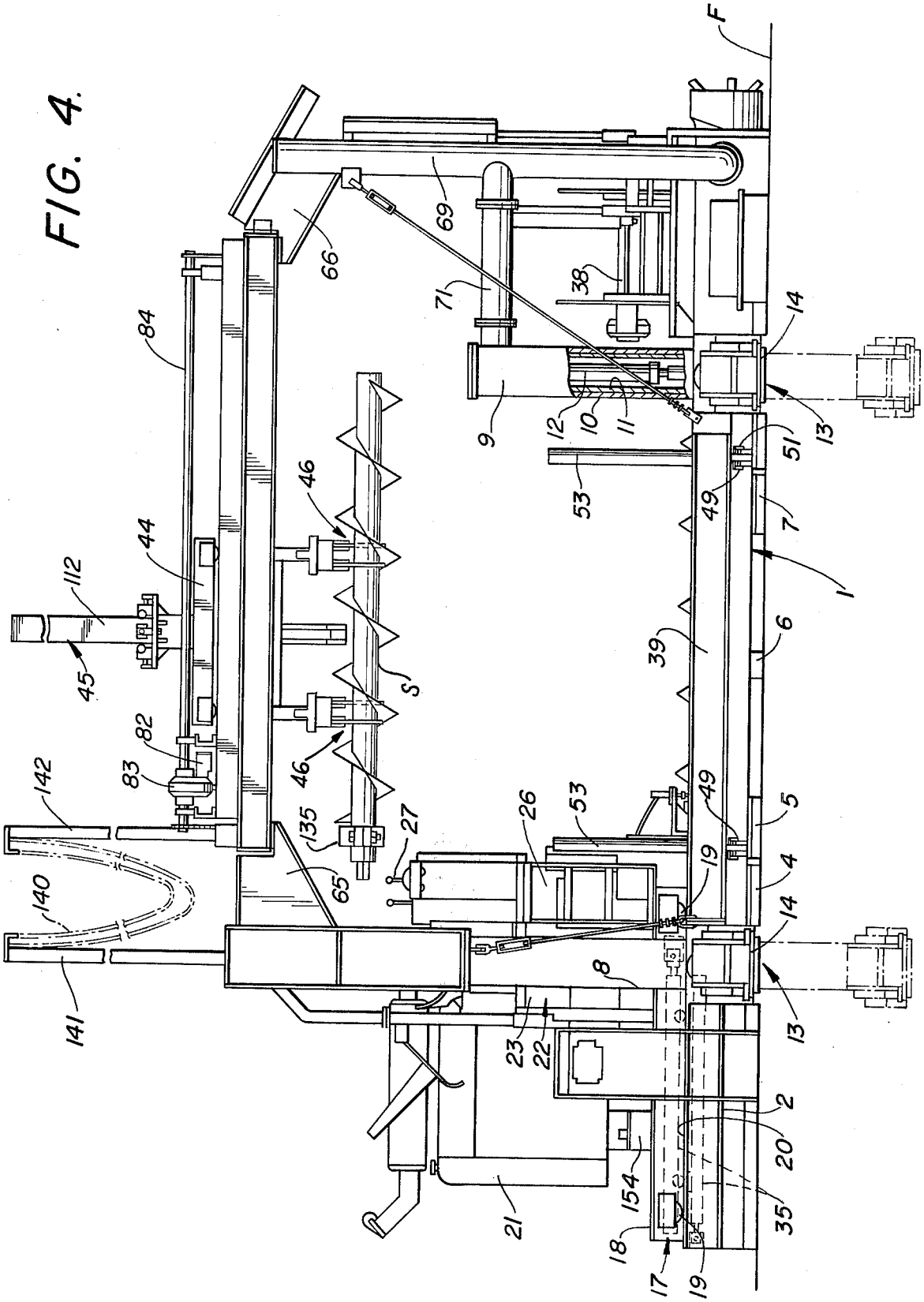

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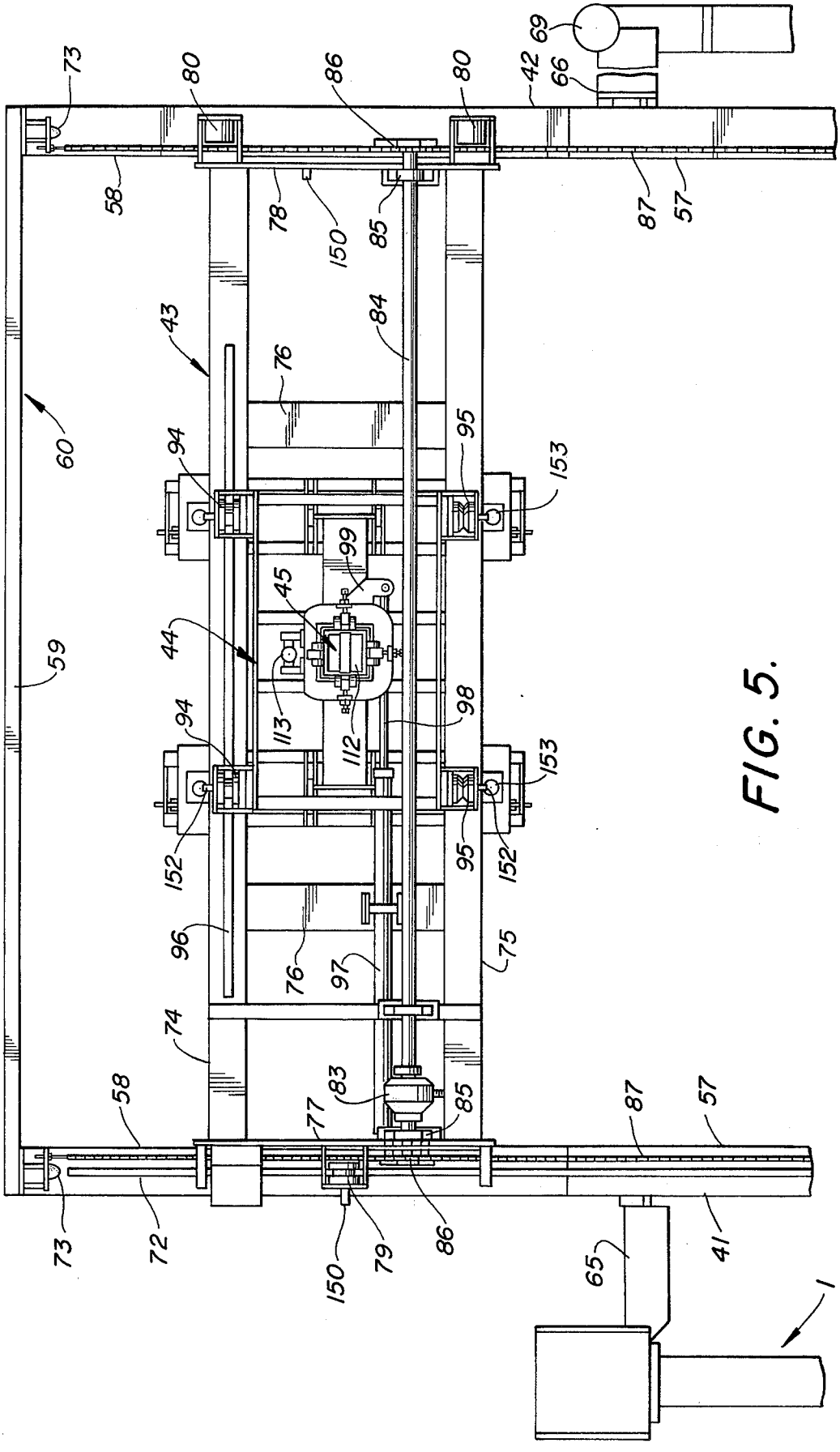

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FIG. 5.

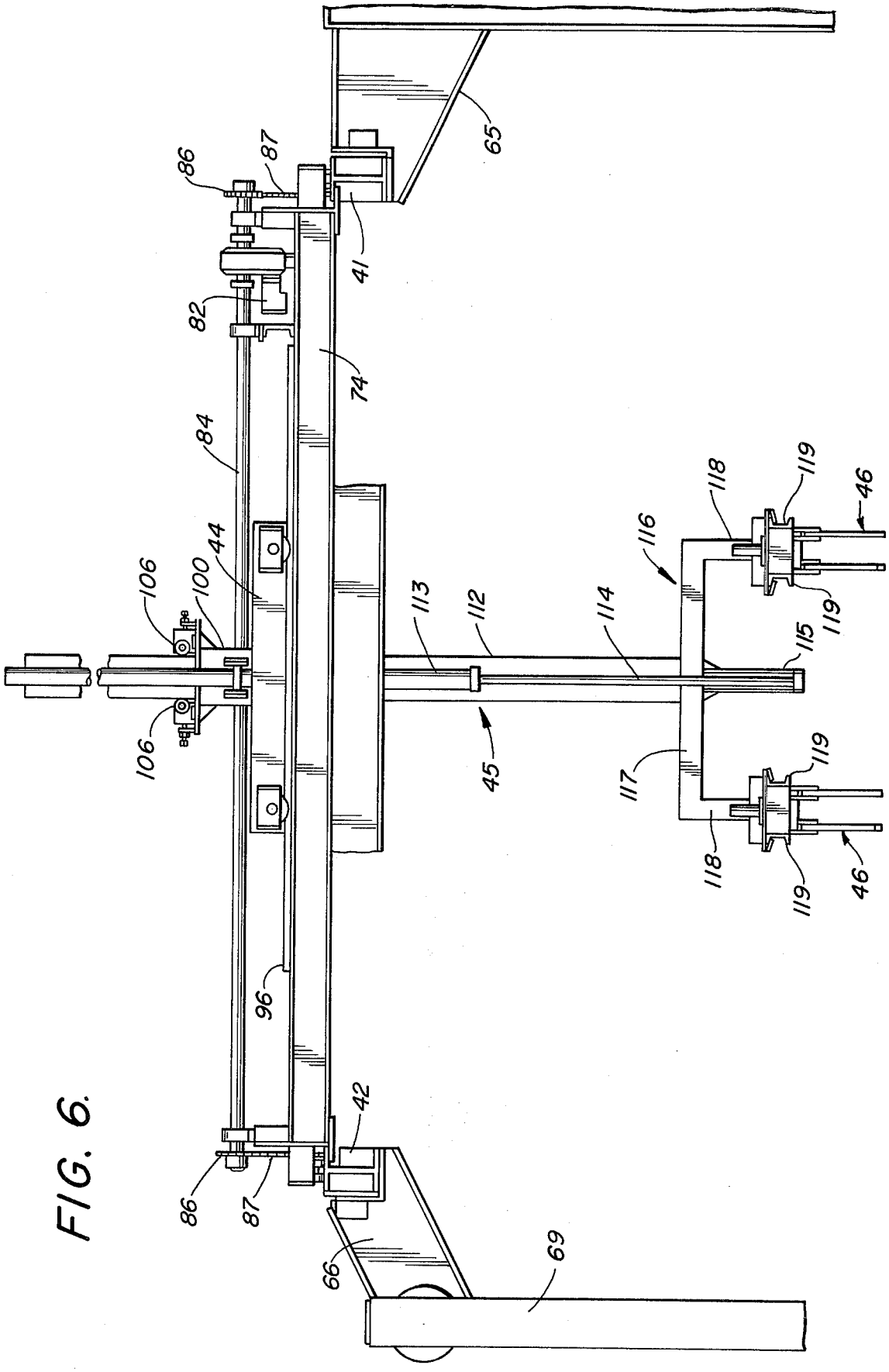

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FIG. 6.

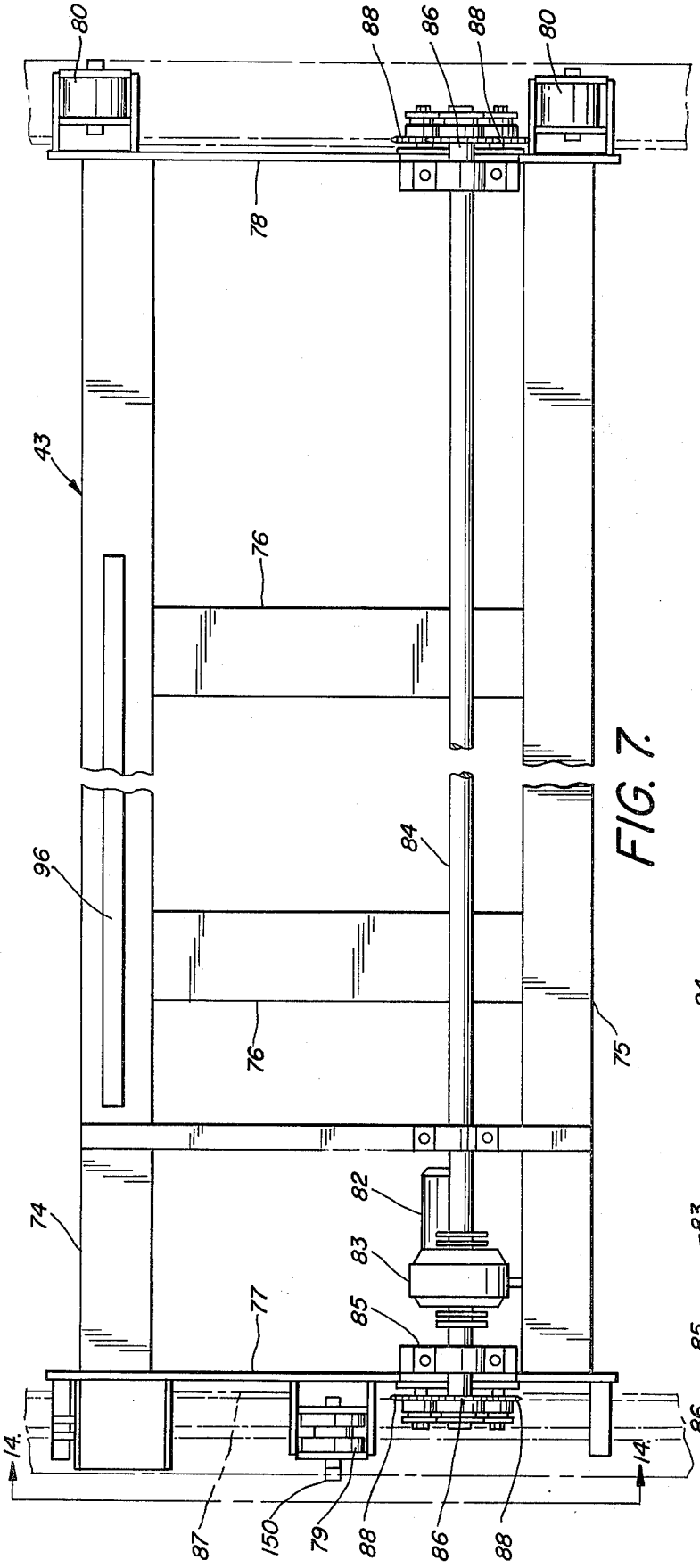

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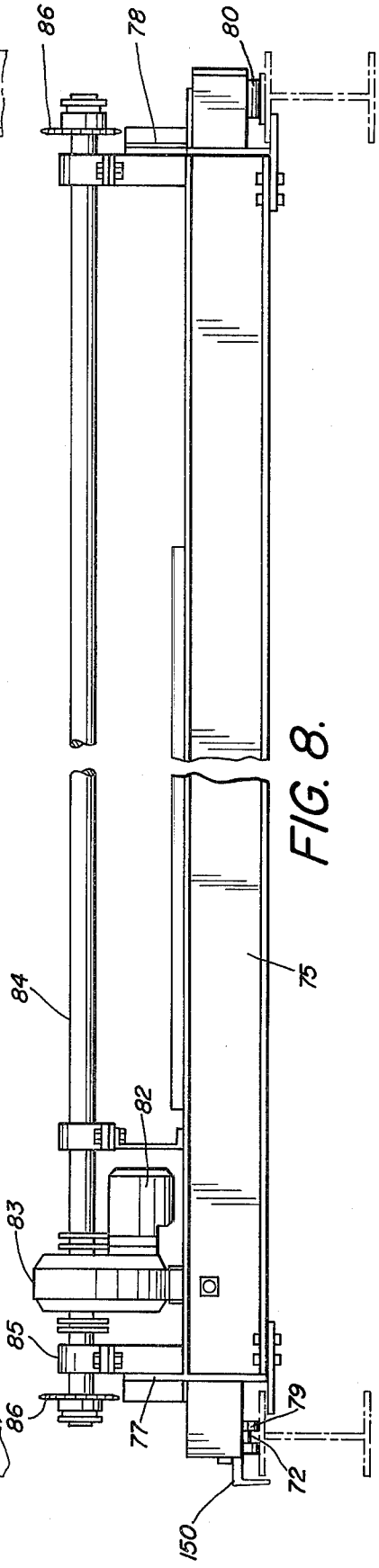

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FIG. 8.

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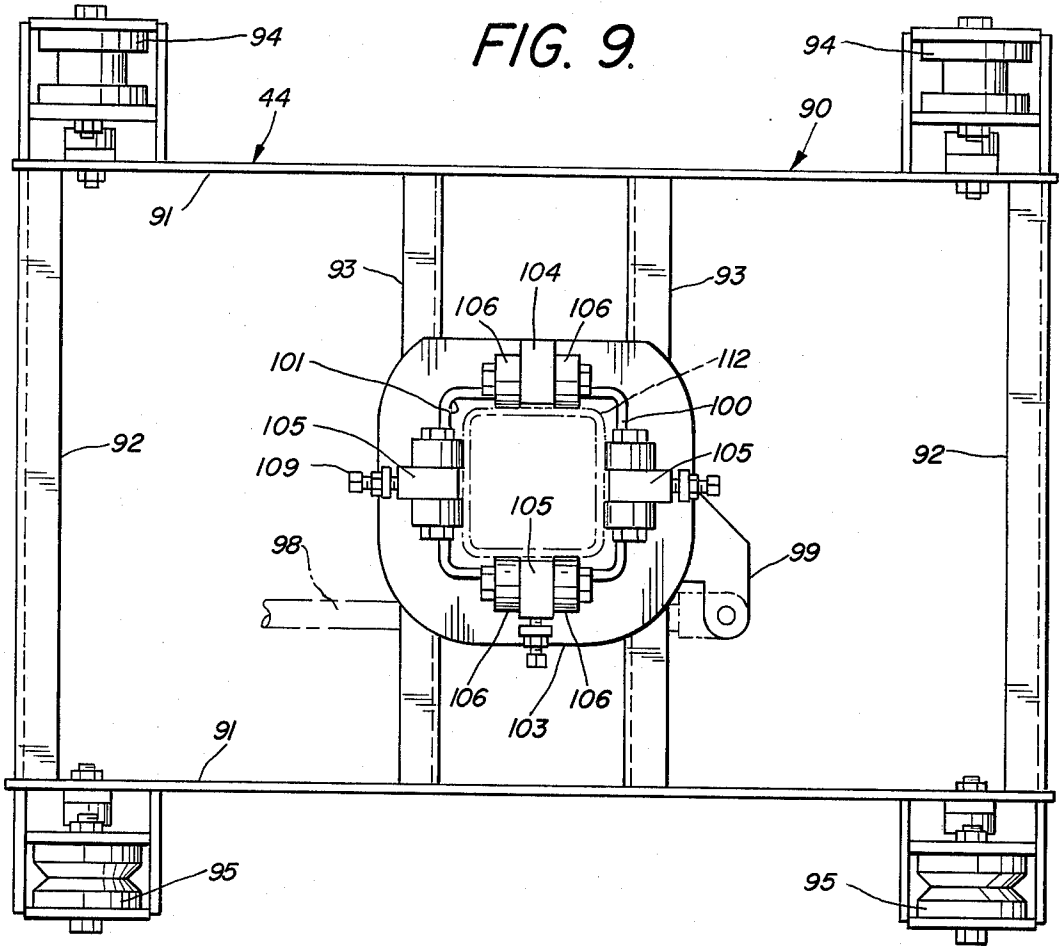
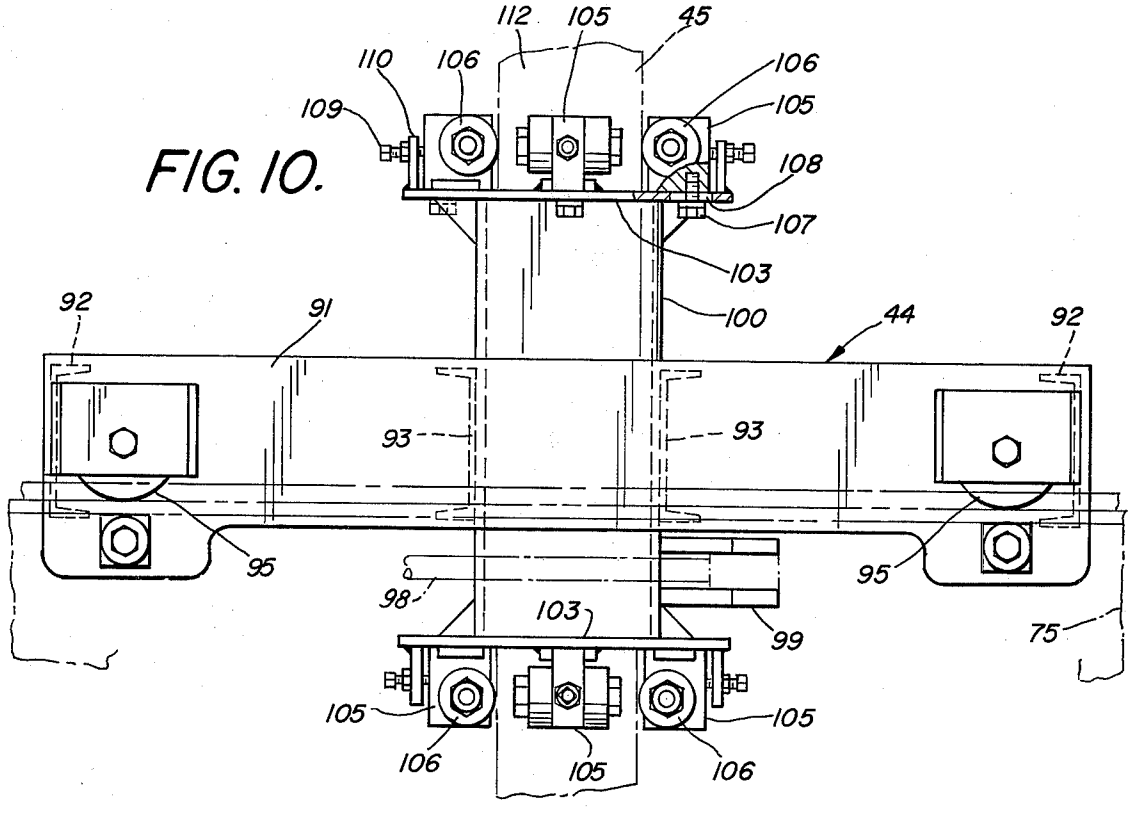

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FIG. 10.


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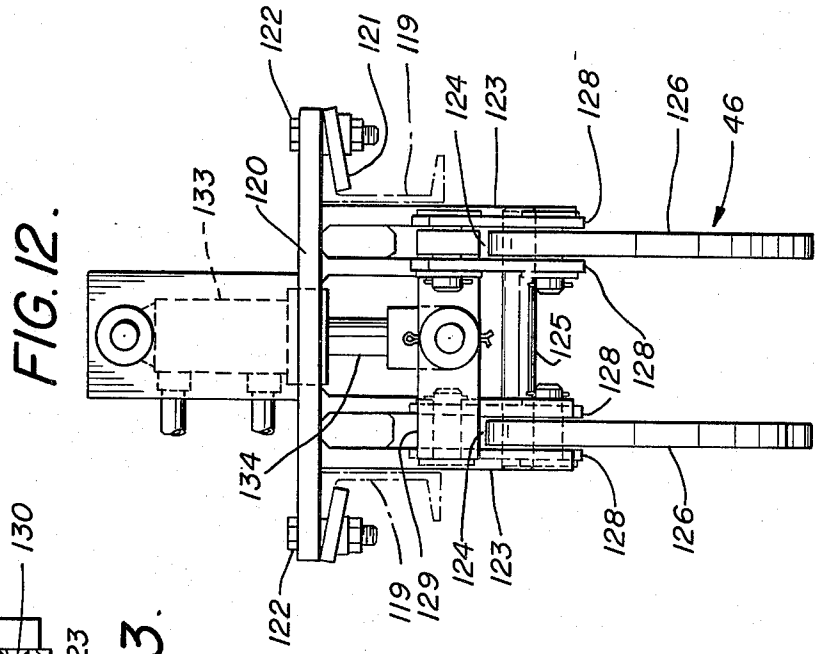


FIG. 12.

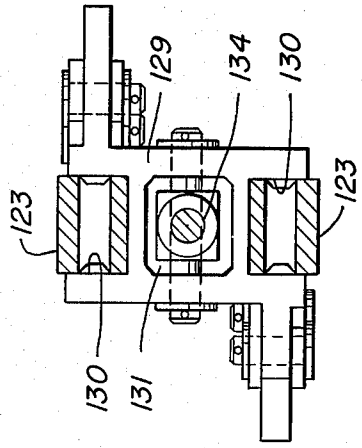


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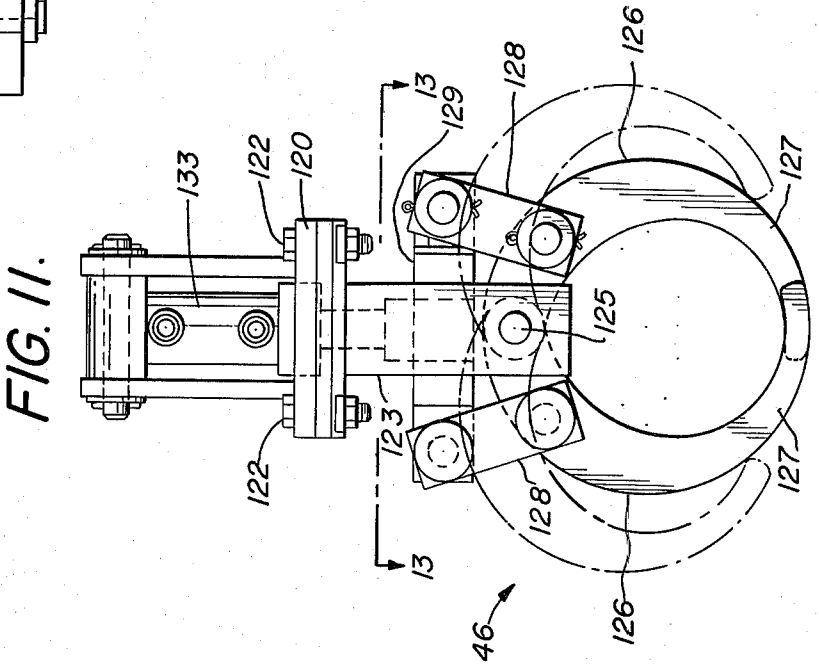


FIG. 11.

FIG. 14.

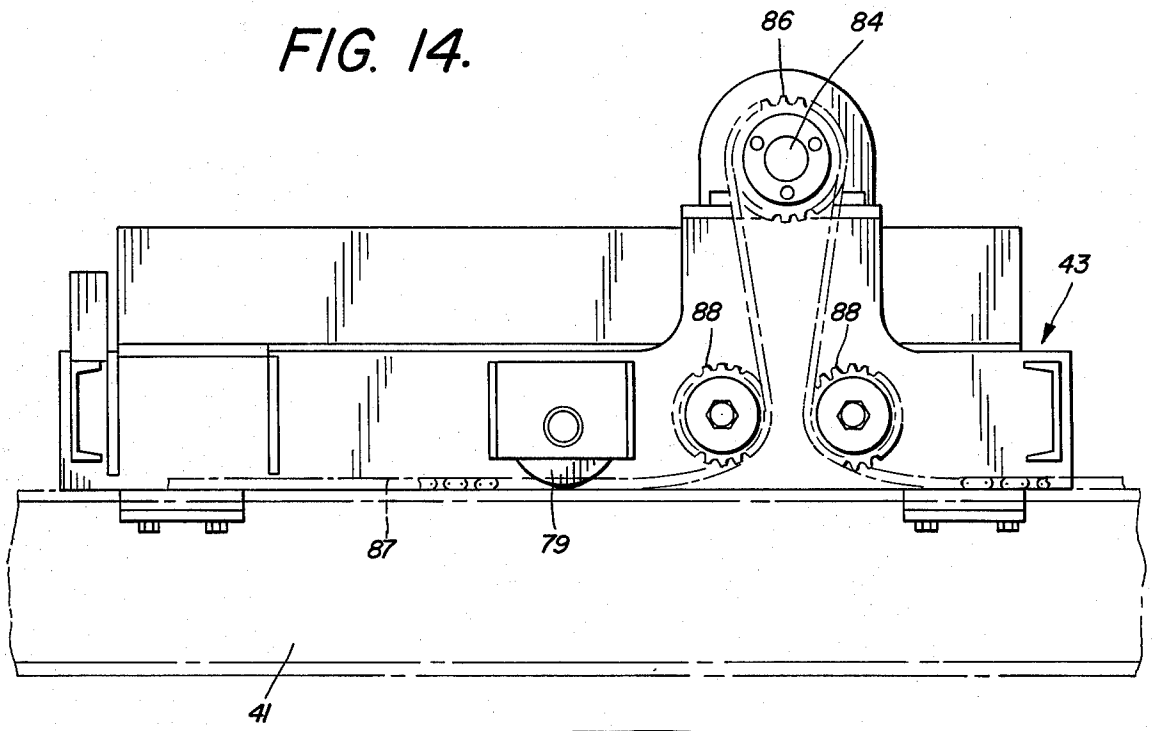

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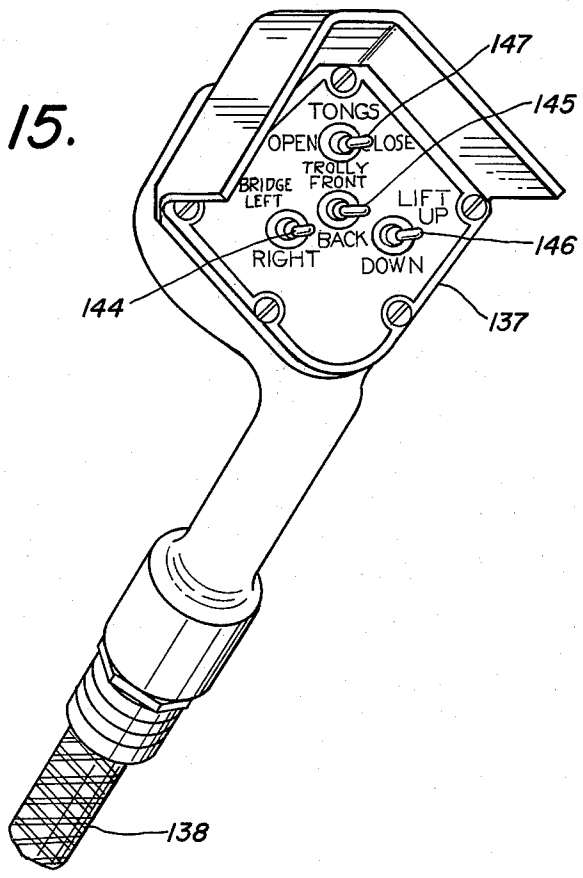
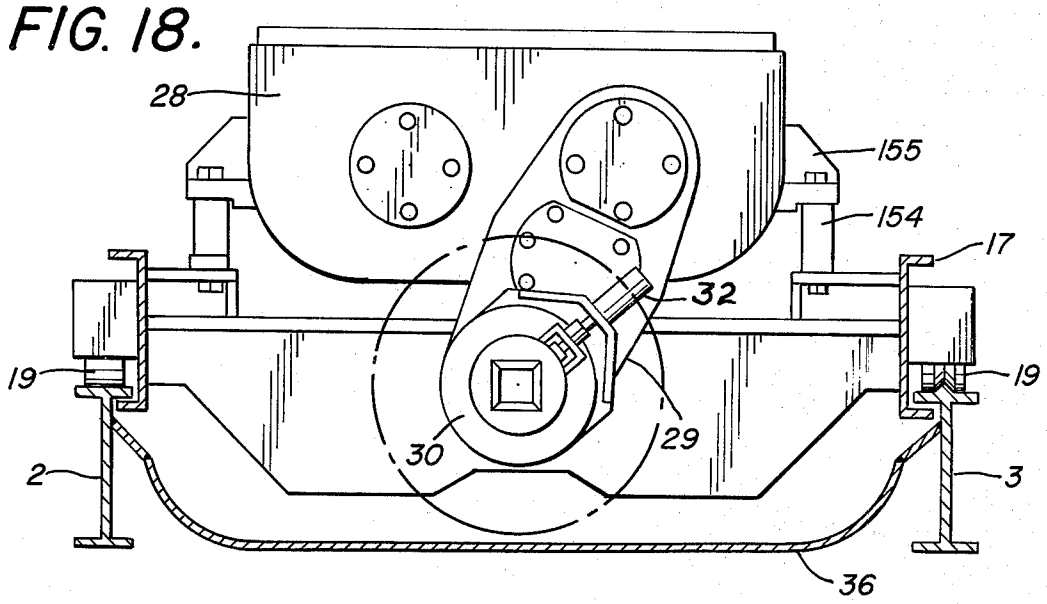

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FIG. 18.



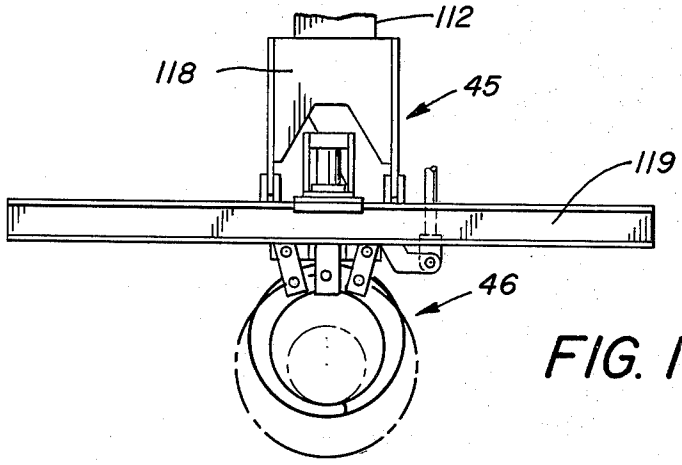


FIG. 16.

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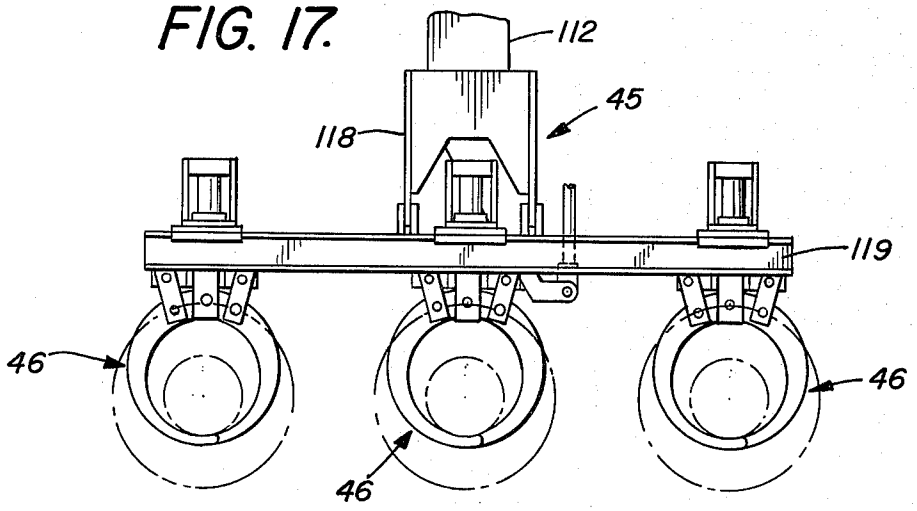
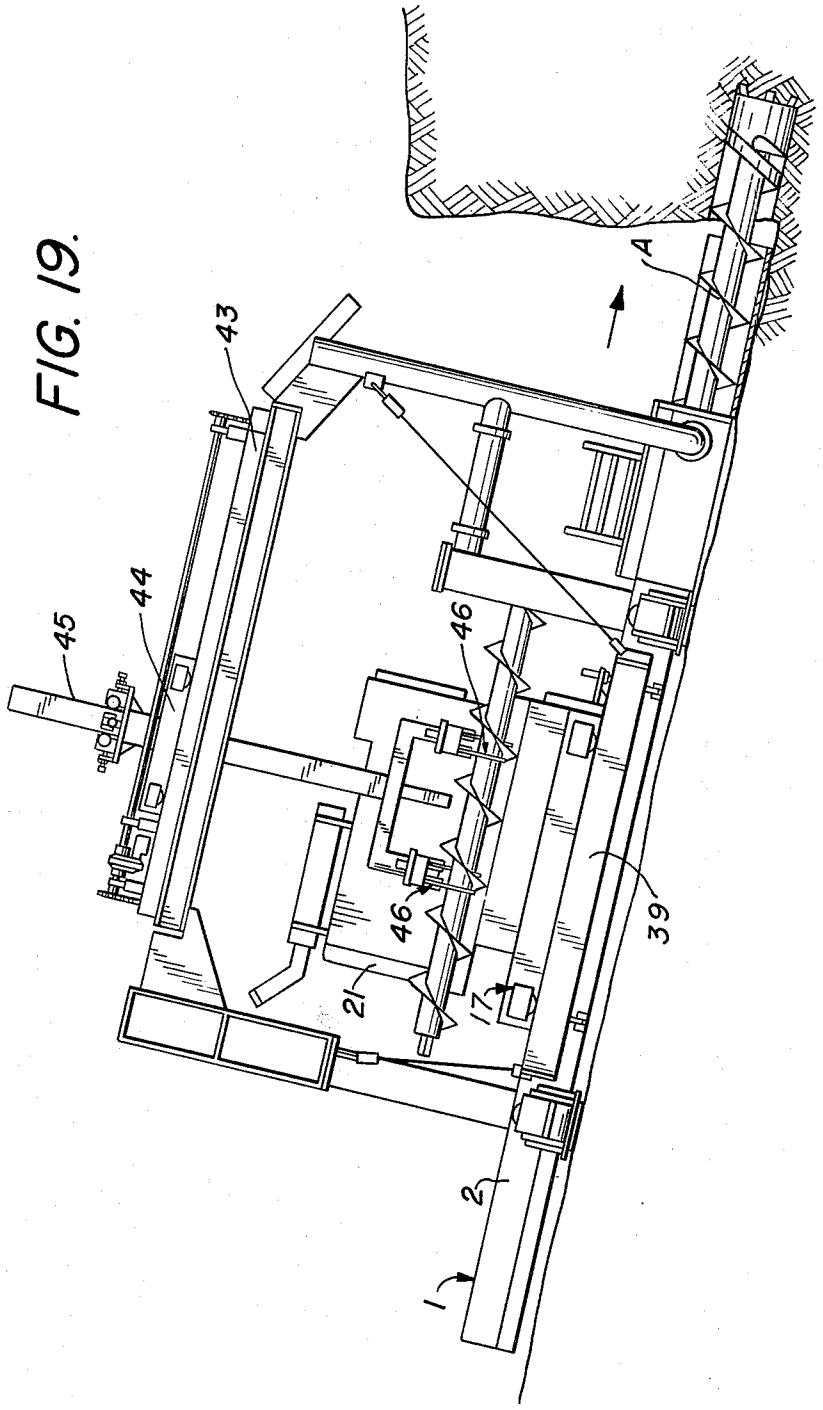


FIG. 19.



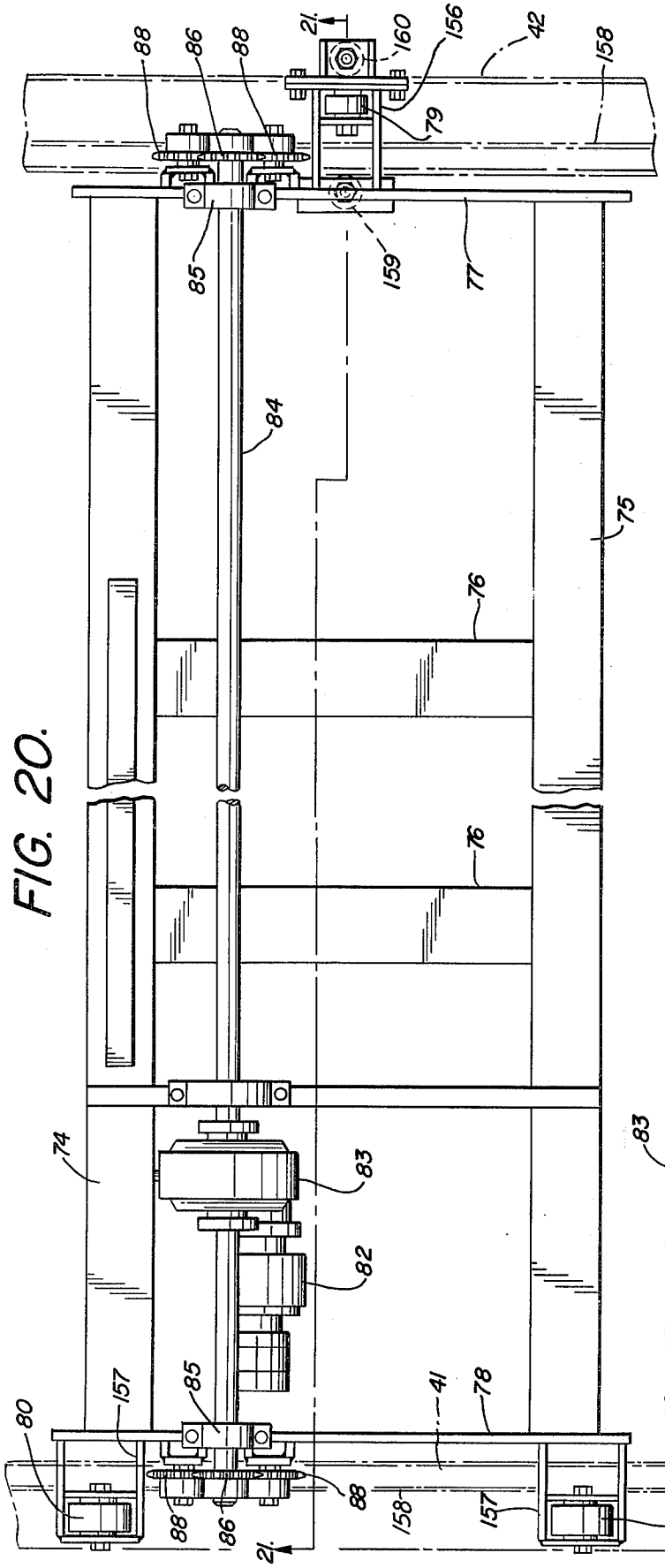

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FIG. 20.

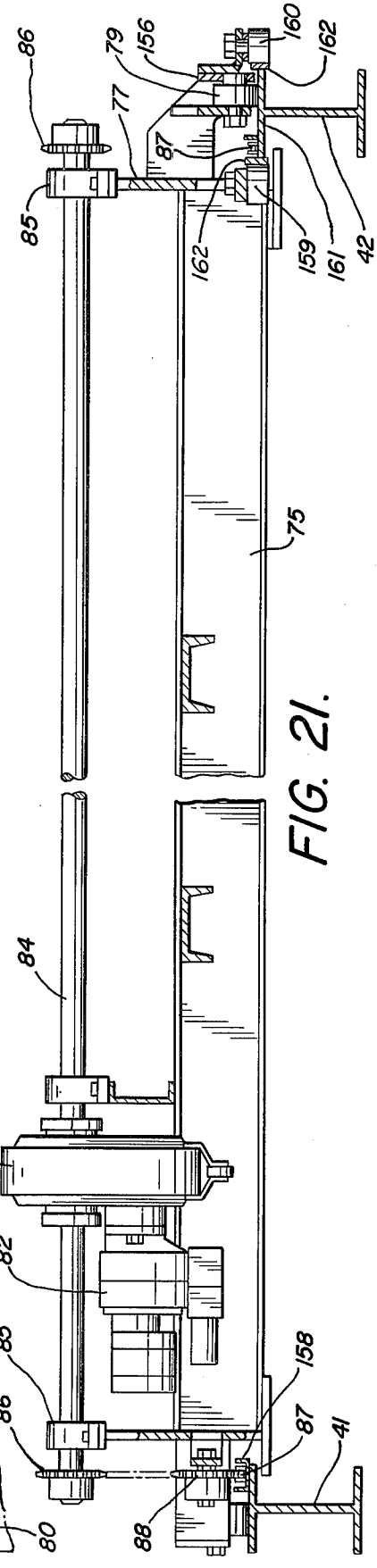

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FIG. 21.

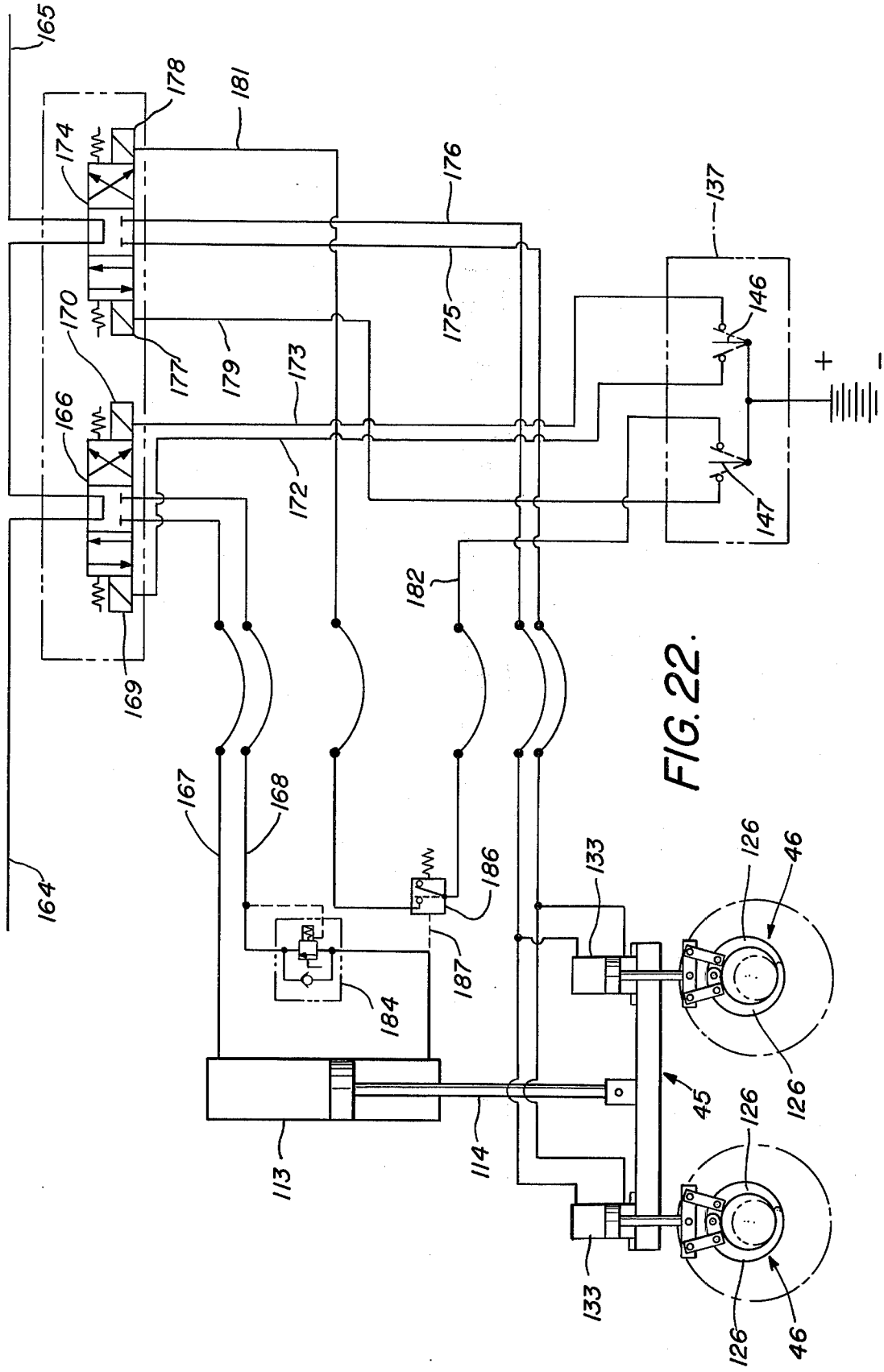

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FIG. 22.

AUGER SECTION HANDLING APPARATUS

FIELD OF THE INVENTION

The invention relates to auger apparatus of the type that bores one or more deep holes by an auger formed of a string of connected auger sections, and more particularly to such auger apparatus providing increased flexibility, speed and efficiency of operation, particularly in the handling of the auger sections.

The invention provides exceptional advantages when employed in auger mining machines, of the type adapted to be positioned adjacent an upwardly extending wall to recover coal from a seam that is exposed in such wall and extends generally laterally into the earth. Therefore, for convenience, the invention will be discussed in connection with such a machine.

Auger mining machines of this type comprise one or more augers each embodying a cutting head of relatively large diameter connected to and rotationally driven by a string of helically vaned auger sections driven from the machine. The cutting head penetrates the coal seam, and the mined coal is transported rearwardly from the cutting head along the vaned auger string to the entrance of the hole cut by the cutting head where the coal is collected and removed. As the cutting head is caused to penetrate into the hole, it is necessary to introduce auger sections into the string until the desired depth of the auger string is reached to achieve the desired depth of hole.

After the cutting head has penetrated the desired depth of hole, it is necessary to withdraw it by removing auger sections until the cutting head is out of the hole. The machine as a whole then may be moved laterally to another position where its auger or augers can drill another hole or holes generally parallel to the previously drilled hole.

The maximum diameter of the auger to be used is largely determined by the thickness of the coal seam, an auger of smaller diameter being used for a thinner seam, and an auger of larger diameter being used for a thicker seam. Occasionally a coal seam that is being mined varies in thickness; or in the same wall there are seams of widely varying thickness; or in the locality in which the mining machine is working there are different seams of widely varying thicknesses.

It is desirable that a single machine be capable of handling and driving a varying number of augers of widely varying diameter and length in order to permit maximum utilization of the machine and maximum recovery of coal with the single machine without the necessity of bringing in other machines. For a given power output of an auger machine, it is also most desirable that the machine be capable of driving a single auger of as large diameter as possible and that it also be capable of driving several augers of smaller diameter from the same power source within the power output capabilities.

Moreover, in order to achieve desired high production, it is necessary rapidly and accurately to handle the auger sections in taking them from a store of sections and placing them in the auger string and in then removing them from the auger string and placing them in a store of sections. The auger sections are quite heavy, often weighing several hundred pounds or more particularly when of large diameter. It is desirable that the sections be rapidly lifted and put in place accurately longitudinally and rotationally, in the auger string to

enable them to be connected preferably automatically to the driving means on the auger machine and to other auger sections of the string when auger sections are being placed in the string, and in the store of auger sections after the auger sections are disconnected preferably by remote control from the driving means and from other auger sections.

Moreover, when more than one auger string is being driven by the auger machine it is desirable, to save time, simultaneously to handle several corresponding auger sections for all strings either in placing them in the auger strings or removing them from the auger strings and placing them in the store.

Because of the size and weight of the auger sections, they must be handled by mechanical hoist means. The hoist means preferably should be such that it can carry out the above functions with safety to the operator. It is necessary for the operator closely to observe the position of the auger section or sections being handled by the hoist means while controlling the hoist means to handle the sections rapidly and accurately, while permitting the operator to remain in a safe place free of any danger of being struck by an auger section being moved by the hoist means.

Furthermore, heretofore it has been usually necessary to use at least two operators in moving auger sections, one operator controlling handling of auger sections between an auger string in the machine and a store of auger sections as in a rack at one side of the machine, and the other operator controlling handling of auger sections between the auger string and a store of auger sections as in a rack at the other side of the machine. However, for economical operation, it is desirable that only one operator be used to perform these functions.

Furthermore, seams of coal or other material to be mined often do not run substantially horizontal, but are inclined at substantial angles to the horizontal. In such case, the ledge on which the machine is supported must be cut at an angle corresponding to that of the seam so that the auger can be properly positioned to drill holes in the seam. Such prior auger section hoist means usually support the auger section by one or more cables, it has heretofore been extremely difficult if not impossible accurately to place the auger sections in the string and remove them from the string and place them in the store because of tendency of the auger sections to move longitudinally as they are being hoisted. With such prior auger hoisting means it was necessary to use operators to guide the auger sections into place manually because they tended to swing out of place longitudinally, with consequent delays, expenditure of physical effort and possibilities of danger to operators.

SUMMARY OF THE INVENTION

It is an object of the invention to provide auger apparatus that overcomes the disadvantages indicated above of prior apparatus and satisfies the desired aspects set forth above.

It is another object of the invention to provide auger apparatus embodying as many as desired of the features summarized above, including apparatus providing all of such features. It is a further object of the invention to provide auger apparatus that is flexible in operation in permitting use of a wide range of sizes of augers and a wide variety of numbers of augers. A further object is the provision of auger apparatus that is dependable in

operation, requires little maintenance and can be manufactured at reasonable cost.

The present invention provides auger apparatus, preferably a mining machine of the type discussed above, that overcomes such disadvantages and provides greatly increased flexibility in operation because it can be made adaptable to various mining conditions, including boring holes at substantial angles to the horizontal, without the necessity of replacing it with a different machine or necessity for manual handling or guiding of the auger sections.

According to the present invention, an auger mining machine may be provided that is adapted to drive one, two, three or even more augers of a wide range of diameters from a single power source.

According to another aspect, auger apparatus is provided comprising hoist means that is adapted to lift and move one, or a plurality of auger sections simultaneously, from an auger store to one or more auger strings, or from one or more auger strings to an auger store, and to accurately locate the augers longitudinally and rotationally with respect to the auger string and driving means of the auger machine and with respect to the auger store, without appreciable longitudinal movement relative to the machine.

BRIEF DESCRIPTION OF THE DRAWINGSS

The above advantages, features and objects will become more clearly apparent from the following description of the preferred embodiments of the invention in connection with the accompanying drawings, in which:

FIG. **1** is a plan of an auger mining machine embodying the invention, useful for mining coal in seams, having two auger strings with two cutting heads, connected to a single power source, and having hoist means embodying the invention;

FIG. **2** is a front elevation of the machine of FIG. **1** and to a larger scale, the cutting heads being omitted and the auger sections in the machine being shown in broken lines;

FIG. **3** is a detail to a larger scale, along line **3—3** of FIG. **2**, showing the adjustable mounting of a post on one of the auger section storage racks;

FIG. **4** is a side elevation of the machine to the scale of FIG. **2**, showing in broken lines the jacks extended to raise the main portion of the apparatus;

FIG. **5** is a plan view of a portion of the auger hoist means showing a portion of the rails supporting the bridge, the bridge, and the trolley on the bridge, the bridge being positioned near the other end of the rails from the position in FIG. **1**;

FIG. **6** is a side view of the auger hoist means from line **6—6** of FIG. **1**, parts of the auger machine being omitted;

FIG. **7** is a plan of the bridge to a larger scale than the preceding figures;

FIG. **8** is a side view of the bridge;

FIG. **9** is a plan view of the trolley that travels on the bridge, to a larger scale than FIGS. **6** and **7**;

FIG. **10** is a side view of the trolley showing the upwardly movable lift member in broken lines;

FIG. **11** is an end view of one of the auger grasping tongs, showing the tong fingers in full lines in the closed position and in broken lines in the open position, this figure being to a larger scale than the preceding figures;

FIG. **12** is a side view of the tong of FIG. **11**;

FIG. **13** is a section along line **13—13** of FIG. **11**;

FIG. **14** is an end elevation of the bridge showing the drive means for moving the bridge;

FIG. **15** is a perspective showing a switch hand set for the pendant control of the hoist means;

FIG. **16** is a fragmentary view showing how the hoist means can be adapted to carry a single auger;

FIG. **17** is a fragmentary view showing how the hoist means can be adapted to carry three auger sections;

FIG. **18** is a front view of a portion of the auger drive means showing how the apparatus can be modified to drive a single auger by removal of one of the auxiliary gear boxes;

FIG. **19** is a view to a smaller scale showing how auger apparatus embodying the hoist means of the invention can handle auger sections when the apparatus is inclined so that it can bore into an inclined seam;

FIG. **20** shows the bridge of the apparatus of FIG. **19**;

FIG. **21** is a section along line **21—21** of FIG. **20**; and

FIG. **22** is a schematic diagram showing the control means for raising and lowering the tongs and for opening and closing the tongs, embodying safety features preventing dropping of auger sections.

DESCRIPTION OF PREFERRED EMBODIMENT

The auger machine of FIGS. **1** to **15** comprises a rigid main frame **1** from which two augers A and B are supported and driven. The augers are detachably connected at their outer ends to a cutting head assembly C and are made up of strings of connected identical auger sections S between the cutting head assembly and the auger machine. The cutting head assembly C shown is similar to that of FIG. **11** of U.S. Pat. No **3,663,062** of May **16, 1972,** and comprises a rigid frame rotatably supporting two cutting heads D that are driven by augers A and B made of strings of auger sections S. Other types of cutting head assemblies may be used such as those of FIG. **4** or other figures of that patent. The disclosure of U.S. Pat. No. **3,663,062** relating to cutting head assemblies and to other features referred to hereinafter is incorporated herein by reference.

Main frame **1** comprises a pair of spaced longitudinally extending massive parallel frame beams **2** and **3** rigidly joined by cross members **4–7** (FIG. **4**). Near its end, and in a corresponding position on either side, the main frame has four vertical jacks **8, 9** each comprising a vertical outer tubular member **10** rigidly fixed to the frame **1** and having a telescoping inner member **11** adapted to be moved downwardly and upwardly into bottom of member **10** by fluid cylinder **12** to raise or lower frame **1** as required. The lower ends of the telescoping members **11** of the two jacks **8,** and the two jacks **9,** at each end of the machine carry a skid assembly **13** comprising a skid **14** adapted to rest on the pit floor F and known hydraulic cylinder means **16** for causing relative movement between the members **11** and the skid longitudinally of the skid and hence laterally of frame **1,** for predetermined distances within design limits. The jacks **8, 9** are capable of lifting the main frame and the portions of the machine carried by it free of the ground and the skid assemblies permit the frame and such portions to move in directions laterally of the frame as desired. By suitable manipulation of the jacks and skids in known manners, it is possible to move the machine laterally or closer or further from the wall into which the augers penetrate, as desired.

the skid assemblies are made of high strength steel and so designed that they are of minimum vertical thickness safely feasible for the load to be carried, so that when the skids are retracted as shown in FIGS. 2, 4 the distance between the floor F supporting the machine and the bottom edges of the augers and cutting heads is as small as feasible thus reducing the excavating necessary to provide the floor F and expose the coal seam, which is particularly advantageous where hard or rocky material must be excavated.

Frame 1 also supports a carriage 17 for guided movement longitudinally on beams 2 and 3, between an extreme rearward position shown in full lines in FIG. 4, to a forward position. This is to advance the augers A and B and cutting heads for cutting and to retract them for removal of the auger sections S, or to retract the carriage without the augers for insertion of additional auger sections to lengthen the augers A and B, in a known manner. Carriage 17 comprises a rigid frame 18 having wheels 19 (FIGS. 1, 4) that ride on guide portions 20 of beams 2 and 3.

An internal combustion engine 21 constituting the power source for rotating the augers is fixed on carriage frame 17 and drives through main power train means 22 comprising a clutch 23 having control lever 24, a flexible coupling 25, a shiftable transmission 26 having shift lever 27, and a main gear box 28, and two auxiliary power train means taking the form of gear boxes 29 that rotate two drive chucks 30. The main power train means is compact and of exceptionally short overall length to provide as short an overall length of the carriage 17 and auger machine as possible, the transmission 26 being as short as possible and positioned above main gear box 28. An operator on seat 31 on carriage 17 can manipulate the engine throttle controls, the clutch and shift levers and the controls for known means 32 for automatically locking and unlocking auger sections to the drive chucks 30. The apparatus also includes known unlatching means similar to that disclosed in U.S. Pat. No. 3,278,236, comprising a fluid cylinder 33 that can move means 34 to engage latches on the auger sections to disconnect auger sections from each other.

The carriage is moved between its rear and forward positions by fluid cylinder actuating means 35.

The frame 1 includes a belly plate 36 between and supported from beams 2 and 3 by cross members 5, 6. The belly plate supports those auger sections in the machine extending from drive chucks 30 to the front end of the machine at the wall into which the augers penetrate. Coal mined by the cutting heads and augers passes onto a conveyor 37 carried by the main frame near the front of the machine. The apparatus also includes auxiliary power means 38, such as an internal combustion engine and appurtenant apparatus for producing auxiliary power, such as pumped hydraulic fluid under pressure which through known means is controlled to actuate various other portions of the apparatus such as the jackes, the skids, the conveyor and hoist apparatus to be later described.

The machine of FIGS. 1 to 15 positively rotates the auger cutting heads D by rotation of the two augers A and B as will be described later. As the cutting heads are rotated and caused to penetrate the coal or other material being mined by movement of carriage 17, auger sections S from the storage racks 39 are inserted adjacent the drive chucks 30 when the carriage 17 is located in its rear position on frame 1, to extend the lengths of augers A and B as required as the holes are bored deeper by the cutters.

A hoist apparatus 40 for handling auger sections is supported from the main frame 1. This apparatus comprises two spaced parallel rails 41, 42 extending transversely of the auger machine over the auger storage racks 39 and over the central portion of the apparatus in which are located the auger sections forming the augers A and B. A bridge 43 is adapted to travel on the rails 41, 42. A trolley 44 is adapted to travel on the bridge 43 transversely of rails 41, 42. The trolley 44 carries a lift 45 that is movable upwardly and downwardly relative to the remainder of the trolley and that carries tongs 46 adapted to grasp simultaneously a pair of auger sections S and move them from either of the storage racks to the desired positions in the central portion of the machine where they can be connected to the driving heads 32 and to other auger sections, or to move them from such positions to the storage racks.

Each storage rack 39 (FIGS. 1–4) comprises two side beams 47 rigidly connected together at their outer ends by a cross beam 48, and pivotally connected at their inner ends by joints 49 having removable point pins 51. The outer ends of the racks are supported by cables 52 from the machine. The racks can therefore be removed or swung upwardly to reduce the width of the machine when it is moved to a different location. Each rack has upright posts 53 that are demountably and adjustably fixed to side beams 47 of the rack to hold auger sections of different diameters on the rack. As shown in FIG. 3, each post rigidly carries laterial members 54 that extend across a beam 47 and are clamped by members 55 and bolts 56.

In the illustrated apparatus, each of the hoist apparatus rails 41, 42 comprises a central portion 57 and two end portions 58. The end portions at each side of the machine are rigidly connected together by a cross member 59 to form a movable rail structure 60 that is connected by hinges 61 to the center portions 57 of the rails and is adapted to be firmly held in its lateral or extended position as shown in FIG. 2 by bolts 62 passing through flanges 63 and 64 on the central and side portions of the rails. By removal of the bolts, the movable rail structures 60 can be caused to hang downward to reduce the width of the machine when it is moved.

Rail 41 is supported by brackets 65 connected to the central portion 57 of the rail and mounted on the rear jacks 8 of the apparatus. The other rail 42 is supported from brackets 66 connected to the central portion of the rail and fixed to upwardly extending front posts 69 the lower ends of which are fixed to the main frame 1 of the apparatus. Intermediate side cross member 71 connects each post 59 to its associated front jack 9, to aid in stiffening and holding the post firmly in place. Posts 69 are located forward of the front jacks 9 for a purpose to be later described.

Rail 42 has a raised track 72 (FIGS. 1, 2, 5) to guide bridge 43 in a straight path along the rails. Both outer end portions 58 of each of rails 41, 42 carry stops 73 having rubber buffer portions to limit the travel of bridge 43 on rails 41, 42.

Bridge 43 comprises two beams 74, 75 extending between rails 41, 42 and rigidly held together by widely spaced intermediate cross members 76 and end cross members 77 and 78 fixed to the ends of beams 74, 75. At one end of the bridge cross member 77 carries a sin-

gle roller 79 located midway between beams 74 and 75 and riding on rail 41; roller 79 engages track 72 to guide the bridge. At the other end of the bridge cross member 78 carries two rollers 80 adjacent the ends of the beams which rollers ride rail 42. The bridge is thus supported from three points on the beams 41 and 42, and thus is stable even though these in use may not be exactly level with respect to each other.

The bridge is moved either direction as required along rails 41, 42 by a fluid power motor 82 (FIGS. 5—8) that drive through a gear box 83 a shaft 84 tht extends along the bridge beams and sufficiently above them to clear trolley 44. Shaft 84 is rotatably carried by bearing brackets 85 fixed on members 77, 78. The shaft rigidly carries a drive sprocket 86 at each end outside of members 77, 78.

The top of each rail beam 41, 42 of the hoist apparatus supports a chain 87 fixed at its ends to the stops 73 to secure the chain against longitudinal movement. The chain is long enough to extend for substantially the full distance between stops 73 and also to extend upwardly around and between idler sprockets 88 fixed to the ends of the bridge and over drive sprockets 86 carried by shaft 84. Consequently, as shaft 84 is rotated in a desired direction by fluid motor 82, the bridge is moved in the desired direction by engagement of sprockets 86 with chains 87 on the rails 41, 42. Such movement is positive at both ends of the bridge so that there is no tendency for the bridge to twist or move out of alignment relative to the rails.

The trolley (FIGS. 1, 2, 4, 6, 9, 10) comprises a rigid frame 90 including two longitudinal side members 91 rigidly connected together by end cross members 92 and intermediate cross members 93, all of substantial depth, the cross members being flanged, so that the frame is a rigid, strong structure.

The trolley is supported for movement on and along the beams 74, 75 of the bridge by rollers 94 and 95 rotatably supported from the corners of the trolley, at least two of the rollers 94 on one side being grooved to engage a longitudinally extending guide 96 fixed to the upper surface of beam 74 of the bridge to guide the rollers and trolley in a straight path along the bridge. While four rollers are shown, the trolley could have two rollers on one side such rollers preferably engaging guide 96, and one roller centrally located on the other side to provide three-point support of the trolley if desired; however, this is in general not necessary if the bridge is sufficiently rigid.

The trolley is moved longitudinally of the bridge by a fluid cylinder 97 that is rigidly connected to the bridge and has a piston rod 98 connected to a bracket 99 fixed to the trolley.

Trolley 44 carries an upwardly extending sleeve 100 that is located centrally of the trolley and is rigidly fixed to cross beams 93 and that has an opening 101 through which passes lift member 45.

At its upper and lower ends sleeve 100 carries (FIGS. 9, 10) flanges 103 on which are mounted brackets 104 and 105 carrying rotatable guide rollers 106. Brackets 104 at one side of the sleeve at its upper and lower ends are fixed in relation to the sleeve. Brackets 105 on the other three sides of the sleeve at its upper and lower ends are adjustably mounted on flanges 103 to permit the rollers 106 to be moved toward and away from opening 101 through the sleeve. Each bracket 105 is clamped to its flange 103 by a bolt 107 extending through a radial slot 108 in flange 103, and on loosening of bolt 107 is adapted to be adjusted in a radial path extending toward the center of the sleeve by an adjusting screw 109 threaded through a fixed lug 110 on flange 103.

Lift member 45 has an upwardly extending leg 112 of similar but smaller polygonal cross section as the sleeve opening 101, which is square in this case. Leg 112 is guided by contact of rollers 106 with its flat outer sides to move non-rotatably in the sleeve in an essentially fixed upright path relative to the frame of trolley 44. Lift member 45 is moved upwardly and downwardly in such path, as required, by a fluid cylinder 113 mounted on the trolley and having a downwardly extending piston rod 114 that is connected to a bracket 115 at the lower end of the leg (FIGS. 2, 4, 6).

The lower end of the leg also rigidly carries a structure 116 on which a desired number of tongs 46 may be mounted in various spacings relative to each other. In the embodiment of FIGS. 1–15 there are four tong units mounted on the structure 116 in two pairs are aligned longitudinally of the machine so that the lift member 45 can simultaneously carry two auger sections S. As shown in FIGS. 2, 4, 6, 16, 18, structure 116 comprises member 117 extending longitudinally of the machine and rigidly fixed to the leg and rigidly carrying downwardly spaced extending portions 118 to which are fixed flanged members 119 extending transversely of the machine. Members 119 are arranged in pairs so that each pair can demountably and adjustably support one or more tongs as shown in FIGS. 2, 11–13, 17, 18. Each tong comprises a generally horizontally extending plate member 120 having near its edges clamping strips 121 that are adapted to be tightened by bolts 122 and their nuts to clamp the tong to the flanges of each pair of members 119. Each member 120 carries inside of the members 119 two rigid parallel downwardly extending members 123 each having a slot 124 at its bottom.

A pin 125 extends through and pivotally supports tong fingers 126 in the slot 124 of each member 123. The tong fingers are oppositely disposed relative to each other and each is shaped in the form of a hook with a lower portion 127 extending toward the other tong finger, so that when the fingers are in the closed position relative to each other their lower portions overlap as shown in full lines in FIG. 11, and when they are retracted to their widest open position as shown, their lower portions are separated by a substantial distance as shown in broken lines in FIG. 11. The tong fingers are thus moved between their closed and open positions by links 128 pivotally connected to each of the fingers and to a slidable member 129 that can move vertically between downwardly extending members 123. Member 129 is shaped to have oppositely disposed slots 130 that slidably fit around a vertical side and two vertical edges of each member 123 to guide member 129 vertically and to prevent twisting or jamming of slidable member 129 under load. Member 129 also has a central opening 131. Member 129 is moved upwardly and downwardly as required to open and close the tong fingers by a double acting fluid actuated cylinder 133 that is pivotally connected above and to the top of plate member 120 and has a piston rod 134 extending through member 120 and connectd to slidable member 129 in its opening 131. As is apparent from FIGS. 11–13, when cylinder 133 retracts the pis-

ton rod, slidable member **129** moves up and links **128** pull up on the tong fingers **126** of each tong **46** so they pivot around pin **125** and retract to their open position. When cylinder **133** moves slidable member **129** down, the tong fingers pivot around pin **125** and move downwardly to their closed position, aided by gravity.

As is apparent from FIG. **4**, the tongs on the spaced parallel members **117** are arranged in alignment longitudinally of the machine so there are two tongs that grasp one of the auger sections around its central portion between its vanes. In the embodiment of FIGS. **1–15** in which two parallel auger sections are handled simultaneously, the spacing between the tongs is such that the auger sections are properly spaced to be put in the augers A and B. Preferably a tie bar **135** (FIGS. **1**, 2, 4) is rotatably connected to each pair of a substantial number of pairs of adjacent auger sections near at least one end of the pair to aid in maintaining proper spacing of the sections during the drilling operation and during handling and storage of the sections.

As is also apparent from FIGS. **2, 16–17**, the apparatus of the invention is adapted to carry one, two, three or even more auger sections at various spacings to compensate for various numbers and diameters of auger sections, by proper positioning of a proper number of tongs which may be readily put in place, removed or adjustably spaced by means of the above described clamping means. The hoist apparatus could therefore be advantageously held to handle simultaneously the auger sections for the varying numbers of auger strings shown in U.S. Pat. No. **3,663,062.**

The hoist apparatus of the machine of FIGS. **1–15** is controlled from either of two stations X on opposite sides of the machine, by use of pendant control means at such station by an operator, who can stand on either of the walkways **136** extending longitudinally along opposite sides of the machine. Such pendant control means comprises a switch handset **137** (FIG. **15**) at each station X, connected by suitable known electrical circuits through flexible cables **138, 139, 140,** supported in part by masts **141, 142** on the frame of the machine an the trolley, that supply electrical power from a suitable source, such as batteries, on the machine, not shown, and that control operation of the fluid actuated motor **82** that moves bridge **43,** fluid actuated cylinder **97** that moves the trolley **44,** and the fluid actuated cylinder **113** that moves the lift member **45** in its upward and downward path.

It is apparent from FIG. **15** the handset **137** of the pendant control means includes a switch **144** of known type which when moved to the position marked "Left" will move the bridge to the left relative to the operator, and when moved to the position marked "Right" will move the bridge to the right, and when centered will cause the bridge to be halted. Similarly, the switch **145** is of known type that when moved to the position marked "Front" will move the trolley toward the front of the apparatus, when moved to the position marked "Back" will move the trolley to the back of the apparatus, and when centered will halt operation of the trolley.

The switch **146** when moved to the position marked "Up" will raise the lift member and when moved to the position marked "Down" will lower it; when centered it will halt its operation. The switch marked **147** when moved toward the position marked "Open" will open the tongs, when moved to the position marked "Closed" will close the tongs, and when centered will not operate the tongs but leave them at the position at which they are opened or closed.

An operator at either of the positions marked X is completely safe and out of any location where he can be struck by an auger section as it is being moved between an auger rack and the operating position or vice versa. Moreover, an operator in the seat **31** controlling rotation of the augers can also control the pendant control means at one of the position X so that one man control of the entire machine, including handling of auger sections, is possible.

Assuming two auger sections are to be simultaneously handled, operation of the illustrated hoist apparatus for moving the pair of auger sections simultaneously from one of the storage racks to positions in the auger string may be as follows. The switch handset **137** at one of the locations X is actuated by operation of the switches to open the four tongs **46** on the lift member **45,** then to lower the lift member while aligning the tongs with the selected two augers in one of the storage racks **39.** The tongs are then closed and the lift member is raised sufficiently to cause the auger sections to clear the top of the adjacent jack **9.** The trolley is then moved forward on the bridge as shown in FIG. **4,** to move the auger sections forward to approximate longitudinal alignment with positions in which they are to occupy in the auger string, the bridge is then moved on the rails **41, 42** to cause the auger sections to be approximately laterally aligned with respect to the auger sections, after which the lift member is lowered to lower the auger sections until they are actually or very close to it in place. If necessary, final adjustments of the positioning of the auger sections can be made by visual observations and operation of the switches on the handset so that the auger sections are perfectly aligned in the position which they are to occupy after which the operator can move the carriage **17** forwardly to cause the locking means **32** to lock the auger section to the drive chucks **31** and then further move the carriage **17** carrying these auger sections forwardly until they engage with and lock onto the auger sections of the string extending forwardly from the machine. The apparatus is then ready to be operated to bore mining holes.

When it is desired to remove auger sections from the auger strings, as when auger strings are removed from the drilled holes, the reverse operation is followed. The bridge **43** and the trolley **44** on the bridge are moved so that the auger tongs **46** are properly aligned in relation to the augers to grasp the auger sections by their central portions, the lift member **45** is lowered, the final adjustments and alignment are made, and the tongs actuated to grasp the auger sections.

Before or after this operation, both ends of each auger section to be removed are disconnected first by actuation of the unlatching means **34** to disconnect the auger sections from the other forwardly positioned auger sections in the strings, and then by actuation of the means **32** to disconnect the auger sections from the drive chuck, the carriage **17** being moved rearwardly to accomplish such disconnection.

Thereafter the tongs are actuated to grasp the auger sections the tongs being then closed, and the lift member **45** actuated by operation of the handset to lift the auger sections to a position where they will clear the top of adjacent jack **9,** then to move the auger sections laterally and rearwardly to the proper location on the

selected auger storage rack on which they are then deposited by moving the lift downwardly.

It is desirable to provide locating indicia by which the bridge by visual observation can be rapidly and properly located transversely relatively to the frame of the apparatus so that the tongs on the lift member of the trolley can be properly aligned transversely relatively to the positions of the auger section or sections in the auger strings in the apparatus. Such indicia are illustrated as pointers **150** on the bridge and markers **151** on the rails **41, 42** of the apparatus, located so that they are aligned when the bridge is properly located over the auger section positions in the machine and so at least one set of cooperating indicia can be seen by an operator at either of stations X or the seat **31.** For similar reasons, indicia such as pointers **152** on the trolley and markers **153** on the bridge may be provided to permit rapid, accurate location of the trolley longitudinally on the bridge by visual observation.

The illustrated apparatus also includes drive means by which either one or more auger strings may be driven, and in which augers of different sizes may be driven.

As shown in FIGS. **1** and **2,** apparatus shown in these figures is adapted to drive two auger strings from main gear box **28** through two auxiliary power train boxes **29** and two auger drive chucks **30.** The auxiliary boxes **29** may be similar to those disclosed in U.S. Pat. No. **3,663,062** in that they include gears by which the chucks **30** are driven from the main gear box. In a manner like that disclosed in the patent, the auxiliary gear boxes **29** may be adjustably positioned toward or away from each other to permit the proper positioning of augers of different sizes, and the rigid unit comprising the main gear box **28** and power source **21** may be raised or lowered by means of adjustable shims **154** and bolts **155** (FIGS. **4, 18**) to raise or lower the axes of the augers and the driving heads **30** relative to the bottom plate **36** to accommodate different diameters of augers.

If it is desired to drive more than two cutting heads, three or more cutting heads as disclosed in U.S. Pat. No. **3,663,062** may be driven through a cutting head assembly from two auger strings or the auxiliary power train boxes **29** may each be adapted to drive more than one drive chuck and auger string, as a total of four drive chucks and corresponding auger strings, the auger sections for which may be readily simultaneously handled by the hoist apparatus of the invention by suitable adjustment of the member and spacing of the tongs.

As shown in FIG. **18** in the present embodiment, one of the auxiliary boxes **29** may be removed and the remaining auxiliary box **29** may be swung into position so that its drive chuck **30** is centered relative to the width of the apparatus to permit the driving of a single auger. In such case the shims **154** should be the proper height to accommodate the diameter of the single auger, which is usually a large diameter auger.

Therefore, the auger drive means and the hoist apparatus of the machine are both flexible in that they can handle a varying number of augers of widely varying diameters, each cooperates with the other in making this possible.

Auger machines and particularly the hoist apparatus embodying the present invention may be advantageously used for boring holes at a substantial angle from the horizontal, as shown in FIG. **19,** since the hoist apparatus makes possible proper and accurate placement, removal and handling of auger sections with safety to the operators, despite the substantial inclination of the auger sections as they are lifted.

This is possible because (FIGS. **19–21**) the bridge may be mounted to travel on rails **41, 42** so that it cannot lift or otherwise move off these rails, and the trolley is so designed that it cannot move off the bridge despite the substantial inclination of the auger machine, and because the lift member **45** moves the auger sections in an essentially fixed path relative to the trolley and does not include any cables or other flexible suspension portion between the trolley and auger sections.

FIGS. **20, 21** show a modification of the bridge that insures that the bridge will be properly positioned on its rails **41, 42** despite substantial inclination of the machine as a whole the trolley being omitted for clearness. The bridge comprises beams **74, 75** rigidly connected together by intermediate cross members **76** and by end cross members **77** and **78.** These end cross members carry brackets **85** that support a shaft **84** that is driven through gear box **83** by a fluid powered motor **82,** as in the previous embodiment. The bridge travels on rails **41, 42** by a single roller **79** at one end of the bridge and two rollers **80** at the other end. Roller **79** is rotatably mounted in bracket **156** fixed centrally of end member **77** and rollers **80** are rotatably mounted in brackets **157** fixed to the end member **78.** Consequently there is the same three point support as in the previous embodiment. The bridge is caused to travel along rails **41,** 42 by a sprocket **86** on each end of shaft **84** engaging the closed end of an open loop of a chain **87** on each rail that passes over each sprocket **86** and over idler sprockets **88** in the previous embodiment.

In order to insure that the portions of the chains that rest on rails **41, 42** do not slip laterally because of the inclination of the machine, the chains are carried in guide portions **158** fixed on the rails (FIG. **21**). Furthermore, in order to insure that the bride maintains its proper lateral position with respect to rails **41, 42** despite any longitudinal inclination of the machine, the bridge is located laterally of the rails by rollers **159** and **160** that rotate about upright axes and are mounted on the bridge. Roller **159** is rotatably mounted on end member **77** of the bridge in an opening therein that bears against one side of the flange **161** of beam **42;** roller **160** is rotatably mounted on bracket **156** and is located directly opposite roller **159** to bear against the other edge of flange **161.** Preferably as shown in FIG. **21,** the edges of the flange have wear strips **162** fixed to these edges.

The trolley **44** moves in the direction of inclination and its weight distribution is such that at all times will be properly located on the bridge by means of the guide **96** engaging grooved rollers on the trolley as previously described.

Lift member **45,** as previously described is accurately located to move in a fixed upright path relative to the trolley.

The above described apparatus embodies important safety means that prevents inadvertent dropping of any auger section carried by the hoist apparatus, as shown in FIG. **22,** which diagrammatically shows the control system for raising and lowering the lift member **45** carrying tongs **46** and for opening and closing the tongs, which system embodies the above indicated safety means.

In FIG. 22, power fluid under pressure is supplied from a suitable source such as source 38 previously indicated, through line 164 and is returned to such source through line 165. The power fluid can be supplied and returned through conventional 4-way hydraulic control valve 166 connected by line 167 to the blind or lowering end of cylinder 113 that raises and lowers the lift member 45; and power fluid can be supplied and returned through valve 166 and line 168 connected to the rod or lifting end of the cylinder 113. Valve 166 is actuated by solenoids 169 and 170 through electrical circuit wires 172, 173 connected to control switch 146 on handset 137 that controls raising and lowering of lift member 45.

Power fluid under pressure can also be supplied from line 164 through conventional 4-way hydraulic control valve 174 that controls the flow of fluid through lines 175 and 176 to and from each cylinder 133 that moves the fingers 126 of a tong 46. Valve 174 is actuated to solenoids 177, 178 connected through circuit lines 179 and 181 and 182 to the switch 147 on the hand-set 137 that controls operation of the tongs.

A valve 184 of known type, often referred to as an over-center valve is mounted on trolley 44 near cylinder 113 and interposed in line 168 connected to the lifting end of cylinder 113 to supply power fluid for raising the lift member 45. This insures that in the event loss of pressure in the fluid in the line 168 between valve 184 and control valve 166 or even before valve 166, as by a line break, fluid cannot escape from the lifting end of cylinder 113 past valve 184, and piston rod 114 of cylinder 113 therefore cannot move down and drop the lift member 45 or any auger section carried by it. The portion of line 168 between cylinder 113 and the valve 184 is preferably made of steel or other high strength metal that is essentially unbreakable and leakproof, whereas at least a portion of the remaining line 168 must necessarily be made of flexible hose material to compensate for movement of the trolley and bridge.

The illustrated apparatus also embodies means to prevent inadvertent opening of auger tongs that could allow any auger carried by the tongs to drop, while the hoist apparatus carries an auger section. The illustrated means comprises a pressure switch 186 of known type connected by line 187 to sense the fluid pressure in the line 168 that supplies power fluid under pressure to the lifting end of cylinder 113 for lifting the member 45 carrying the auger tongs, preferably in the strongest portion of the line between the valve 184 and cylinder 113. This pressure switch thus also senses the fluid pressure in the lifting end of the cylinder. This fluid pressure holds switch 186 in its open position and therefore interrupts the electrical circuit through lines 181 and 182 between the tong control switch 147 on handset 137 and the hydraulic control valve 174, thus rendering this circuit inoperative to actuate valve 174 to open any tong so long as a predetermined pressure corresponding to a load of one or more auger sections carried by the tongs is in the fluid in the lifting end of cylinder 113. When the load of the auger section is removed, as because the lift cylinder has lowered lift member 45 and the auger section or sections carried by its tongs into the machine or into an auger rack, then the fluid pressure in cylinder 113 is reduced and switch 186 closes. This permits the switch 147 when properly moved to energize the circuit that operates the solenoid of hydraulic control valve 174 to open the tongs.

Pressure switch 186 may be adjustable if desired, although in general it can be set to open even if only one auger section is carried by the tongs even though the apparatus may be adjustable to carry several auger sections.

Thus, these two safety features cooperate to prevent inadvertant dropping of auger sections due to loss of pressure in the line supplying power fluid to lift cylinder 113 as due to line breakage or malfunction or to inadvertant operation of the tong switch to the open position, or for other reasons Each tong itself will normally remain closed until positively opened by operation of its cylinder 133. Therefore, in the illustrated embodiments, the tongs cannot open to release an auger section until the lift member carrying the tongs is intentionally lowered and the load of the auger sections is removed from the tongs.

Another safety feature of the present apparatus arises because the walkways 136 on the machine extend completely to the rear of the machine to permit an operator to leave the machine quickly in case of emergency, as if there should be a slide from an overhanging cliff.

As previously indicated, safety is also provided because the auger sections can be manipulated and moved by the hoist apparatus in such a way that they completely avoid any location in which an operator is located so they cannot strike the operator which being moved, and because auger sections carried by the lift member are raised and lowered in a fixed path relative to the trolley, which itself moves in a fixed path relative to the bridge that itself moves in a fixed path relative to the machine as a whole, which means that the auger sections cannot swing and strike an operator while they are raised.

Moreover, since the illustrated machines are extremely short in length as compared to prior auger machines for the reasons indicated above, and since there is only a very small distance between the pit floor on which the machine rests when the jacks are retracted and the bottom edges of the augers or cutting heads, the depth and the width of the floor that must be cut to form a pit to permit the auger machine to operate against a face containing the seam of material to be mined are substantially reduced, the width being reduced by as much as several feet, over those of prior auger machines. This substantially reduces the amount of material to be excavated and the costs of excavating the pit and establishing the floor, particularly when rocky or hard material is encountered; it also provides for ecological benefits because considerably less excavating is required.

The present apparatus therefore provides important advantages in reducing the amount of digging or excavating that must be done to establish the machine in operating position, in providing greatly increased safety for operators, in making possible substantial reductions in labor, in improving speed of operation because the hoist apparatus makes possible rapid handling of auger sections and simultaneous handling of a multiplicity of auger sections, in reducing costs of mining, in providing greater ease of transportation of the machine because of its smaller size and the fact that it can be made more compact for transportation, and in making possible economical recovery of coal or other material in inclined seams because the hoist apparatus makes possible the

handling and accurate placement of auger sections where the machine is inclined, all as described above. Other advantages will be apparent to those skilled in the art.

Apparatus embodying the invention may be used for purposes other than mining coal.

Various modifications apparent to those skilled in the art, in addition to those indicated, may be made in the apparatus and methods indicated above, and changes may be made with respect to the features disclosed, provided that the elements or steps set forth in the claims hereof or the equivalent of such be employed.

What is claimed is:

1. Auger apparatus comprising a frame; means associated with said frame for rotating at least one auger extending in said apparatus along a lateral axis and made up of a plurality of elongated auger sections connected end-to-end and having axes substantially coinciding with said auger axis; and, associated with said frame, hoist means for lifting and lowering an auger section, comprising a laterally movable member, means for supporting said laterally movable member for lateral movement between a location above a portion of said axis of said auger in said auger apparatus and a location spaced laterally from the said axis of said auger, rigid lift means including auger section holding means, said lift means being carried by said laterally movable member for movement in an upwardly extending path that is essentially fixed relative to said laterally movable member so that by cooperation of said laterally movable member and said lift means said auger section holding means can lift and carry an auger section between said two locations without appreciable relative lateral movement between said auger section and said upwardly extending path of movement of said lift means on said laterally movable member.

2. The apparatus of claim **1** in which said auger section holding means is adapted to hold a single auger section.

3. The apparatus of claim **1** in which said auger section holding means is adapted to hold a plurality of auger sections in substantially parallel relation.

4. The apparatus of claim **1** in which said auger section holding means is adjustable to hold simultaneously one or a plurality of auger sections.

5. The apparatus of claim **1** in which said auger section holding means is adapted to hold a plurality of auger sections is substantially parallel relation, and which is adjustable to permit the spacing between the axes of said auger sections to be adjusted.

6. The auger apparatus of claim **1** comprising rotatable drive means for rotating an auger section, means for detachably connecting one end of said auger section to said rotatable drive means, means operated by remote control for acutating said connecting means to disconnect said auger section from said drive means, and means operated by remote control for disconnecting the other end of said auger section from another auger section.

7. The apparatus of claim **1** comprising power means for moving said lift means in said upwardly extending path relative to said laterally movable member, and means for preventing downward movement of said lift means in the event of failure of said power means.

8. The apparatus of claim **1** comprising means for actuating said auger section holding means to release an auger section carried thereby, and means to prevent actuation of said auger section holding means to release an auger section carried thereby while said auger section holding means supports the load of an auger.

9. The apparatus of claim **1** in which said means for supporting said laterally movable member for lateral movement supports said laterally movable member for lateral movement in directions generally longitudinally and generally transversely relatively to said auger axis.

10. Auger apparatus comprising a frame; means associated with said frame for rotating at least one auger extending in said apparatus along a lateral axis and made up of a plurality of elongated auger sections connected end-to-end and having axes substantially coinciding with said auger axis; and associated with said frame, hoist means for lifting and lowering an auger section, comprising laterally movable trolley means, means for supporting said trolley means for lateral movement between a location above a portion of said axis of said auger and a location spaced laterally from the axis of said auger, said means for supporting said trolley means comprising rail means fixed to said frame of said auger apparatus and extending transversely of and above said lateral axis of said auger and above said locations and bridge means adapted to travel on and along said rail means in a path transverse to the auger axis, said trolley means being adapted to travel on said bridge means in a path transverse to the path of travel of said bridge means, and, carried by said trolley means, rigid lift means including auger section holding means for movement in an upwardly extending path relative to said trolley means, so that by cooperation of said trolley means and said lift means said auger section holding means can lift and carry an auger section between said two locations without appreciable movement between said auger section and said upwardly extending path of movement of said lift means on said trolley means.

11. The apparatus of claim **10** in which at least one of said bridge means and said trolley means is supported by three rollers only with the two rollers on one side of said means and one roller on the other side of said means, to provide three point supports for said means.

12. The apparatus of claim **11** in which said bridge means is supported by said three rollers.

13. The apparatus of claim **10** in which said bridge means and the rail means on which it travels include means cooperating to cause said bridge means to travel in a guided path on said rail means with substantially no lateral movement of said bridge means relative to said means.

14. The apparatus of claim **10** in which said bridge means and said trolley means include means cooperating to cause said trolley means to travel on said bridge means in a fixed path relative to said bridge means with substantially no lateral movement of said trolley means relative to said bridge means.

15. The apparatus of claim **10** comprising control means on said auger apparatus at a location such that an operator at said control means is away from any portion of the path of movement of any auger section carried by said hoist means.

16. The apparatus of claim **15** in which said control means is pendant control means permitting movement of the operator that he may visually observe the position of said auger section being hoisted.

17. The apparatus of claim **10** in which said rail means has at least one end portion that can be moved

from its operative extended position to reduce the width of the auger apparatus.

18. Auger apparatus comprising a frame; means associated with said frame for rotating at least one auger extending in said apparatus along a lateral axis and made up of a plurality of elongated auger sections connected end-to-end and having axes substantially coinciding with said auger axes; and, associated with said frame, hoist means for lifting and lowering an auger section, comprisiing a laterally movable member, means for supporting said laterally movable member for lateral movement between a location above a portion of said axis of said auger in said auger apparatus and a location spaced laterally from said axis of said auger, rigid lift means carried by said laterally movable member for movement in an upwardly extending path relative to said laterally movable member said rigid lift measns comprising an upwardly extending rigid supporting member having an axis and supporting auger section holding means, and said laterally movable member comprising guide means operating between said upwardly extending supporting member and said laterally movable member to guide said lift means for movement in a predetermined upwardly extending path relative to said laterally movable member, so that by cooperation of said laterally movable member and said lift means said auger section holding means can lift and carry an auger section between said two locations without appreciable movement between said auger section and said upwardly extending path of movement of said lift means on said laterally movable member.

19. The apparatus of claim **18** in which said guide means includes adjustable means.

20. The apparatus of claim **19,** in which said guide means includes rollers at least some of which are adjustable toward and away from the axis of said upwardly extending supporting member to guide it nonrotatably in its upward path.

21. Auger apparatus comprising a rigid frame comprising a generaly horizontally extending lower portion haviing a front end and a rear end, power means carried near said rear end of said lower frame portion adapted to rotate at least one elongated auger section about its axis while it is positioned in an operative location in said auger apparatus with its axis extending generally parallel to said lower frame portion, spaced rails mounted above said lower frame portion and extending transversely of said axis of said auger section when it is mounted in said machine, first spaced upright members fixed to said lower frame portion near the rear end thereof for supporting said rails, second spaced upright members fixed near the front end of said lower frame portion for supporting said rails said second spaced upright members having two upwardly extending portions that are laterally substantially offset toward the front of the apparatus, bridge means adapted to travel on said spaced rails in a path transverse to the axis of said auger section, trolley means adapted to travel on and along said bridge means in a path transverse to the path of travel of said bridge means, lift means carried by said trolley means and having auger section holding means, said lift means being adapted to move in a substantially fixed path relative to said trolley means, auger section storage means at at least one side of said lower frame portion, said auger section storage means being adapted to support auger sections at a location offset laterally and rearwardly of the operative location of the auger section in said apparatus, and means for operating said bridge means, said trolley means and said lift means so that an auger section from said auger section storage means may be lifted upwardly above said storage means to a location where it can clear the laterally offset lower portion of said adjacent front supporting member, then moved forwardly over said laterally offset portion, and then moved transversely until it is above the operative location of the auger section in the apparatus, and then is moved downwardly to the operative location in said apparatus, and then can be removed in the reverse procedure to remove it from the machine and place it in said auger storage means.

22. The apparatus of claim **21** in which said auger section holding means is adapted to carry a plurality of parallel auger sections in fixed predetermined relation to each other.

23. Auger apparatus comprising a frame, means associated with said frame for rotating at least one auger extending in said apparatus along a lateral axis made up of a plurality of elongated auger sections connected end-to-end and having axes substantially coinciding with said auger axis; and, associated with said frame, hoist means for lifting and lowering an auger section, comprising auger section holding means, rigid means movable in an upright path relative to said frame for lifting and lowering said auger section holding means, means for actuating said rigid means to move in said upright path, and means associated with said rigid means for lifting and lowering said auger section holding means for preventing lowering of said auger section holding means in the event of failure of said means for actuating said rigid means for lifting and lowering said auger section means.

24. Auger apparatus comprising a frame; means associated with said frame for rotating at least one auger extending in said apparatus along a lateral axis and made up of a plurality of elongated auger sections connected end-to-end and having axes substantially coinciding with said auger axis; and, associated with said frame, hoist means for lifting and lowering an auger section, said hoist means comprising auger section holding means adapted to be actuated to grasp and to release an auger section carried by said auger section holding means, means for lifting and lowering said auger section holding means, and means for preventing actuation of said auger section holding means to release an auger section after said auger section holding means has been actuated to grasp an auger section and while it is supporting said auger section.

25. The apparatus of claim **24** comprising means for preventing said means for lifting and lowering said suger section holding means from lowering said auger section holding means in the event of failure of said means for lifting and lowering said auger section means.

26. Auger apparatus comprising a frame; means associated with said frame for rotating at least one auger extending in said apparatus along a lateral axis and made up of a plurality of elongated auger sections connected end-to-end and having axes substantially coinciding with said auger axis; and, associated with said frame, hoist means for lifting and lowering an auger section, said hoist means comprising auger section holding means adapted to be actuated to grasp and to release an auger section carried by said auger section holding means, rigid means for lifting and lowering said auger

section holding means, means for actuating said rigid means to move in an upright path relative to said frame, and means for preventing inadvertent lowering of an auger section in the event of failure of said auger section holding means or said means for actuating said rigid means for lifting and lowering said auger section holding means after said auger section holding means has been actuated to grasp an auger section and while it is supporting said auger section.

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